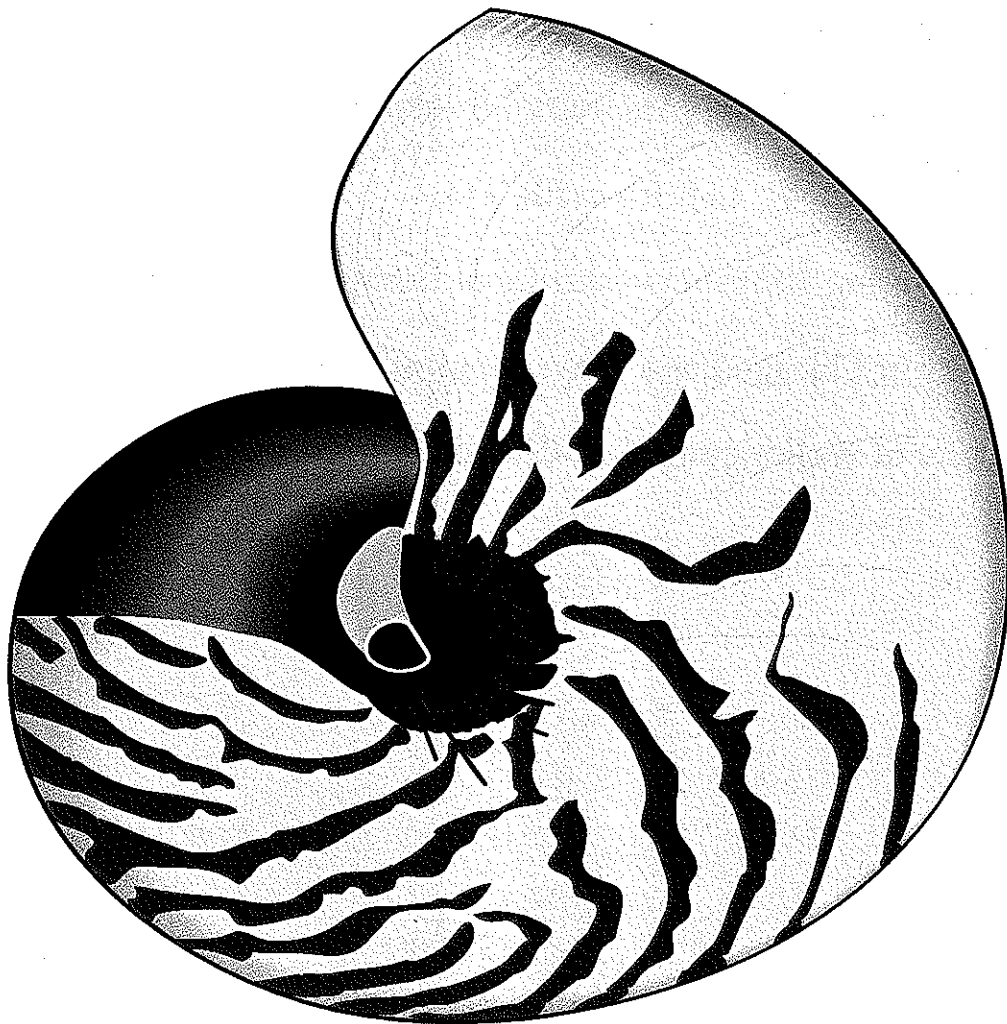


ANZSCPB



Program & Abstracts

*Australian & New Zealand Society for Comparative Physiology & Biochemistry,
14th annual meeting, University of Wollongong, Dec 5-7, 1997*

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Program**Friday December 5th**

9.00 registration & coffee/tea

chair**Talks (in lecture theatre 104)**10.30 Paul Else **Welcome & Introduction**10.45 Jean Joss

Lungfish hormone homologies

11.00 Diane Grozdanovski & Tes ToopNatriuretic peptide binding sites in the gills of adult, upstream migrating lamprey, *Geotria australis*.11.15 Janet McLeod, Chris Tewierik & John Donald

The role of the brain in osmoregulation in amphibians

11.30 Louise J. Kuchel & Craig E. Franklin

The estuarine crocodiles plastic osmoregulatory parts

11.45 Julie Roberts, Alison Leary & Peter Sharp

Hormonal regulation of osmoregulation in avian species

12.00 **LUNCH****(downstairs cafeteria)**13.30 Jean Joss Lee Astheimer, Bill Buttemer & Karen Fildes

Hormonal appraisal of year-round testicular maintenance in White-plumed honeyeaters

13.45 Bill Buttemer & Lee Astheimer

Effects of exogenous testosterone on BMR and morphology of male White-plumed Honeyeaters

14.00 ~~Andrew P. Arney~~Reproductive endocrinology of the bearded dragon, *Pogona barbata* (Reptilia, Sauria)14.15 Ellen Bennett & Susan JonesCorrelations between the secretory activity of the corpora lutea and embryonic stage in the viviparous skink, *Niveoscincus metallicus*14.30 Bronwyn McAllanHormonal influences on renal structure in *Antechinus stuartii* (Marsupialia)14.45 **Coffee / Tea and Posters**14.45 - 16.00 **POSTER PRESENTATIONS****(in room 101)**Ellen Bennett & Susan JonesInduction of parturition by arginine vasotocin and prostaglandin F2a in the viviparous lizard, *Niveoscincus metallicus*Du Zaixiang & A.J. Hulbert

Influence of temperature on tissue ion homeostasis in an endotherm and an ectotherm

S.L. Edwards & T. ToopMolecular identification of a putative Na⁺/H⁺ exchanger in the gill of the Atlantic hagfish (*Myxine glutinosa*)Karen Fildes

The hormonal relations of moult/breeding overlap in an Australian Honeyeater

Posters (cont'd)**(in room 101)**

Ashley Edwards & <u>Susan Jones</u>	The annual cycle of plasma testosterone, oestradiol and progesterone concentrations in males of a large viviparous skink, <i>Tiliqua nigrolutea</i>
<u>Tracy A. Maddocks</u> & Fritz Geiser	Energetics, nocturnal hypothermia and thermoregulatory limits of Australian silvereyes (<i>Zosterops lateralis</i>)
<u>Stuart Meier</u> & John Donald	The effect of natriuretic peptides on renal function in the kidney of the cane toad, <i>Bufo marinus</i>
<u>Annette Patak</u> & John Baldwin	Adaptations to high speed running in the pelvic limb musculature of the emu
<u>Mark D. Powell</u> , Will Callahan & Tes Toop	Localisation of natriuretic peptide binding sites in the gills and head kidney of rainbow trout, <i>Oncorhynchus mykiss</i> .
<u>Yoke Kum Wan</u> , Loraine Holley & Rosemarie Einstein	Relation of heart weight to ventricular defibrillation thresholds in anaesthetised sheep and dogs
<u>Roy Winstanley</u> & Bill Buttemer	Body energy reserves and physiological indices for the red fox, <i>Vulpes vulpes</i>

chair**Talks****(in lecture theatre 104)**

16.00	Julie Roberts	<u>Cintina Blaney</u> , Terence Dawson, Hugh McCarron & Andrew Krockenburger	Renal function and water metabolism during water deprivation and renal structure in eastern grey kangaroos
16.15		<u>Louise Godge</u> & Julie Roberts	Renal function and structure in <i>Notomys alexis</i> and <i>Mus musculus domesticus</i>
16.30		<u>Stuart Linton</u> & Peter Greenaway	Sites of uric acid synthesis and catabolism in the Gecarid Land Crab <i>Gecarcoidea natalis</i>
16.45		<u>Edward Meyer</u> & Craig E. Franklin	Acid tolerance in larval anurans
17.00		<u>Toni Priest</u> & Craig E. Franklin	Bimodal respiration and dive behaviour of the Fitzroy River Turtle, <i>Rheodytes leukops</i>

18.00

FRIDAY SOCIAL**in sports pavilion (bldg 13 on campus guide)**

<u>chair</u>	<u>Program</u>	<u>Saturday December 6th</u>
9.00	Bill Buttemer	Roger Seymour HOT PLANTS (Invited Keynote Address)
9.30		David T. Booth Egg composition and the energetics of incubation in the turtle egg
9.45		Gordon Rogowitz Constraints to parental allocation during lactation
10.00		Mark D. Powell Cardio-respiratory responses to acute gill irritation in rainbow trout, <i>Oncorhynchus mykiss</i>
10.15		Jason Cummings, M.B. Thompson & S. Morris Ecophysiology of hibernating long-necked turtles, <i>Chelodina longicollis</i>
10.30		Coffee / Tea
11.15	Terry Dawson	Gordon Grigg, Frank Seebacher & Lyn Beard Thermal relations of very large crocodiles
11.30		Joanne C. Holloway & Fritz Geiser Metabolism and thermoregulation in the sugar glider, <i>Petaurus breviceps</i> : response to season
11.45		Koa Webster & Terence Dawson Thermal properties of Koala fur
12.00		Kerry Withers, John Billingsley, Debra White & David Hirning Torpor in hypothyroid <i>Sminthopsis macroura</i>
12.15		J.E. P. W. Bicudo Euthermia and hypothermia in <i>Metachirus</i> (marsupial) and <i>Eupetomena macroura</i> (hummingbird)
12.30		LUNCH (downstairs cafeteria)
14.00	Tony Hulbert	Michelle L. Baker & Robert T. Gemmell The relocation of brushtail possums <i>Trichosurus vulpecula</i> from the environs of Armidale into captivity in Brisbane
14.15		Rufus Wells & Alice Jones Effects of season on haematology and blood chemistry in the brushtail possum, <i>Trichosurus vulpecula</i>
14.30		Robert A.B. Holland & Andrew A. Gooley Relationship of structure to function in the embryonic hemoglobins of the tammar wallaby, <i>Macropus eugenii</i>
14.45		Joseph F.Y. Hoh, Yoonah Kim, Christine A. Lucas & Louise G Sieber Cardiac myosins of macropodid marsupials: postnatal changes and expression of V1 in jaw-closing muscle
15.00		Robert T. Gemmell The role of the thyroid gland in the early development of the brushtail possum, <i>Trichosurus vulpecula</i>
15.15		Coffee / Tea
16.00	Peter Greenawa	Harry Battam & Bill Buttemer Energy and feeding relationships of non-breeding albatrosses
16.15		Ben Jing Wu & Paul L. Else Increasing the power of the sodium pump: a comparison of membranes and sodium pump molecular activities in ectotherms and endotherms
16.30		David Rolfe & Martin Brand The importance of proton leak- a mitochondrial uncoupling pathway - to mammalian SMR
16.45		A.J. Hulbert, Richie Porter, Paul Brookes & Martin Brand Mitochondrial proton leak: phylogeny and allometry
17.00		TEACHING FORUM Demonstration of some comparative physiology teaching software (Bill Foley et al)
19.00		DINNER Beach house restaurant, (North Wollongong beach)

<u>chair</u>	<i>Program</i>	<u>Sunday December 7th</u>
9.00	Roger Seymour <u>Rodger Kram & Terence Dawson</u>	Energetics and biomechanics of locomotion by red kangaroos
9.15	<u>Jacqueline Milton</u> & Craig E. Franklin	Locomotor performance and muscle mechanics in the aestivating frog, <i>Cyclorana alboguttata</i>
9.30	<u>Robbie Wilson</u>	Thermal plasticity of locomotor performance in larval and adult anurans
9.45	<u>Anita Wohlson</u> , Gordon C. Grigg & Craig E. Franklin	Can heart rate be used as an index of oxygen consumption in free ranging echidnas (<i>Tachyglossus aculeatus</i>)?
10.00	<u>Craig E. Franklin</u>	Cardiac control sites in the crocodilian heart
10.15	Coffee / Tea	
11.00	Lee Astheimer <u>William J. Foley</u> , Georgia P. Bass & Ivan Lawler	Antifeedant effects of eucalyptus secondary metabolites is mediated by serotonin in common brushtail possums
11.15	<u>Perdita J. Hope</u> , G.A. Wittert, I. Chapman, M. Horowitz & J. Morley	The effect of diet on the response to leptin in the marsupial <i>Sminthopsis crassicaudata</i>
11.30	<u>Terence Dawson</u> , Peter Whitehead, A. McLean, F.D. Fanning & W.R. Dawson	Digestive function in the magpie goose (<i>Anseranas semipalmata</i>)
11.45	<u>Shane K. Maloney</u> & David A. Gray	Characteristics of the acute phase febrile response in Pekin ducks
12.00	DISCUSSION & PRESENTATION OF STUDENT PRIZES	
12.30	LUNCH	(downstairs cafeteria)

Fri. 10.45

notes

LUNGFISH HORMONE HOMOLOGIES.

