

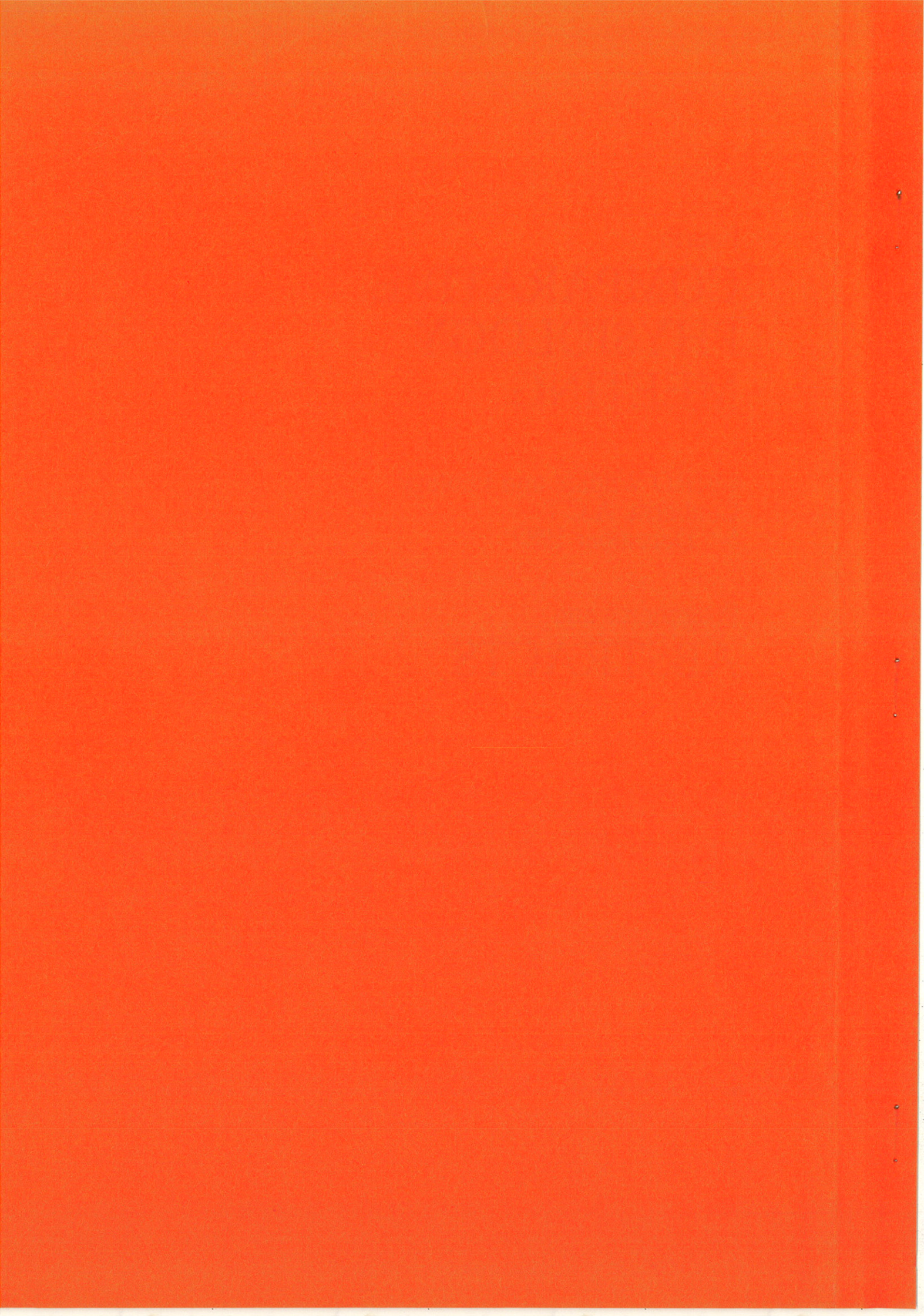
Hubert

Fourth

**COMPARATIVE  
PHYSIOLOGY  
MEETING**

CSIRO Wildlife and Ecology  
Canberra, A.C.T  
5-6 December 1987

Programme and  
**ABSTRACTS**



Fourth  
COMPARATIVE PHYSIOLOGY MEETING

Organised by:      Graham Brown  
                             Steve Cork

Saturday December 5

0830-0850  
0850-0900

Registration  
Preliminaries

Session 1                      ENERGETICS

0900-0918

Body temperature, water loss, and estimated energy expenditure of incubating emus.  
William A. Buttemer and Terence J. Dawson