Jean Joss

School of Biological Sciences, Macquarie University, NSW 2109, Australia. Fax: 612 9850 8245; E-mail: jjoss@rna.bio.mq.edu.au

While controversy remains over phylogenetic relationships of the lungfish, the majority view is that the living dipnoans represent the closest extant ancestor of the amphibians. As such, study of their physiology, development and behaviour can provide insights into the evolutionary preadaptations for life on land. Before study of their endocrine preadaptations can be attempted, the structure of the hormones present in lungfish must first be elucidated. A number of such studies have been undertaken over the last few years, most of which have provided intriguing insights into the vexed question mentioned above of the dipnoan phylogenetic relationships. The hypothalamic neurosecretory hormone, gonadotropin-releasing hormone (GnRH), has been characterised by HPLC as primarily mGnRH with some cGnRH II. It shares these forms of GnRH with other extant ancient bony fish, amphibians and mammals, while most teleosts examined possess different forms. Lungfish neurohypophyseal hormones have recently been sequenced as primarily mesotocin, with some arginine vasotocin also present. Mesotocin has not been found in any other fish whereas it is commonly found in non-mammalian tetrapods. More recently, [Phe²]mesotocin has been identified in *Neoceratodus* and the precursors for both neurohypophyseal hormones have been characterised as tetrapod-type. Several anterior pituitary hormones have also been sequenced or partially characterised. These include prolactin, the alpha subunit of the glycoprotein hormones and the POMC peptides, ACTH and alpha-MSH, which all exhibit close homology with the tetrapod hormones. Finally, angiotensin has now been sequenced as the Asn 1, Val 5 form which is commonly found in fish. The steroid response to this form of AII in lungfish, however, is that of a tetrapod and not that of a teleost. Only aldosterone responds to this form of AII, both cortisol and corticosterone are unaffected. These hormone homologies provide strong evidence that the dipnoans are a living evolutionary link between the fish and the tetrapods.

Fri. 11.00

notes

Natriuretic peptide binding sites in the gills of adult, upstream migrating lamprey, *Geotria australis*

..... Diane Grozdanovski and Tes Toop
 School of Biological and Chemical Sciences
 Deakin University
 Geelong, Vic 3217.

..... Natriuretic peptide binding sites were examined in the gills of upstream migrating pouched lamprey, *Geotria australis*, using tissue section autoradiography, affinity cross-linking and SDS-polyacrylamide gel electrophoresis (SDS-PAGE), guanylate cyclase (GC) assays and molecular cloning. Specific binding of iodinated ANP was observed on the axial plates and the secondary lamellae, especially towards the efferent side of the gill. Binding was located on areas where pillar cells are found and around the marginal channels, but not on the major gill blood vessels; neither was binding observed on gill epithelial tissue. Specific binding was displaced equally by the addition of 1 μM rat ANP, porcine CNP and C-ANF. Affinity cross-linking of iodinated ANP to gill membranes followed by SDS-PAGE and autoradiography revealed bands with the apparent molecular weights of 204 kDa and 65 kDa under non-reducing conditions and 85 kDa and 65 kDa under reducing conditions. Guanylate cyclase assays failed to stimulate cyclic GMP production rates in the adult; however, in saltwater (SW) and freshwater (FW) acclimated juveniles, ANP stimulation of GC activity was observed. Reverse transcriptase polymerase chain reaction (RT-PCR) using degenerate primers to conserved regions of the NP C-type receptor (NPR-C) produced a PCR band of 470 base pairs which was subcloned and sequenced. Sequence analysis revealed a fragment with strong homology to the eel NPR-D and vertebrate NPR-C. Based on these data, it is hypothesised that an NPR-C/D is the predominant, if not the only, NP receptor present in the adult FW gill, whereas guanylate cyclase linked NP receptors are present in the juvenile gill when the juvenile is migrating to and entering the sea (currently, we have no data to confirm the presence of an NPR-C/D in the juvenile gill, although it is almost certainly present). It seems likely that the GC receptors have an importance in the SW adapted gill but not in the FW adapted gill of these animals.

Fri. 11.15

notes

The Role of the Brain in Osmoregulation in Amphibians

Janet McLeod, Chris Tewerik, and John A. Donald

School of Biological and Chemical Sciences, Deakin University

..... Amphibians are subject to dehydration in air and volume loading in fresh water if compensating mechanisms are not invoked. Our understanding of osmoregulation in amphibians is biased towards those mechanisms which prevent and counteract dehydration. Arginine vasotocin (AVT) released from the neurohypophysis has long been considered the principal hormone countering dehydration; however, there are doubts in the literature regarding the direct link between AVT and dehydration control. In contrast to the status of AVT, there is little understanding of the mechanisms controlling hypervolaemia. Our research group has been studying the role of the brain in osmoregulation in the cane toad, *Bufo marinus*. In particular we are interested in the linkage between blood volume and osmotic status and the activation of neurons in the brain, and the potential for interaction between two antagonistic neuropeptide systems, AVT and the natriuretic peptides (NPs), a hormone/neuropeptide implicated in the control of hypervolaemia in mammals. To study this, we have used immunohistochemistry, receptor binding, and expression of the immediate early gene *c-fos*. Our data show that AVT and NPs are not colocalised in any neural structure, but that NP-containing axons could modulate AVT neurons in the hypothalamus. Interestingly, the hypophysis contains the densest distribution of NP binding sites and suggests that NPs from the brain portal circulation or the heart could modulate both anterior and posterior pituitary function, including the release of AVT. A homologous toad *c-fos* cDNA was generated by molecular cloning and used to determine the effect of intravascular volume loading. Toads were prepared with a ventral abdominal vein catheter and the blood volume was increased by 50%. However, no rapid increase in *c-fos* mRNA expression was found in the brain, two hours after volume loading. This result is in contrast to previous work in birds and mammals which has shown that in the brain, *c-fos* mRNA is rapidly transcribed in the hypothalamus in response to volume and osmotic stimuli.

Fri. 11.30

notes

The Estuarine Crocodile's Plastic Osmoregulatory Parts

Louise J. Kuchel and Craig E. Franklin

Physiological Ecology Lab, Department of Zoology

The University of Queensland

The estuarine crocodile *Crocodylus porosus* is able to osmoregulate over a range of salinities by the combination of kidney function, post-renal modification of urine and secretory activity by the lingual salt glands. Morphological and biochemical evidence is presented to demonstrate the importance of the cloaca in the post-renal modification of urine, and indicating the urodaeum as the primary where this occurs within the cloaca. Combined data on electrolyte concentrations in ureteral and cloacal urine show that under hyperosmotic conditions both sodium and chloride are almost completely reabsorbed. Retention of sodium and chloride indicates the necessity for secretory activity by the lingual salt glands. Histological evidence will be presented to demonstrate the plasticity of salt glands in response to different environmental salinities, in particular the apparent increase in salt gland activity when exposed to hyperosmotic conditions.

functional significance)

Powerpoint presentation dysfunctional - had to use OH as backups

Fri. 11.45

Hormonal Regulation of Osmoregulation in Avian Species

¹Julie Roberts, ¹Alison Leary and ²Peter Sharp

notes

¹Division of Animal Physiology, School of Rural Science and Natural Resources, University of New England, Armidale, NSW 2351 and ²Roslin Institute, Edinburgh, Scotland

A number of hormones appear to be involved in overall osmoregulation and the regulation of renal function in avian species. These include the antidiuretic hormone arginine vasotocin (AVT), aldosterone, prolactin, atrial natriuretic peptide and angiotensin II. AVT is released primarily in response to elevated plasma osmolality and has actions on glomerular filtration rate (GFR), by vasoconstriction of the afferent arteriole, and on tubular permeability to water. The release of AVT in response to plasma osmolality is modulated by circulating fluid volume. Atrial natriuretic peptide is released in response to elevated extracellular fluid volume and has been shown to increase GFR. Angiotensin II stimulates drinking and also promotes the release of AVT. The roles of aldosterone and prolactin remain unclear. Aldosterone has been shown to enhance the uptake of sodium and water across the lower intestine of birds. However, although receptors for aldosterone are present in the kidney, the effect of aldosterone on kidney function has not been elucidated. Responses of plasma aldosterone to osmotic stress appear to be species dependent. Water deprivation resulted in a reduction in plasma aldosterone in chickens but an increase in the galah. In addition, the plasma aldosterone concentrations in the galah were consistently much higher than in the chicken, even for animals supplied with *ad libitum* water. Infusion of aldosterone into chickens resulted in few changes in kidney function. However, sodium and chloride excretion and fractional excretion were lower in the aldosterone group (as compared with a control group) following 40-80 minutes of aldosterone infusion. A role for prolactin in avian osmoregulation has been proposed following studies which have shown that the plasma concentration of prolactin increased following water deprivation or saline loading. However, our studies which have used an assay specific for chicken prolactin (antibody raised to recombinant chicken prolactin) have been unable to duplicate this response. Saline loading resulted in reduced plasma prolactin (perhaps a result of dilution of the plasma) and water deprivation caused no change in plasma prolactin. The role of aldosterone and prolactin in avian osmoregulation requires further clarification.

Fri. 13.30

notes

The Role of Reproductive Hormones in Life History Events in an Australian Passerine, the White-plumed Honeyeater

L.B. Astheimer¹, W. A. Buttemer² and Karen Fildes²

Dept. Biomedical¹ & Dept. of Biological Sciences², Univ. of Wollongong, NSW

In seasonal habitats, reproductive hormones are recognised as the important "downstream" response to environmental cues available to the CNS. As such, these hormones are used to simultaneously signal and synchronise both physiological and behavioural events to maximise reproductive success. Our descriptive and experimental studies of reproductive hormones and gonadal status in the white-plumed honeyeater, *Lichenostomus penicillatus*, reveal trends suggesting that reproductive hormones are not be as important for initiating reproductive readiness or for timing annual events as they are in most north temperate species. Support for this suggestion comes from the following observations made on an arid zone population of white-plumed honeyeaters. 1. Breeding may occur in any month of the year, although females show the lowest stage of ovarian activity in mid-winter. 2. Annual testicular cycles of recrudescence and regression are absent or are very damped in post-juvenile males. 3. Male testosterone levels are typically very low, even during the peak of breeding activity. 4. The male HPG axis remains responsive all year, with exogenous LHRH eliciting equivalent increases in LH and T at all times of year tested. 5. Moulting/breeding overlap is common; moulting proceeds slower in captive birds given T implants, but is not arrested- as it is in House Sparrows given a similar dose. Some of these life history attributes are also typical of tropical passerines. We suggest that many north-temperate species have evolutionarily coopted reproductive steroids as an endogenous signal to time life history events and synchronise behaviours. In this derived role, selection has favoured high hormone levels, well in excess of the needs for reproductive competence.

Fri. 13.45

notes

Effects of exogenous testosterone on BMR and morphology of male White-plumed Honeyeaters

W. A. Buttemer² and L. B. Astheimer¹

Dept. Biomedical¹ & Dept. of Biological Sciences², Univ. of Wollongong, NSW

We have previously established that the plasma testosterone of breeding male White-plumed Honeyeaters (WPHE) is about an order of magnitude lower than that of their north-temperate counterparts. Because of indirect evidence suggesting that testosterone elevates metabolic rate in some birds, we evaluated the physiological and morphological consequences of elevated testosterone in WPHE's. Free-living males were captured and placed in individual cages for 3 weeks before having their basal metabolic rate (BMR) and certain morphological features evaluated. Birds then received either empty silastic subcutaneous implants (controls) or testosterone-filled silastic tubes (T-birds) and then evaluated again 4 weeks later. T-birds differed from control birds in gaining more body mass, having larger testes, having darker bills, and having higher hematocrits. There was no effect of T on BMR. The gonadal regression seen in the controls along with their change in bill colour is never seen in free-living adult males. We believe such declines in breeding readiness in the control birds is a result of being isolated from contact with females and a consequent decline in stimulation of their HPG axis.

Fri. 14.00.

notes

Reproductive endocrinology of the bearded dragon, *Pogona barbata* (Reptilia, Sauria).

Andrew P. Amey

Dept. of Anatomical Sciences, The University of Queensland, Qld., 4072

The reproductive endocrinology of *Pogona barbata* has not been previously investigated. I measured the annual cycle in male and female dragons of plasma progesterone (P), testosterone (T), oestradiol (E) and corticosterone (B) using RIA. The most notable finding was the very low, usually undetectable, levels of E in vitellogenic females (0.075 ± 0.026 ng/mL, n=28, average \pm standard error; assay sensitivity 0.062 ng/mL). P was higher in vitellogenic females (6.75 ± 1.89 ng/mL, n=26) than gravid (3.21 ± 0.091 ng/mL, n=10) and non-reproductive ones (3.79 ± 1.64 ng/mL, n=28). T was low and invariant (0.85 ± 0.29 ng/mL, n=50). Neither month, reproductive state or body condition index correlated with plasma B levels. In males, T peaked at the beginning of breeding in August (21.62 ± 7.29 ng/mL, n=5) and was lowest at the end of breeding in December (2.97 ± 0.54 ng/mL, n=14). However, levels in the non-breeding period between January and July were significantly increased (5.90 ± 1.29 ng/mL, n=19). The August peak in male T corresponds with emergence from winter torpor and territorial/mating behaviour. The decline at the end of breeding corresponds with cessation of breeding behaviour and a brief testicular regression, while the post-breeding increase correlated with renewed testicular development and spermatogenesis. In both sexes, variation in plasma B did not correlate with reproductive state, month or body condition index (2.73 ± 0.46 ng/mL, n=162).

Fri. 14.15

notes

NIVEOSCINCUS METALLICUS

PLASMA PROGESTERONE

Correlations between the secretory activity of the corpora lutea and embryonic stage in the viviparous skink, *Niveoscincus metallicus*

Ellen Bennett and Susan Jones

Department of Zoology, University of Tasmania, GPO Box 252C-05, Hobart, 7001

Niveoscincus metallicus is a small viviparous skink, common and widespread throughout Tasmania and south-eastern Australia. Jones and Swain (1996) provide some data on annual cycles of estradiol and progesterone. However, this is the first study of this species in which production of progesterone during gestation has been correlated with embryonic stage and activity of the corpora lutea using histological parameters. Plasma progesterone concentrations increase rapidly during early gestation, and remain elevated until late gestation, when concentrations drop significantly. Plasma progesterone concentrations return to basal levels following parturition. Histological examination of the corpora lutea show clearly that the luteal cells are the predominant source of progesterone during gestation in *N. metallicus*, with the maximal diameter of the luteal cell mass correlating with the peak in plasma progesterone concentration. This is also supported by *in vitro* incubation studies, in which corpora lutea tissue produced significantly more progesterone than other ovarian tissue or adrenal glands. However, there was no significant difference between tissues incubated with prostaglandin F₂α and those incubated without PGF₂α, suggesting that the mechanisms controlling luteolysis in *N. metallicus* are different from those inducing parturition.

Fri. 14.30

notes

Hormonal influences on renal structure in *Antechinus stuartii* (Marsupialia)

B. M. McAllan

Division of Human Biology, School of Biological Sciences, University of New England, Armidale, N. S. W. 2351

The highly synchronised life cycle of the marsupial *Antechinus stuartii* culminates in complete male mortality following a one week mating period in mid August. Since male *A. stuartii* show pronounced physiological changes over the life cycle, renal structure was assessed for correlation with these changes. Firstly renal morphology was assessed in February, May, July and August and was found to change in males during the yearly cycle when endogenous concentrations of testosterone and cortisol are elevated (July and August). Secondly administration of testosterone-only, cortisol-only, or testosterone plus cortisol affects renal structure in comparison to saline treated males at a time of year when endogenous hormones are low (May). Pathological changes were observed in distal tubules and collecting ducts from cortisol treated groups, and in the glomeruli of testosterone treated males. Hypertrophy of the proximal tubules, distal straight tubules, and the cells of the cortical collecting duct occurred with the administration of testosterone. Distension of the distal convoluted tubules, cortical collecting ducts and outer medullary collecting ducts occurred with the administration of cortisol, although there was some interaction with testosterone. Many of these changes mimicked those seen in the seasonal study, with the kidneys of the testosterone plus cortisol group closely resembling those of males in August, just prior to the male mortality. This demonstrates that testosterone administration causes hypertrophy of renal tissue, whereas cortisol administration can cause tubular disruption in male *A. stuartii*.

ANZSCP'97 University of Wollongong ABSTRACTS

Fri. 14.45-16.00 (Posters)

notes

Induction of parturition by arginine vasotocin and prostaglandin F_{2α} in the viviparous lizard *Niveoscincus metallicus*

Ellen Bennett and Susan Jones

Department of Zoology, University of Tasmania, GPO Box 252C-05, Hobart, 7001

The viviparous mode of reproduction requires a delay in the induction of parturition relative to the oviparous mode. Embryos need to be held within the body of the female until they are fully developed; therefore the action of the hormones involved in parturition, such as prostaglandin F_{2α} (PGF_{2α}) and arginine vasotocin (AVT), must be delayed in viviparous species. This is one of very few studies that has compared the effects of PGF_{2α} and AVT on parturition in one species. Twenty one females carrying embryos at stage 40 were randomly divided into groups and administered with either PGF_{2α}, AVT or saline solution. In *Niveoscincus metallicus*, AVT has a more potent effect on inducing parturition than PGF_{2α}. This result is surprising, as AVT is believed to act by stimulating the production of PGF_{2α}, whereas PGF_{2α} acts directly on the oviductal tissue. This apparent contradiction may be explained by the stimulation and inhibition of β-adrenoreceptors. Parturition in *N. metallicus* is likely to involve a number of other factors, including circulating levels of progesterone and other gonadal and neurohypophysial hormones.

Fri. 14.45-16.00 (Posters)

notes

Influence of temperature on tissue ion homeostasis in an endotherm and an ectotherm.

Xiang Z. Du and A.J.Hulbert,

Department of Biological Sciences, University of Wollongong, Australia 2522

Although they have evolved from ectothermic animals that can tolerate a wide range of body temperature, in general, endothermic mammals cannot tolerate low body temperatures (hypothermia). For instance, the lethal body temperature of the laboratory rat is between 18-19°C for 24 hour hypothermia. The precise reasons why endothermic mammals cannot tolerate hypothermia are not known. One hypothesis centres around the role of cell membranes and proposes that death is due to the inability of mammalian cells to maintain cell ion homeostasis at low temperatures. The Na⁺ and K⁺ gradients across the plasma membranes are the core of cell ion homeostasis. At normal body temperature, these ion gradients are maintained by active pumping to balance the various leaks.

In this comparative study, liver and brain slices from rat and toad were used to determine the effect of low temperature challenge on tissue ion homeostasis. Intracellular K⁺ and Na⁺ contents were measured by flame photometry after the extracellular space of slices was washed out. To assess the damage of slicing and thus the active cell mass of slices, LDH (Lactate dehydrogenase) activity of slices was compared with that of the whole tissue. The leaks were measured as ²²Na flux with and without ouabain. Pump activity was measured as K⁺-uptake rate, (using ⁸⁶Rb as a K analogue). It was found that during 1 hour incubation rat liver and brain slices can maintain Na⁺ and K⁺ gradients between 19 and 37°C, but lost intracellular K⁺ and gained Na⁺ at temperatures <19°C. Toad tissue slices lost K⁺ and gain Na⁺ at temperatures less than 13°C. (2) The effect of low temperatures on the leakiness of tissue slices from both rat and toad was linear and relatively small. This indicates that the effect of low temperature on permeability of plasma membranes was basically physical rather than physiological (3) Sodium pump activity of rat liver and brain showed a dramatic increase in its temperature sensitivity at temperatures below 24°C and 29°C respectively, whereas the toad sodium pump activity either showed no increased temperature sensitivity at low temperatures (brain) or showed an increased sensitivity below 14°C (liver). It was concluded that the effect of low temperature on the leaks to ions is linear and small, but that the pumping mechanism is more sensitive, especially when temperature was lowered below a critical temperature. This leak/pump imbalance is greater in the endotherm tissues than in ectotherm tissues.

Fri. 14.45-16.00 (Posters)

notes

Molecular identification of a putative Na⁺/H⁺ exchanger in the gill of the Atlantic hagfish (*Myxine glutinosa*).

S L. Edwards and T. Toop

School of Biological and Chemical Sciences, Deakin University, Geelong, Victoria

Na⁺/H⁺ exchangers (NHE) are essential plasma membrane proteins involved in numerous functions including the maintenance of acid-base balance. To date five isoforms of the electroneutral NHE have been cloned from a number of vertebrate and invertebrate animals. The mechanism of acid-base regulation in seawater animals is poorly understood. It is thought that transbranchial Na⁺/H⁺ exchanger may assist in the ability of marine fishes to compensate for marine acidosis. Molecular studies on marine teleosts have identified gill cDNA homologous to the Na⁺/H⁺ exchanger with the resulting sequence showing an ~63% homology to the β-NHE found in the trout cephalic kidney. Hagfish are exclusively marine and provide a primitive vertebrate model to increase the understanding of early vertebrate systems. Physiological experiments have demonstrated an apparent Na⁺/H⁺ exchange system in the hagfish which has been suggested to be present in the branchial epithelium. We have used molecular techniques with the aim of identifying and characterizing the hagfish gill Na⁺/H⁺ exchanger. RT-PCR was used with degenerate primers to the conserved regions of the vertebrate NHE family which resulted in a the identification of an 723bp band by agarose gel electrophoresis. Subsequent cloning and sequencing of this band resulted in a partial sequence of hagfish gill cDNA which showed homology to other known vertebrate NHE isoforms. This evidence supports the presence of a Na⁺/H⁺ exchanger in the gill of the hagfish.