0918-0936

Changes in standard metabolic rates, body weight and deposition of body fat in eastern spinebills, *Acanthorhynchus tenuirostris* (Aves: Meliphagidae) in winter.  
Stephen J. Ambrose, Kenneth Chan, and Hugh A. Ford

0936-0954

Field energetics of little penguins: validation of methods and preliminary results.  
Rosemary Gales

0954-1012

Water and energy metabolism and estimated food consumption of *Phascogale calura*.  
D. King, B. Green, A. Bradley.

1012-1030

Hibernation in the echidna.  
G.C. Grigg, L.A. Beard, and M.L. Augée

1030-1048

Comparative growth energetics in rat-kangaroos.  
R.W. Rose

1048-1106

Morning tea

1106-1124

Energetics of lactation in *Antechinus swainsonii* and *A. stuartii*.  
H.M. Crowley

Session 2                      RESPIRATION

1124-1142

Blood oxygen transport in the kowari, *Dasyuroides byrnei*.  
J.F. Hallam, R.A.E. Holland, and T.J. Dawson

1142-1200

Shape of the oxygen-haemoglobin equilibrium curve in the adult tammar wallaby (*Macropus eugenii*).  
Elisabeth A. Tibben and Robert A.B. Holland

- 1200-1218      Respiratory function in the little penguin,  
*Eudyptula minor*.  
Stewart Nicol and Colin Stahel
- 1218-1236      Acclimation by an antarctic fish to low ambient  
oxygen.  
R.M.G. Wells, G.C. Grigg, L.A. Beard, and  
G.W. Summers
- 1236-1254      Respiratory adaptations in freshwater crayfish from  
Tasmania.  
R. Swain
- 1254-1400      Lunch
- 1400-1418      Hypoxia and blood lactate levels in the marine  
yabby *Callinassa australiensis* (Decapoda,  
Thalassinidea).  
B.D. Patterson
- Session 3              ACID/BASE BALANCE
- 1418-1436      Acid-base regulation and transepithelial ionic  
transfer in carp during and after exposure to  
environmental hyperoxia.  
N.A. Anderson, J.B. Claiborne, and N. Heisler
- 1436-1454      Effects of acid water on ionic and acid-base  
balance in New Zealand freshwater crayfish.  
H.H. Taylor
- 1454-1512      Blood metabolism: Interacting effects of  
temperature and pH and implications as regards to  
ectotherms and blood storage.  
M. Guppy and R. Sabaratnam
- 1512-1530      Phosphate regulation and parotid salivary secretion  
in the red kangaroo.  
A.M. Beal
- Session 4              WATER and KIDNEYS
- 1530-1548      Sodium regulation in the amphibious landcrab  
*Cardisoma hirtipes*.  
P. Greenaway
- 1548-1606      Afternoon tea
- 1606-1624      Water and sodium fluxes in seabirds.  
B. Green and N. Brothers
- 1624-1642      X-ray microanalysis of sea turtle salt gland  
A.T. Marshall

Rice

Alan

- 1642-1700      The mechanism of cutaneous water transport in the tree frog *Litoria caerulea*.  
Paul P. Arena
- 1700-1718      Malpighian tubule function in crickets  
 (*Teleogryllus oceanicus*).  
Paul P. Cooper, A.T. Marshall, and G. Rippon
- 1718-1736      Kidney function in emus during dehydration and nesting.  
Terry T.J. Dawson, S.K. Maloney, and E. Skadhauge
- 1736-1754      The effect of prolactin on renal function in feral chickens.  
Julie Juliet R. Roberts