Fri. 14.45-16.00 (Posters)

notes

The hormonal relations of moult/breeding overlap in an Australian honeyeater. (Karen Fildes, Dept. Biol. Science, University of Wollongong)

Moult and breeding are two of the most energetically and nutritionally demanding phases in the avian life cycle. As moult typically follows breeding it has been proposed that sex steroids such as testosterone (T), may be a component of the physiological mechanism that keeps these events temporally separated within the life cycle. It is thought that this allows these events to occur with a minimum of energetic stress. However, much of the data in avian physiology and ecology have been generated in the Northern-Hemisphere and in many Australian passerine species moult and breeding commonly overlap. This study was concerned with the endocrinological basis of moult and breeding overlap in an Australian passerine, the white-plumed honeyeater (*Lichenstomus penicillatus*). A parallel study was conducted with house sparrows (*Passer domesticus*), a seasonally breeding species in which moult and breeding are temporally separated within the life cycle. The following questions were addressed: 1) Does an elevated level of plasma (T) have a similar effect on moult in honeyeaters as it does in house sparrows? and does plasma T affect plasma levels of thyroxine (T4) similarly in honeyeaters and house sparrows? The moult was affected by elevated plasma T in both species. In white-plumed honeyeaters it was significantly slowed, however in house sparrows it was completely arrested.

Fri. 14.45-16.00 (Posters)

notes

The annual cycle of plasma testosterone, oestradiol and progesterone concentrations in males of a large, viviparous skink, *Tiliqua nigrolutea*.

Ashley Edwards and Susan M. Jones

University of Tasmania, Zoology Department, GPO Box 252C-05, Hobart, 7001

Tiliqua nigrolutea is a large, viviparous skink distributed across south-eastern mainland Australia and Tasmania. This species is torpid throughout winter, with males emerging in spring (Sep), approximately one month before females (Oct), in order to complete gamete maturation. Mating occurs from late spring (late Oct) to early summer (Dec) and thereafter, males are reproductively quiescent until autumn (Apr) when spermatogenesis commences for the next reproductive season. Plasma steroid (testosterone (T), oestradiol (E2) and progesterone (P4)) concentrations show annual cycles of production. Striking and significant changes in monthly mean concentrations are coincident with important reproductive events. Plasma T concentrations are low during early spermatogenesis but increase throughout spermiogenesis and decline prior to mating, while plasma E2 concentrations are elevated only for the duration of the mating period. Plasma P4 concentrations show a less distinct annual cycle, with a tendency to be slightly elevated during the reproductive season.

Fri. 14.45-16.00 (Posters)

notes

Energetics, nocturnal hypothermia and thermoregulatory limits of Australian silvereyes (*Zosterops lateralis*)

Tracy A. Maddocks* & Fritz Geiser

Division of Zoology, School of Biological Sciences, University of New England, Armidale, NSW 2351 Australia.

As little is known about the thermal physiology of small Australian birds, we investigated the thermal capacity and energetics of an 11g Australian passerine (the silvereye, *Zosterops lateralis*) at low and high ambient temperature (T_a) extremes. Silvereyes entered nocturnal hypothermia on a regular basis, decreasing metabolic rate (MR) by up to 50 %, body temperature (T_b) by up to 3.5 °C, and thermal conductance by 30 % in comparison to resting values during the photophase. Silvereyes exhibited very high maximum MR (approx. sevenfold basal metabolic rate, BMR) induced by helium-oxygen (79:21 % He-O₂) exposure which resulted in an effective lower limit T_a of -41.7 ± 9.9 °C. Thus, they are able to produce heat which is sufficient to maintain a thermal differential between T_b and T_a of up to 80 °C. Within the thermoneutral zone (TNZ) the BMR was 2.30 ± 0.29 mL O₂ g⁻¹ h⁻¹ ($n = 8$, body mass = 11.30 ± 1.26 g), T_b was 38.4 ± 0.8 °C ($n = 4$), and thermal conductance was 0.38 ± 0.1 mL O₂ g⁻¹ h⁻¹ °C ($n = 4$). Above the TNZ, MR increased steeply with minor T_a increases but animals were able to tolerate T_a of 40 °C. Our study shows that silvereyes are able to enter nocturnal hypothermia, have very high heat production, and a high cold tolerance. This allows them to withstand a range of T_a of more than 80 °C, from about -42 °C to +40 °C.

Fri. 14.45-16.00 (Posters)

notes

.....
..... **The effect of natriuretic peptides on renal function in the kidney of**
..... **the cane toad, *Bufo marinus*.**
.....

..... Stuart Meier and John Donald
..... School of Biological and Chemical Sciences, Deakin University, Geelong.
.....

..... It is well established that natriuretic peptides (NP) are potent natriuretic / diuretics in
..... mammals, having direct renal effects while also inhibiting water conserving hormones.
..... Little is known however, about the effect of NPs in lower vertebrates such as
..... amphibians. It has been established that a population of NP receptors (NPRs) are
..... present on glomeruli and blood vessels in the kidney of the cane toad, *Bufo marinus*,
..... which can mediate rises in the intracellular second messenger, cGMP in response to NPs.
..... This is consistent with NPR locations in mammalian kidneys where NP stimulation
..... causes an increase in glomeruli filtration rates (GFR) while inhibiting water and salt
..... reabsorption in collecting ducts. This study aimed to identify the physiological
..... consequences of a NPR system in the toad kidney. Isolated toad kidneys were perfused
..... at a constant rate and a dose response curve to NPs was obtained. It was found that in
..... the toad kidney, NPs are potent vasodilators and also act to increase urine volume,
..... sodium excretion and GFR while reducing tubular water reabsorption. Thus, it appears
..... that the toad kidney responds to NPs in a similar way to mammalian kidneys.
.....

Fri. 14.45-16.00 (Posters)

notes

..... **Adaptations to high speed running in the pelvic limb musculature of the emu.**

..... *Annette Patak¹ and John Baldwin²*

..... ¹School of Natural Sciences, Edith Cowan University, ²Department of Ecology and Evolutionary
..... Biology, Monash University

..... The flightless Australian emu provides an extreme example of sustained aerobic high-
..... speed running by a bird. Although several descriptions of the pelvic limb musculature are
..... available, the nomenclature is inconsistent, and in several cases the information is
..... contradictory and contains obvious errors. We have redescribed these muscles in order to
..... provide a sound morphological basis from which to identify features characteristic of this
..... highly specialised form of avian locomotion.

..... Several anatomical features of the emu pelvic limb reflect the ability for sustained
..... running at high speed: a reduction in the number of toes; a unique *M. gastrocnemius* with four
..... bellies, rather than the usual three bellies found in other birds; the contribution to the total
..... body mass of the pelvic limb muscles is similar to that of the flight muscles of flying birds.

..... Generally, with the notable exception of *M. gastrocnemius*, the pelvic limb
..... musculature of the emu resembles that of other ratites. The presence, and arrangement, of four
..... muscle bellies increases the effectiveness of *M. gastrocnemius* and other muscles during
..... cursorial locomotion by moving the limb in a cranio-caudal rather than a latero-medial plane.
.....

ANZSCP'97 University of Wollongong ABSTRACTS

Fri. 14.45-16.00 (Posters)

notes

Localisation of natriuretic peptide binding sites in the gills and head kidney of rainbow trout, *Oncorhynchus mykiss*.
Mark D. Powell, Will Callahan, and Tes Toop.
School of Biological and Chemical Sciences, Deakin University, Geelong, Victoria 3217, Australia.

Natriuretic peptides have been implicated in a number of ionoregulatory and cardiovascular roles in fishes. Previous studies have demonstrated the localisation of natriuretic peptide binding sites in the vasculature of a number of different fish species as well as in the kidney. The gills and the head kidney from fresh water and salt water acclimated rainbow trout were cryostat sectioned at 14 μm then incubated with rat ^{125}I -ANP (0.2 nM) alone or in the presence of the receptor competitors rat ANP (10^{-6} M) or C-ANF (10^{-6} M). The sections were then fixed in 4% paraformaldehyde before overlaying with photographic film or dipping in a photographic emulsion. Following development of the photographic emulsion, slides were counterstained with either H & E or Müllers fluid for histological visualisation of the chromaffin tissue by the chromaffin reaction. Silver grains were localised over the branchial cartilage with specific binding to chondrocytes. Similarly specific binding was seen over the efferent lamellar arteries and arterioles. In the head kidney, specific binding was seen diffuse throughout the tissue. In all cases binding could be displaced with rat ANP and C-ANF. This study therefore supports the notion that natriuretic peptides have a cardiovascular function and may be involved in the modulation of catecholamine or cortisol release in trout.

Fri. 14.45-16.00 (Posters)

notes

Relations of Heart Weight To Ventricular Defibrillation Thresholds(DFTs) in Anaesthetised Sheep and Dogs. *Yoke Kum Wan, †Loraine Holley and ‡Rosemarie Einstein. CRC-Cardiac Technology, Australia. *Nanyang Techological University † University of Technology Sydney ‡ University of Sydney.

The application of an electrical shock via electrodes to the fibrillating heart is known as electrical defibrillation. An electrical dose concept that greater shock strengths are required with increasing body and heart weights for transthoracic- and direct-heart defibrillation respectively had been proposed (Geddes et al. 1974a; 1974b). These studies employed different species of animals but the possible influence of species difference on the dose data was not considered. Since sheep have a higher ventricular DFTs than dogs (Wan et al. 1996), the present study examines the influence of animal species on the relations of heart weight to ventricular shock strengths. Sixteen merino sheep (heart weight ranged 125-277gm) and 8 mongrel dogs (heart weight ranged 180-234gm) were used and the animals were anaesthetised with i.v. pentobarbitone (22 mg/kg for sheep and 30 mg/kg for dogs) and maintained with continuous infusion of pentobarbitone at 17-23 mg/kg/hr for sheep and 3 mg/kg/hr for dogs. Ventricular fibrillation was induced by a 1 sec burst of 50Hz square wave delivered via the screw-in pacing leads. Fifteen seconds after fibrillation onset, defibrillation was attempted by delivering a biphasic shock (5.6, 2.4 msec) via the epicardial patches on the left and right ventricles. An approximate defibrillation threshold was obtained by decreasing shock energies by 30V until 2 failures on consecutive trials occurred. Six voltages were selected around each of the defibrillation threshold and each voltage tested in a randomised order (5 repeats at each voltage). The voltage versus % success data were computed using logistic regression analysis and expressed as the shock voltages associated with 50% probability success (DFT50). The relationship between DFT50 and heart weight were analysed by simple linear regression. Although the trend line of DFT50 and heart weight appears to suggest a rise in DFT50 with increase heart weight, the low correlation coefficients between heart weight and DFT50 ($r^2 = 0.0395$ for sheep and 0.1087 for dogs) indicate that in a single animal species, heart weight is not a influential predictor for defibrillation success.

Geddes LA, Tacker WA, Rosborough JP et al. (1974a) *J of Clinical Investigation* 53:310-319

Geddes LA, Tacker WA, Rosborough JP et al. (1974b) *J of Thoracic & Cardiovascular Surgery* 68:593-602

Wan YK, Wong TW, Einstein R et al. (1996) *Abstracts of the Cardiac Society of Australia and New Zealand Annual Scientific Conference*, p177

Fri. 14.45-16.00 (Posters)

notes

**BODY ENERGY RESERVES AND PHYSIOLOGICAL INDICES
FOR THE RED FOX (*VULPES VULPES*)**

Roy Winstanley^{1*} and Bill Buttemer²

²Department of Biological Sciences, University of Wollongong, New South Wales, Australia.

¹Vertebrate Pest Research Unit, NSW Agriculture, Orange Agricultural Institute, Orange, New South Wales, Australia.

The red fox (*Vulpes vulpes*) in Australia is regarded as a significant environmental and agricultural pest. Predation by foxes presents a serious threat to native fauna and livestock. In planning strategies for fox control, an understanding of their energy balance is important as it may indicate critical times of the year when energy reserves are limited. These critical times may indicate periods of increased demand on prey biomass and potential periods to maximise bait uptake. Energy reserves are notoriously difficult to estimate. We used total body fat (TBF) as a measure of body condition for foxes in order to determine seasonal variation in body energy reserves and to evaluate various indices to predict total body fat. The study was conducted in the Central Tablelands of New South Wales, Australia, from August 95 to July 96. Total body fat was determined as a percentage of skinned body mass each month for seven male and seven female adult foxes ($n=168$). Fat content was determined from homogenized samples using chemical analysis.

Mean TBF varied considerably over time ($P<0.001$). There was no interaction between month and sex ($P=0.145$) (ANOVA). Body fat in females declined dramatically during lactation (September), and fat declined in males during mating (July). Fat indices were correlated with TBF using simple regression analyses. Kidney fat was the most reliable index for estimating TBF ($r^2=0.76$), followed by back fat thickness ($r^2=0.69$) and a subjective visual index (visceral fat) ($r^2=0.67$). None of the non-destructive indices evaluated were found to be useful. A multivariate model based on kidney fat index and back fat thickness accounted for 85% of variability. These indices were found to be reliable under field conditions.

Fri. 16.00

notes

Renal function and water metabolism during water deprivation and renal structure in eastern grey kangaroos.

Cintina Blaney, Terence Dawson, Hugh McCarron and Andrew Krockenberger

School of Biological Science, University of New South Wales, Sydney NSW 2052

The effects of water deprivation on renal function and water metabolism were investigated in eastern grey kangaroos. Basic kidney structure was also examined. Water deprivation for a period of 8 days caused a 15% reduction in body weight, reduced urine flow rates by 65% and glomerular filtration rates by 50%. Urine and plasma osmolality and plasma protein concentration all increased during water deprivation. Water content as a percentage of body weight was not significantly altered during water deprivation, but water turnover had significantly declined. Water was lost from all body water compartments, especially from the interstitial space, extracellular fluid, cell and gut water. Eastern grey kangaroos were able to maintain their plasma volume during the initial stages of dehydration. They possess kidneys that are bean-shaped and smooth without any superficial lobation. Their kidneys have a single distinct papilla that does not extend into the ureter. Renal indices include a kidney size of 45.5 and a relative medullary thickness of 5.14. These results suggest the eastern grey kangaroo possess some renal and metabolic powers for water conservation.

Fri. 16.15

notes

Renal function and structure in *Notomys alexis* and *Mus musculus domesticus*.

Louise Gorge and Julie Roberts

Department of Animal Physiology, University of New England, Armidale, NSW 2350.

Notomys alexis (Australian hopping mouse) has an efficient renal system which allows it to live indefinitely without free water. In order to further investigate renal ability we measured the following parameters in *Notomys alexis* and *Mus musculus domesticus*: inner medullary insulation, medullary vascular bundles, glomerular filtration rate, plasma concentration and haematocrit, while animals were maintained at different levels of hydration. Two groups of *M. m. domesticus* were fed different diets to determine the effect of diet on renal response. The comparison between *N. alexis* and *M. m. domesticus* allowed us to measure the renal response in xeric and non-xeric adapted species. The inner medullary insulation of *N. alexis* did not fit the model proposed by Bankir and DeRouffignac (1985). A third model is needed to explain the urine concentrating and diluting ability of *N. alexis*. Glomerular filtration rate was unchanged by hydration level in *N. alexis*. Plasma and blood homeostasis was maintained in *N. alexis* but not *M. m. domesticus* during water deprivation. The renal function of *N. alexis* is extremely responsive to the amount of water present, obviously a valuable asset in the desert environment.

Sites of uric acid synthesis and catabolism in the

Gecarcinid Land Crab *Gecarcoidea natalis*

Stuart M. Linton and Peter Greenaway

School of Biological Science, University of NSW, Sydney 2052

The gecarcinid land crab *Gecarcoidea natalis* synthesises uric acid *de novo* from excess dietary nitrogen and stores it intracellularly within spongy connective tissue throughout the body. The site of urate formation is unknown and was investigated by assaying various tissues (midgut, muscle, gill, spongy connective tissue) for xanthine oxidoreductase, the last enzyme in urate synthesis pathway. The possibility that urate could be catabolised was investigated by assaying the same tissues for uricase and urease. These are the first, and last enzymes of the uricolytic pathway. Xanthine oxidoreductase activity was present in midgut and connective tissue and these tissues were believed to be the sites of urate synthesis. Xanthine oxidoreductase activity within the midgut ($58.9 \pm 4.76(10)$ nmol urate produced. g^{-1} wet wt tissue. min^{-1} (mean \pm SE(n))) was 2.7 times the xanthine oxidoreductase activity in the connective tissue. Thus the midgut was considered to be the main site of urate synthesis. The dehydrogenase of xanthine oxidoreductase (which uses NAD⁺ as the electron acceptor) was the only form of the enzyme detected within the tissues of *G. natalis*. As xanthine dehydrogenase produces 2 NADH (=6ATP) during the oxidation of hypoxanthine to uric acid it could potentially reduce the total cost of synthesising urate *de novo* to 0-2 ATP. This means synthesis of urate *de novo* is not as energetically expensive as first thought. Uricase and urease activities and probably the full uricolytic pathway were present in *G. natalis*. Thus it is possible the urate deposits could be catabolised completely to yield ammonia. Spongy connective tissue contained the largest activities of uricase ($44.4 \pm 4.29(8)$ nmol urate consumed. g^{-1} wet weight tissue. min^{-1}). Uricase was also present in the midgut and gill but these activities were respectively 0.08 and 0.28 times the uricase activity in the spongy connective tissue. Urease was contained in the gills and midgut. The urease activity in gill tissue was large ($365.3 \pm 37.2(8)$ nmol urea consumed. g^{-1} wet weight tissue. min^{-1}), 4.2 times the urease activity in the midgut and 7.5 times the uricase activity in the spongy connective tissue.

Fri. 16.30

notes

(12)

Fri. 16.45

notes

Acid Tolerance in Larval Anurans

Edward Meyer and Craig E. Franklin
Vertebrate Physiological Ecology Lab, Department of Zoology,
University of Queensland.

Acidic water of pH 4.5 or less are toxic to most aquatic vertebrates, nevertheless there are frog species which naturally reproduce in acidic waters of pH less than 4.5. Among these are the 'acid' frogs of the wallum (east Australia's coastal sandy lowlands). Breeding only in acidic waters of pH 3.4-5.2, these species provide an excellent model for the study of the mechanisms underlying tadpole acid tolerance. Comparative ion flux, morphological and morphometric data from laboratory-reared acid-frog (*Litoria coolooensis*) tadpoles and acid sensitive *Litoria fallax* tadpoles indicate the involvement of resistance mechanisms enabling the maintenance of sodium balance in low pH waters. Such mechanisms include an efficient and presumably high affinity Na⁺ uptake system, high affinity Ca²⁺ binding at respiratory surfaces (i.e. the gills and tail) and an increase in mucus production at respiratory surfaces (mucus acting as a physical and or chemical buffer to H⁺ ions in the external environment).

Fri. 17.00

notes

**Bimodal Respiration and Dive Behaviour of the Fitzroy River Turtle,
*Rheodytes leukops***

Toni Priest and Craig E. Franklin
Vertebrate Physiological Ecology Lab, Department of Zoology,
University of Queensland.

Rheodytes leukops is a medium sized, river dwelling chelid that has the unusual ability of being able to respire from lungs and from flushing water in and out of its cloaca. Two large cloacal bursae lined with well vascularised papillae provide an excellent exchange surface for aquatic respiration. *R. leukops* can obtain a significant proportion of its oxygen from the water using chiefly the cloaca as the respiratory surface (mean = 42%, range 30-70%). In comparison, the Brisbane River turtle, *Emydura signata*, which has no evidence of specialised aquatic respiratory organs, obtains only 10% of its oxygen from the water, presumably via cutaneous routes. The extensive aquatic respiration by *R. leukops* enables it in under favourable water conditions (normoxic) to extend dive times beyond those recorded for *E. signata*. The effect of water temperature and oxygen content on the dive performance of *R. leukops* and *E. signata* was examined.

Sat. 9.00

Invited Keynote Address

notes

HOT PLANTS

Roger Seymour, Department of Zoology, University of Adelaide

*Sacred Lotus
(Birthplace of Buddha)*

The flowers of some plants produce enough heat to raise their temperatures as much as 35°C above air temperature. Three species, *Philodendron* (*P. selloum*), skunk cabbage (*Symplocarpus foetidus*), and the sacred lotus (*Nelumbo nucifera*) regulate flower temperature within a narrow range by an unknown physiological mechanism that increases the rate of heat production as ambient temperature decreases. The 42 g flowers of the sacred lotus remain between 30-36°C during a 2-4 day period, despite fluctuations in environmental temperatures between 8-45°C. Temperature regulation apparently occurs at a cellular level, by a steep, reversible, thermal inhibition of respiration at flower temperatures above 30°C. There is a marked time lag between temperature change and compensatory response, suggesting regulation through a biochemical feedback mechanism rather than structural changes in enzymes or membranes. Oxidising carbohydrate, the flowers produce up to 1 Watt, with about half of the heat coming from the 8.5 g carpellary receptacle. Equivalence of direct and indirect calorimetry substantiated the assumed caloric equivalent of oxygen consumption of 21.1 J ml⁻¹ and indicated that there was no conservation of energy in metabolic processes during thermogenesis. The period of temperature regulation begins before petal opening and continues through the period of stigma receptivity. Thermogenic plants occur only in ancient families of seed plants, and have apparently evolved in association with beetle pollinators. Because many beetles require high body temperatures for activity, the warm environment inside thermoregulating flowers may be an energetic reward during their visits. Thermoregulatory flowers lead us to question the role of direct cellular effects on thermogenesis in animals.

Sat. 9.30

notes

EGG COMPOSITION AND THE ENERGETICS OF INCUBATION IN TURTLES. David T. Booth, Department of Zoology, The University of Queensland, Qld. 4072.

Email: DBooth@zoology.uq.edu.au

Two species of freshwater turtle *Chelodina expansa* and *Emydura signata*, nest on the University of Queensland's St. Lucia campus. *C. expansa* has an incubation period twice as long as *E. signata* (100 days and 50 days respectively at 28°C) so differences in egg composition and energetics of incubation may be expected because embryos that take longer to develop generally require more maintenance energy compared to embryos that develop rapidly. Significant differences in dry egg energy density and composition were found. Both eggs had a similar ash fraction (6%), but *C. expansa* eggs had a greater energy density (28 kJ/g Vs 27 kJ/g), greater lipid content (31% Vs 25%), smaller protein content (54% Vs 60%), and greater production cost (the total amount of oxygen consumed during incubation per gram of yolk-free hatchling tissue; 114 mL O₂/g Vs 103 mL O₂/g) compared to *E. signata* eggs. These findings are consistent with predictions based on differences in incubation periods and indicate that *C. expansa* compensate for their greater production cost by increasing the high energy density lipid fraction in eggs.

Sat. 9.45

notes

Constraints to parental allocation during lactation: When is enough enough?
Gordon Rogowitz, Dept. of Biology, University of Puerto Rico

Studies of the hispid cotton rat (*Sigmodon hispidus*), a grassland rodent of North America, have revealed processes that influence milk flow and, hence, the growth of suckling offspring. These rodents have a substantial capacity to support the high cost of lactation by increasing intake. Hence, a central limit to energy assimilation is not evident. Furthermore, there is no evidence of competitive allocation, viz., between milk production and thermoregulation, which might occur if energy assimilation were limited. Mothers have some capacity to increase milk production (allocation per litter). Nonetheless, there are limits to the milk flow to offspring. Milk flow does not increase sufficiently to satisfy the higher total energy demand of offspring in larger litters or at lower temperatures (offspring growth declines in both cases). It is likely that safety mechanisms act to limit parental allocation during lactation. Selection may act to decrease maternal risk and reproductive cost.

Sat. 10.00

notes

Cardio-respiratory responses to acute gill irritation in rainbow trout, *Oncorhynchus mykiss*.
Mark D. Powell

School of Biological and Chemical Sciences, Deakin University, Geelong, Victoria 3217, Australia.

Chloramine-T, which is used as a disinfectant in aquaculture, has been used effectively to elicit respiratory and acid-base disturbances in rainbow trout blood resulting in an increased arterial PCO_2 . To examine whether this rise in arterial PCO_2 was mediated by changes in branchial blood flow or by diffusional limitations across the gill epithelium adult rainbow trout ($748.8 \pm SE 30.0g$) were exposed to $9 mg.L^{-1}$ chloramine-T for 45 min. Controls consisted of unexposed fish. Arterial and venous blood samples were withdrawn prior to and following exposure for the determination of blood gas and haematological parameters. Measurements were continuously made of ventral and dorsal aortic pressure, cardiac frequency and output. Exposure to chloramine-T had no significant effect on dorsal or ventral aortic blood pressures nor calculated branchial or systemic vascular resistances. However, exposure resulted in an increase in cardiac output (from 25.87 ± 3.05 to $33.35 \pm 4.50 mL.Kg^{-1}.min^{-1}$) and a concomitant increase in oxygen uptake rate (from 3.24 ± 0.38 to $4.17 \pm 0.37 mmol.Kg^{-1}.h^{-1}$). However, CO_2 excretion rates were not significantly increased. Calculation of the perfusion convection requirements for O_2 and CO_2 (cardiac output per unit gas uptake or excretion) revealed that increases in cardiac output were sufficient to maintain or increase O_2 uptake but insufficient to promote CO_2 excretion. These findings demonstrate that gill irritation by chloramine-T leads to an impediment of CO_2 excretion which is primarily diffusion limited but not O_2 uptake which is primarily perfusion limited under normal physiological conditions.

Sat. 10.15

notes

Ecophysiology of hibernating long-necked turtles, *Chelodina longicollis*

J. Cummings, M.B. Thompson and S. Morris
School of Biological Sciences, University of Sydney

Abstract:

The physiology and ecology of hibernating *Chelodina longicollis* were examined. The observation of this species hibernating on land led to the hypothesis that decreased water oxygen tensions force these turtles out of the water during hibernation. Ten animals were radio-tracked over the winter in two separate lagoon systems near the Murray River, Albury N.S.W. Water oxygen partial pressures and temperatures were monitored in these lagoons during winter. Within the lagoons, *C. longicollis* was exposed to decreasing water oxygen partial pressures, which fell to a daily average of 70 torr. Radio-tracked animals maintained low levels of mobility over winter even when water temperatures were as low as 5°C. No radio-tracked animals were observed hibernating on the land during any of the sampling periods. Animals in the laboratory were maintained at 8°C and exposed to hypoxic conditions (water PO₂ ≅ 40 torr) for up to one week with control animals maintained in normoxic water (water PO₂ ≅ 159 torr). Animals exposed to hypoxic conditions surfaced to breathe more often and consumed more oxygen aerially than those maintained under normoxia. There was no difference in levels of anaerobic metabolism between the treatments, with mean plasma lactate levels of 3.26 mmol.L⁻¹. There was an energetic cost associated with surfacing to breathe more often with muscle glucose levels significantly reduced in hypoxic animals. However, hibernation under short term exposure to reduced oxygen partial pressures was within the physiological capabilities of *C. longicollis*.

Sat. 11.15

notes

THERMAL RELATIONS OF VERY LARGE CROCODILES

Gordon Grigg, Frank Seebacher and Lyn Beard,
Department of Zoology, The University of Queensland, Q 4072.

We explored daily and seasonal changes in body temperatures of 11 *Crocodylus porosus* spanning 32-1010kg in naturalistic surroundings at the Edward River Crocodile Farm, Cape York, Queensland. Despite the tropical location (15°S), air and water temperatures showed pronounced daily cycles in both winter (16-33 °C and 20-31°C respectively) and summer (21-45 °C, 24-36 °C), which were reflected in large daily and seasonal cycles in operative environmental temperatures (Te). Crocodiles showed marked differences in behaviour between seasons. In winter they frequently basked on land during the day and spent the night in the water. In summer they did not bask, spent the day in the water or in the shade of fringing mangrove forest, and often emerged onto land at night. Daily ranges in Tb were consistently less than ranges in Te and decreased with increasing body mass, from 3.5 °C in 30-40 kg individuals to 1-1.5 °C in 600-1000 kg individuals. Differences were larger between seasons, however, with modal Tb values across all individuals ranging from 25.1-28.7 °C in winter to 28.4-33.6 °C in summer. A 1010 kg individual showed a daily range of 1 °C but had a 4°C difference between summer and winter. A mathematical model was developed from first principles and found to predict the empirical data very well. Using the model we were able to show that seasonal changes in behaviour are very important in modifying body temperature, to the extent, for example, that Tb would reach lethal levels if crocodiles employed winter behaviour in summer. Also, the model offers opportunities to explore the effects of increasing body mass on daily and seasonal values of Tb. A 10,000 kg individual at our study site, for example, would show essentially no daily cycle in Tb (31 °C under winter conditions in which Te ranged daily between 20-38 °C) but would still show a difference between seasons. Predictions of Tb could be made for any location with known climatic data and the model therefore offers opportunities to make realistic speculations about Tb in any very large ectotherm.

Sat. 11.30

notes

**Metabolism and thermoregulation in the sugar glider, *Petaurus breviceps*:
Response to season**

Joanne C. Holloway* & Fritz Geiser
Division of Zoology, School of Biological Sciences, University of New England
NSW 2351, Australia

Marsupials living in temperate regions must be able to cope with the environmental stresses imposed by seasonal changes in climate. However, few detailed investigations are available on the seasonal adjustment of thermal physiology and morphology in this subclass. The sugar glider, *Petaurus breviceps* (120-150 g), responded to the seasonal climatic changes in the Northern Tablelands of NSW in a number of ways. Body mass increased in winter compared to summer, primarily due to the 36 % increase in body fat. Basal metabolic rates (BMR) in winter were 14 % lower than those in summer. Further, the elevation of the regression line for resting metabolic rates at ambient temperatures (T_a) below the thermoneutral zone was also significantly lower in winter. However, thermogenic capacity increased by 20 %, resulting in a greater metabolic scope in winter (6.4-fold BMR) than in summer (4.7-fold BMR). Consequently, the animals could tolerate T_a that was 15 °C lower in winter than in summer before becoming hypothermic. The improved thermal tolerance is largely explained by the increased thermogenic capacity and the 20 % reduction in conductance during winter, the main cause of which appears to be the significant increase in fat content. Therefore, by altering their body size and composition, primarily through a decrease in locomotor activity and an increase food intake, and by increasing their thermal capacity, sugar gliders are able to significantly improve their cold tolerance in winter.

Sat. 11.45

notes

Thermal Properties of Koala Fur

Koa Webster and Terence Dawson, School of Biological Sciences,
University of N.S.W.

Properties of Koala pelts were measured by placing the pelts on a hot-plate (36°C) in a wind-tunnel, below an artificial radiation source. The total resistance (fur plus air boundary layer) was high (0.597 m².°C.W⁻¹ at 1 ms⁻¹) and decreased significantly with each increase in wind speed above 2 ms⁻¹. The air layer contributed 1.55% of the total resistance at each wind speed.

At low wind speeds, the heat load from solar radiation was less than 20% of the incident radiation. This dropped to less than 10% at wind speeds above 8 ms⁻¹.

Solar radiation was absorbed 2-3 mm below the surface of the fur.

Sat. 12.00

notes

Torpor in hypothyroid *Sminthopsis macroura*

Kerry Withers, John Billingsley¹, Debra White, David Hirning,
Pat McConnell and Allan Young

Department of Biology, University of Southern Queensland, Toowoomba, Qld 4350
and ¹Faculty of Engineering and Surveying, University of Southern Queensland,
Toowoomba, Qld 4350

Thyroid hormones influence a variety of physiological parameters, such as metabolic rate and the fatty acid composition and functioning of biological membranes. Whether thyroid hormones influence torpor in marsupials is unclear. To determine whether thyroid hormones have a role in torpor, we induced long-term hypothyroidism in *Sminthopsis macroura*. We did this by feeding *Sminthopsis* with food and water containing methimazole. We then measured basal metabolic rate and metabolic rate during torpor.

Basal metabolic rate was lower in the methimazole-fed *Sminthopsis*. These results indicate that they were indeed hypothyroid. Metabolic rate during torpor also tended to be lower in hypothyroid *Sminthopsis*.

Hypothyroid *Sminthopsis* were often unable to complete arousal from torpor. These animals were successfully re-warmed with external heat. The results suggest that thyroid hormones are involved in torpor in this marsupial species. However, the mechanisms involved are unclear.

Sat. 12.15

notes

Euthermia and hypothermia in *Metachirus nudicaudatus* (marsupial) and *Eupetomena macroura* (hummingbird)

J. E. P.W. Bicudo,

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The mechanism underlying hypothermia in mammals and birds has been an unsolved issue. Three main lines of hypothesis regarding the putative mechanism can be discerned: 1) temperature effect (or Q_{10} effect); 2) the presence of a metabolic depressor factor (e.g., respiratory acidosis); and 3) controlled downregulation of metabolism. Two different experimental animals were used throughout this study, i.e., *Metachirus nudicaudatus* (Brazilian marsupial), and a species of Brazilian hummingbird (*Eupetomena macroura*). Periods of euthermia and entry into torpor were characterized by means of oxygen consumption (VO_2) and body temperature (T_b). *M. nudicaudatus* presents nocturnal activity, and keeps an average T_b of 24°C and 34°C, during the day and night periods, respectively, when ambient temperature (T_a) was kept constant at 25°C. In *E. macroura*, euthermic T_b lies within a controlled range (38–41°C); euthermic VO_2 has an oscillatory pattern, and such an oscillatory pattern is aborted before the onset of torpor; minimum VO_2 is attained before minimum T_b , and minimum T_b occurs at a higher VO_2 value; and T_b fall is not a regular and smooth event. Although a similar pattern of events has also been observed in *M. nudicaudatus*, they were much less pronounced than in the hummingbird species, probably because of size dependent characteristics. Conductance is much higher in hummingbirds. A combination of these findings with misinterpreted measurements of Q_{10} reported in the literature leads to the conclusion that hypothermia in heterothermic-endotherms is a downregulated process without the need of temperature effects to explain it. (Supported by Fapesp Foundation, CNPq, and CAPES, Brazil).

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Sat. 14.00

notes

The relocation of brushtail possums *Trichosurus vulpecula* from Armidale into captivity in Brisbane.

Michelle L. Baker and Robert T. Gemmell, Department of Anatomical Sciences, University of Queensland.

Marsupials trapped in the wild and transferred into captivity undergo stress. These animals are stressed due to captivity and if they are housed at locations distant from their site of capture they are also exposed to new environmental conditions. The present study wishes to determine whether brushtail possums relocated from the environs of Armidale into captivity in Brisbane experience greater stress than possums captured in Brisbane and placed into captivity in Brisbane. Possums from Armidale displayed a decrease in body weight from capture to weeks 5-6 in Brisbane with female possums losing a greater proportion of their original body weight compared to males. After weeks 5-6 an increase in body weight in both male and female possums along with an increase in the plasma concentration of thyroxine indicated that these possums may have begun to adjust to captivity. The ratio of lymphocytes to neutrophils (L:N) in Armidale possums decreased from capture to weeks 6-10 and was lower in females compared to males. However, the subsequent increase in the L:N ratio and an improvement in the lymphocyte proliferation would suggest that possums first begin to show adjustment to captivity after 10 weeks following their relocation to Brisbane. However, a comparison of changes in body weight, plasma hormone concentrations and immune responses indicated that possums transferred from the environs of Armidale into captivity in Brisbane were under greater stress than possums captured in Brisbane and placed in captivity in Brisbane.

Sat. 14.15

notes

Effect of season on haematology and blood chemistry in the brushtail possum, *Trichosurus vulpecula*.

Rufus Wells and Alice Jones
Biological Sciences
University of Auckland

Haematological characteristics of marsupials support the idea that they have lower metabolic rates than do eutherian mammals. It is well known that mammals adopting strategies of seasonal energy conservation (such as hibernation and winter torpor) will adjust haematological parameters to support reduced respiratory demands. There is evidence that several Australian marsupials show seasonal variation in certain haematological parameters, although it is unclear whether these are metabolic or stress related. There have been no studies of seasonal effects on blood parameters of the brushtail possum, *Trichosurus vulpecula*, in New Zealand where factors such as nutrition and temperature may differ from those in Australian habitats.

Blood was sampled from tagged possums at two study sites in summer and in winter thus allowing for paired two-tailed t-testing. There were no significant differences in erythrocyte parameters or in the intraerythrocytic metabolites ATP and 2,3-diphosphoglycerate which regulate haemoglobin-oxygen affinity. Slightly reduced plasma glucose, platelet count, and eosinophil numbers were observed. Other white cell differentials remained unchanged. We believe that nutritional factors rather than temperature are likely to impact on haematology and blood chemistry.

Sat. 14.30

notes

RELATIONSHIP OF STRUCTURE TO FUNCTION IN THE EMBRYONIC HEMOGLOBINS OF THE TAMMAR WALLABY, *Macropus eugenii*

Robert A.B. Holland and Andrew A. Gooley. School of Physiology and Pharmacology, University of New South Wales, Sydney 2052 NSW, and Macquarie University Centre for Analytical Biotechnology, Sydney, NSW 2109.

The special respiratory properties of Tamar Wallaby embryonic blood have previously been reported at this series of meetings. These are: (1) a right shifted oxygen equilibrium curve (OEC) compared with the mother's OEC. (2) A Hill n over 4, and up to 6.5 for the upper part of the OEC; (3) A decreased effect of CO₂ on O₂ carriage.

We have now characterized and partly sequenced the four embryonic Hbs of the Tamar embryo and newborn, and found the following. Two Hbs (the most abundant) had embryonic α -like chains ζ (zeta) and ζ' , and an embryonic β -like chain (ϵ). One had adult α and the embryonic ϵ , and the other (only small quantities present) had adult α and an embryonic β -like chain which resembled avian globins more than mammalian. We have designated it omega (ω).

The α -amino groups at the N-terminus of the ζ chains are blocked. As these groups normally contribute to the Bohr effect, this blockage accounts for the decreased Bohr effect in embryonic blood. The residues which some workers have postulated can cause association of tetramers and a high Hill n in birds (α -71 LYS, and α -82 GLU) are both LYS in the ζ chain and so could not be responsible for association without a negative ion interposed. Also the presence of PHE at ϵ -2 has been suggested as causing left shifted OECs in prenatal animals. It is present in the Tamar but the embryonic OEC is right shifted. Finally excess positive charges in the central cavity of Hb shift the OEC to the left. However, we have not so far found decreased positivity here in the Tamar to account for the right-shifted embryonic OEC.

We do not yet know the function of the component with the ω -chain.

Sat. 14.45

notes

Cardiac myosins of macropodid marsupials: postnatal changes and expression of V1 in jaw-closing muscle. Joseph F.Y. Hoh, Yoonah Kim, Christine A. Lucas and Louise G. Sieber, Department of Physiology and Institute for Biomedical Research, F13, The University of Sydney, NSW, 2006, Australia

Eutherian mammals express two cardiac myosin heavy chain genes, MyHC α and MyHC β , which associate to form the heavy chain core of the three ventricular isomyosins: V1($\alpha\alpha$), V2($\alpha\beta$), and V3($\beta\beta$). These isoforms are also expressed in skeletal muscle, eg, V3 is expressed in slow fibres of eutherian locomotory muscle and jaw-closing muscles of most eutherian herbivores, while V1 is expressed in some rabbit jaw-closing muscle fibres. There has been no previous work on the state of cardiac myosins in marsupial mammals. Myosin was extracted from cardiac and skeletal muscle tissues of adult and postnatal macropodids and analysed by pyrophosphate gel electrophoresis, followed by Western blotting using antibodies against various MyHCs. Tissues were also examined by indirect immunohistochemistry. Ventricular myosin from the tamar wallaby (*Macropus eugenii*) and red kangaroo (*Macropus rufus*) revealed three components, similar to the eutherian counterparts. Myosin from jaw-closing muscles of various macropodids was virtually homogeneous and comigrated with V1. A polyclonal antibody raised in rabbits against red kangaroo jaw muscle myosin reacted immunohistochemically with macropodid jaw fibres, as well as atrial and ventricular muscles, but not with limb muscle fibres. In pyrophosphate Western blots, this antibody reacted with V1 and V2, but not with V3. However, monoclonal 5-4D, which is specific to eutherian slow skeletal fibres and MyHC β in Westerns, reacted with macropodid V2 and V3, but not V1. These results show that macropodid jaw muscle express MyHC α rather than MyHC β . They also strongly suggest that the heavy chain structure of marsupial ventricular myosins is the same as the eutherian counterpart, V2 being a heterodimer of the two types of cardiac MyHC. Analysis of ventricular myosins from 12 tamar wallaby joeys ranging in age from 26-242 days showed that up to 125 days the percentage of MyHC α is below 5%, but thereafter rises rapidly to reach 35% by 242 days of age. We conclude that cardiac myosins in marsupials are similar to their eutherian counterparts and that macropodids are unique among mammals in expressing only cardiac MyHC α in their jaw-closing muscles.

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Sat. 15.00

notes

The role of the thyroid gland in the early development of the brushtail possum, *Trichosurus vulpecula*.

Robert T. Gemmell, Department of Anatomical Sciences, University of Queensland, Brisbane, Australia.

The thyroid gland is not present at birth in marsupials and thyroid function begins during the latter half of pouch life. The developing possum receives thyroid hormones from the mother via the milk. This maternal thyroxine may have a role in the slow development of organ systems early in pouch life by acting on thyroid receptors in the pouch young. To determine the role of the thyroid gland of the possum on growth, the production of hormones from the maternal thyroid gland was inhibited. Methimazole implants were administered to mothers with young between days 10 and 80 post partum. Three young survived and 10 of the young died at 104.0 ± 10.8 days post partum (mean, SEM). All of the young that died had a lower body weight than control possum young and certain organs were retarded in their development. Thus the transfer of thyroxine from the mother to the young early in the lactation period is required for the development of vital organs

Sat. 16.00

notes

Energy and Feeding Relationships of Non-breeding Albatrosses.

Harry Battam & W. A. Buttemer

Dept. of Biological Sciences, University of Wollongong, Australia 2522

As a consequence of inaccessibility, energetic studies of pelagic seabirds during the non-breeding component of their lifecycle are virtually non-existent. In an annual event, from July - October, non-breeding individuals of several albatross species scavenge the large cuttlefish (*Sepia apama*) which dies in large numbers off Wollongong at the completion of breeding. Four albatross species are readily captured and have provided the opportunity for energetic and dietary studies at Wollongong. Studies at Wollongong seek to establish the significance of the cuttlefish in albatross lifecycles and quantify energy use and its relationship to a cuttlefish diet.

Albatrosses were captured at sea from a small craft, returned to Wollongong University and fasted for 30 hours before measurement of basal metabolic rate (BMR) in an open system respirometer. To determine assimilation efficiency and throughput, Wandering Albatross (*Diomedea exulans*) were kept under laboratory conditions for up to 1 week on a diet of *S.apama*. Food quantities were adjusted to achieve stable body weights and faeces were collected twice daily. Cuttlefish and faeces were analysed for lipid, crude protein and energy content. Additionally, water content of cuttlefish was determined. Preliminary results suggest that there is no significant difference between breeding and non-breeding BMR of Wandering Albatrosses. BMR estimates for three albatross species were significantly higher than predicted by the allometric model of Aschoff and Pohl (1970) for non-passerines; Wandering Albatross (26%), Black-browed Albatross (*D.melanophris*) (24%) and Yellow-nosed Albatross (*D.chlororhynchus*) (78%). These suggest that some albatross species while functioning within a limited metabolic scope hold a reserve capacity to meet occasional high power demands, possibly flight take-off and underwater swimming. *S.apama* composition was estimated at water $81.55 \pm 0.78\%$, lipid $0.035 \pm 0.031\%$ and protein $18.7 \pm 5.5\%$. Energy content was assessed at $15.9 \pm 0.67 \text{kJ/g}$. While this forage has low calorific value, Wandering Albatrosses assimilated *S.apama* with an estimated efficiency of $83.5 \pm 2.0\%$ and with a high throughput possible due to the quantity available it apparently accommodates the dietary needs of non-breeding albatrosses.

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Sat. 16.15

notes

**Increasing the Power of the sodium pump:
A comparison of membranes and sodium pump molecular
activities in ectotherms and endotherms.**

Ben Jing Wu and Paul L Else, Biomedical; Science University of Wollongong

Recently we have shown that the sodium pumps of mammalian (endotherms) tissues turn over energy 3-4 times faster than those of reptiles, amphibians and fish (ectotherms) at the same temperature (1). Using membrane cross-over experiments in both brain and kidney (tissues with high sodium pump concentrations) sodium pumps from an ectotherm (*Bufo marinus*), placed in the membrane environment of an endotherm (*Rattus norvegicus*), showed increase activity toward endothermic levels. Conversely, sodium pumps from an endotherm placed in membranes of an ectotherm show reduced levels of activity. These experiments support the hypothesis that the source of the membrane rather than that of the sodium pump primarily determines the large difference in the rate of energy turnover ie molecular activity of sodium pumps.

1) Else, P. L., D. J. Windmill and V. Markus (1996) Molecular activity of sodium pumps in endotherms and ectotherms. *American Journal of Physiology* 271(5):R1287-R1294.

Sat. 16.30

notes

**THE IMPORTANCE OF PROTON LEAK - A MITOCHONDRIAL UNCOUPLING
PATHWAY - TO MAMMALIAN STANDARD METABOLIC RATE.**

David F.S. Rolfe and Martin D. Brand, University of Cambridge, Department of Biochemistry, Tennis Court Rd., Cambridge CB2 1QW, U.K.

Standard Metabolic Rate (SMR) is the steady-state rate of heat production by a whole organism under a set of "standard" conditions. In mammals these conditions are that the individual is awake but resting, stress free, not digesting food (prior food intake being at or around maintenance level) and maintained at a thermoneutral temperature. Mammals use a considerable amount of energy in the Standard state, when no net work is done and all the free energy is dissipated. The question of where this energy goes has been the subject of much research effort.

Recent attempts to quantify the contribution of the cellular processes that underlie SMR indicate that the Na^+/K^+ -ATPase, Ca^{2+} -ATPase and protein synthesis and degradation together account for around 40% of SMR in adult rats. In addition, we recently showed that a futile cycle termed "proton leak" (proton extrusion from the mitochondrial matrix and the subsequent return of those protons to the matrix via leak pathways) accounted for around half of the oxygen consumption rate of resting, perfused rat skeletal muscle and 1/4 of that of resting isolated liver cells. Using these data we calculated that - in vivo - proton leak in liver and skeletal muscle alone could account for as much as one quarter of rat SMR. However, the physiological relevance our data is not clear. The perfused skeletal muscle and isolated liver cell preparations that we used in this study may have had a lower ATP demand than in vivo. For example, resting skeletal muscle in vivo is continually contracting in order to maintain muscle tone and posture and the liver is making urea and glucose. These processes may have been partially or completely inhibited in our preparations due to the nature of our experimental conditions. Ensuring a physiological ATP demand is important because the contribution of the proton leak to tissue or cell metabolic rate would be overestimated if, in our experimental system, the ATP demand was unphysiologically low. We present new data which show that, even under conditions in which a more physiological ATP demand is obtained, proton leak may account for as much as one quarter of Standard Metabolic Rate.

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Sat. 16.45

notes

Mitochondrial Proton Leak: phylogeny and allometry.

A.J. Hulbert[#], Richie Porter^{*}, Paul Brookes^{*}, & Martin Brand^{*}
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Mitochondrial proton leak is a significant contributor to metabolic rate of animals. It varies with the level of standard metabolic rate. It varies between mammals and reptiles and also allometrically in mammals. The purpose of this study was two-fold; (i) to confirm whether the mammal-reptile difference is a general endotherm-ectotherm difference and (ii) to analyse the the allometric variation in mammals in order to determine its basis.

The previously reported mammal-reptile difference is verified but it does not appear to be a general endotherm-ectotherm difference. Whereas reptiles have a less mitochondrial proton leak than mammals, mitochondrial proton leak is similar in amphibians, mammals and birds whilst fish liver mitochondria are more proton leaky than rat liver mitochondria. There is a correlation between the membrane fatty acid composition and proton leak in liver mitochondria from different vertebrates.

Analysis of the allometric relationship between body mass and mitochondrial proton leak in mammals suggest that two-thirds of this trend is due to a greater membrane surface in smaller mammals whilst the other third is due to the intrinsic membrane properties. There are correlations between membrane polyunsaturation and proton leak in liver mitochondria that may be the explanation for some of this allometric variation.

Sat. 17.00

notes

Teaching Forum
a demonstration of software for teaching comparative physiology

Sun. 9.00

Energetics and biomechanics of locomotion by red kangaroos (*Macropus rufus*)

Rodger Kram¹ and ²Terry Dawson

¹Dept. of Integrative Biology, University of California, Berkeley, CA USA

²School of Biological Science, University of NSW Sydney, 2052

As a red kangaroo hops faster, the rate of oxygen consumption (indicating metabolic energy) remains nearly the same; almost all other animals show proportional increases with speed. This phenomenon has been attributed to exceptional elastic energy storage and recovery via long compliant leg tendons. Compliant tendons may allow muscle fibers to act primarily as economical tension generators. Kangaroo muscles may also be exceptionally efficient. To determine if kangaroos have exceptionally efficient muscles, we measured the metabolic cost of uphill hopping where muscle fibers must perform mechanical work against gravity. We found that uphill hopping was much more expensive than level hopping. The maximal rate of oxygen consumption measured ($3 \text{ ml O}_2 \text{ kg}^{-1} \text{ s}^{-1}$) exceeds all but a few vertebrate species. However, efficiency values were normal, ~30%. Biomechanical measurements indicated that the lack of increase in oxygen consumption at faster speeds cannot be explained by an increase in the effective mechanical advantage of the extensor muscles of the ankle joint. Our measurements suggest that the preferred speeds of red kangaroos may be determined by the acceptable levels of tendon stress and not energetic cost.

Sun. 9.15

Locomotor performance and muscle mechanics in the aestivating frog, *Cyclorana alboguttata*.

Jacqueline Milton and Craig E. Franklin

Physiological Ecology Lab, Department of Zoology,
University of Queensland.

Prolonged inactivity or immobilisation of a limb via a plaster cast promotes muscle wastage or immobilisation muscle atrophy in most mammals. Anurans such as *Cyclorana alboguttata*, the striped burrowing frog, inhabiting xeric environments utilize the process of aestivation (a summer dormancy) for survival during extended periods of drought or dehydrating conditions. Aestivating anurans may remain burrowed underground in an inactive, hypometabolic state for several years, and with the return of the summer rains must mobilise themselves quickly to return to the surface to feed and reproduce within a limited time period. The effects of aestivation on locomotor performance and muscle mechanics in *C. alboguttata* were examined. *C. alboguttata* individuals that had been aestivating in the lab for 15 weeks were compared with controls. The results from analyses of jumping and swimming performance and isometric muscle mechanics will be discussed.

Sun. 9.30

notes

Thermal Plasticity of locomotor performance in larval and adult anurans

Robbie Wilson

Physiological Ecology Lab, Department of Zoology
The University of Queensland
St. Lucia 4072

It is often assumed that the locomotor system of amphibians does not possess the capacity to compensate for changes in the thermal environment. I tested this assumption by examining the thermal plasticity of locomotor performance in Striped Marsh Frog larvae (*Limnodynastes peronii*) and African Clawed Frog larvae and adults (*Xenopus laevis*). In addition, I compared the effect of temperature on the jumping performance of Striped Marsh Frogs between four populations over a huge latitudinal range, from Proserpine in the tropical north to Melbourne in the cool temperate south. Burst swimming sequences were filmed using an NAC-high speed video camera at 200 Hz. The maximum jumping performance of the frogs was calculated by using a force platform to measure the ground reaction forces during jumping at 8 different temperatures, from 5 to 32 °C. Compensation of the locomotor system to distinct thermal environments, through either genetic or phenotypic means, will be discussed.

Sun. 9.45

notes

Can heart rate be used as an index of oxygen consumption in free ranging echidnas (*Tachyglossus aculeatus*)?

Anita Wohlsen, Gordon C. Grigg and Craig E. Franklin
Physiological Ecology Lab, Department of Zoology,
University of Queensland

Oxygen consumption is almost impossible to measure in the field but with the use of telemetry, heart rate can be measured quite easily. Oxygen consumption and heart rate were measured in echidnas in the laboratory using flow through respirometry and electrocardiography, respectively. The relationship between heart rate and oxygen consumption was determined for each animal and also how this relationship was affected by ambient and body temperatures, body mass and activity. The results indicate that heart rate is a good indicator of oxygen consumption and with the additional information about body temperature, ambient temperature, body mass and activity, can be used as a predictive tool for oxygen consumption in the field. Even at very low oxygen consumption rates during torpor, heart rate could be used as an index of oxygen consumption, which is useful in determining the mechanisms involved in entry to and arousal from torpor and hibernation in echidnas. Results suggest that the onset of torpor is due to an active suppression of metabolism rather than the effect of reduced temperature, and that body temperature falls as a result of metabolism being turned down and not the other way as originally thought.

Sun. 11.15

notes

The effect of diet on the response to leptin in the marsupial *Sminthopsis crassicaudata*
Hope, P.J., Wittert, G.A., Chapman, I., Horowitz, M. and Morley, J.

Leptin, the protein product of the *ob* gene regulates food intake and thermogenesis. Abnormalities of the *ob* gene and its receptor result in obesity in *ob/ob* and *db/db* mice respectively, and although human obesity is not usually associated with abnormalities of leptin or its receptor, leptin 'resistance' has been postulated. The effect of leptin on body weight and food intake in marsupials has not been evaluated, and the role of dietary intake on the effect of leptin in marsupials is unknown. *Sminthopsis crassicaudata* (*Sc*) is a small (10-20g) nocturnal marsupial which, in captivity, stores 25% of total body fat in its tail. *Sc* prefers mealworms (MW) (2.99 kcal/g, 30% fat) to its usual laboratory diet (LabD) (1.01 kcal/g, 20% fat). The aims of this study were to determine the effects of leptin on food intake, body weight, tail width and metabolism in *Sc*, and whether these effects are modified by diet.

Groups of *Sc* (n=19-20) were randomly allocated to receive either LabD or a choice between LabD or MW. For the first 2 days, all animals received intraperitoneal (IP) injections of Phosphate Buffered Saline (PBS), and for the next 13 days 1/2 the animals in each dietary group received IP human recombinant leptin, 2.5 mg/kg twice daily, while the other 1/2 received PBS.

In animals receiving LabD alone, leptin induced a decrease in body weight (P<0.0001), tail width (P<0.0001), and energy intake (P=0.01). However, in animals receiving both LabD and MW, leptin had no effect on body weight or tail width. In this group of animals, although there was a non-significant fall in overall energy intake (P=0.07), the proportion of LabD eaten was significantly reduced (P=0.001). In animals fed LabD alone, VO₂ was not significantly increased by leptin, but RQ was increased (P=0.05) compared to PBS controls. In animals fed both LabD and MW, VO₂ was lower in the leptin treated animals compared to controls (P=0.04), but there was no significant difference in RQ values between the two groups.

These observations indicate that i) leptin induces weight loss in *S. crassicaudata*, but ii) the effect of leptin on body weight is modulated by diet; an increase in dietary calories and fat content may be associated with 'resistance' to the action of leptin.

Sun. 11.30

notes

Digestive function in the magpie goose (*Anseranas semipalmata*).

Terry Dawson¹, Peter Whitehead², A. McLean¹, F. D. Fanning¹ and W. R. Dawson³.

¹School of Biological Science, University of New South Wales, Sydney 2052.

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Debate on the digestion of vegetation by flying birds has centred on the utilisation of fibre. Geese are large flying herbivores so they might accommodate significant fermentative fibre digestion. We examined digestion in wild magpie goose and in tame birds in metabolism cages.

The patterns of pH and SCFAs along the gut point to acid and enzymic digestion in most of the tract, down to the ileo-caecal junction. Wild birds showed considerable fibre digestion but it occurred cranial to the caeca. Fermentation occurred in the caeca, rectum and cloaca. However, the caeca contained little fibre, 4% of dry matter.

In a feeding trial geese were fed either husked rice grain or fresh aquatic grass, the latter being high in water and fibre. Fibre digestion occurred on both diets, but was focused on hemicellulose. It was greater on the grass diet, possibly due to differing rates of passage of digesta. Maintenance energy requirement was similar to that of other species of geese, as was the maintenance nitrogen level. Magpie geese could not maintain energy or nitrogen balance on the grass; this impacted on their feeding and reproductive biology in northern Australia. Fibre digestion by herbivorous birds appears to differ markedly from the processes seen in mammals.

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Sun. 11.45

notes

Characteristics of the acute phase febrile response in Pekin ducks.

Shane K Maloney and David A Gray

Department of Physiology, University of the Witwatersrand Medical School,
Johannesburg 2050, South Africa

We measured body temperature in Pekin ducks for 22 hours after intravenous injection of the lipopolysaccharide of gram negative bacteria at doses of 0, 1, 10, and 100 mg/Kg. The ducks developed monophasic fevers showing increases in peak temperature reached and duration of fever with increase in dose of lipopolysaccharide. Following a dose of 100 mg/Kg the ducks developed a fever that lasted for at least 18 hours. Mean plasma iron concentration did not change from pre-injection level at 4, 6, , or 22 hours post injection. Body temperatures of unrestrained telemetered ducks without access to food and water were similar to those of saline injected controls in the fever experiments; but were lower in the early hours of the mourning than when the same birds had access to food and water. This nocturnal hypothermia may have resulted from energy restriction imposed by lack of food and water.

Sun. 12.00

notes

future meetings
1998:
1999:

Discussion

(Penton)

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