1830-      Barbeque

Sunday December 6

Session 4 (continued)

- 0900-0918      The influence of ambient temperature, seed composition and body size on water balance and seed selection in coexisting desert rodents.  
 A.J. Hulbert and R.E. MacMillen

Session 5

DIGESTION

- 0918-0936      A particle separator for nutritional research.  
 P.S. Barbosa, D. Freudenberger, N. Taman, and I.D. Hume
- 0936-0954      Digestive function in wombats: *Vombatus ursinus* (the common wombat) and *Lasiorchinus latifrons* (the southern hairy nosed wombat).  
 P.S. Barbosa, I.D. Hume, and R. Busby
- 0954-1012      Feed intake and digestion of increasingly fibrous diets in the eastern wallaroo (*Macropus robustus robustus*), Euro (*M. r. erubescens*), and western feral goat.  
 David Freudenberger and Ian Hume
- 1012-1030      Selective retention of 226Ra in the tissue of the freshwater mussel *Velesunio angasi*: Evaluation of two hypotheses.  
 Ross A. Jeffree



Body temperature, water loss, and estimated energy expenditure of incubating emus.

William A. Buttemer and Terence J. Dawson

Dept. of Physiology, Univ. of Tasmania and School of Zoology, U.N.S.W.

#### ABSTRACT

Heart rate, body temperature, and water turnover were monitored in two male emus throughout their 8-week incubation period. Daily mean body temperature did not vary significantly throughout the entire incubation period for either bird and averaged 37.8 °C. Water efflux rate during incubation was only 12 and 42% of that for hydrated and dehydrated non-incubating emus, respectively, at this season. Based on body mass changes during the 8-week incubation period, average daily energy expenditures were estimated as 2590 and 2480 kJ for the 36.3 and 38 kg emus, respectively. These values are approximately 60% of the standard metabolism predicted for non-passerine birds of the same mass but indistinguishable from those predicted allometrically from measurements of ostrich and kiwi basal metabolism.

CHANGES IN STANDARD METABOLIC RATES, BODY WEIGHT AND DEPOSITION OF  
BODY FAT IN EASTERN SPINEBILLS, *ACANTHORHYNCHUS TENUIROSTRIS*  
(AVES: MELIPHAGIDAE) IN WINTER

Stephen J. Ambrose\*, Kenneth Chan and Hugh A. Ford

Department of Zoology, The University of New England, Armidale,  
NSW 2351

\* Present address: Department of Zoology, The Australian National  
University, GPO Box 4, Canberra, ACT 2601

Large numbers of Eastern Spinebills (*ca.* 13 g) are present in *Banksia* woodland of New England N.P., northern NSW, between May and October (inclusive). This co-incides with the peak flowering period of *Banksia collina*, the nectar upon which the spinebills feed. In winter, ambient temperatures may range from -12°C overnight to 8°C during the day. Spinebills forage continuously throughout the day and build up subcutaneous stores of body fat in the neck and abdominal regions. Only slight reductions in standard metabolic rates were observed in spinebills at night and were still higher than those recorded for other species of honeyeaters. We suggest that the build-up of energy stores assist in fueling the elevated standard metabolic rates to reduce the probability of hypothermia at low ambient temperatures.





## HIBERNATION IN THE ECHIDNA

Grigg GC, Beard LA and ML Augee

Since the pioneering work by Martin in the early years of this century, echidnas have been known to enter torpor in captivity. However, the question of whether torpor occurs naturally in the field has been open and one of us (MLA) has stated repeatedly that echidnas are not hibernators. Current studies using radiotelemetry in the Snowy Mountains have demonstrated that echidnas enter torpor in that region during winter and show a pattern of periodic arousal exactly the same as that known for eutherian hibernators. Therefore, on the basis of current definitions, echidnas are undoubtedly hibernators. The extent to which the hibernation physiology of echidnas is similar to or different from that in eutherians remains to be clarified.

## COMPARATIVE GROWTH ENERGETICS IN RAT-KANGAROOS

R.W. Rose  
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University of Tasmania,  
G.P.O. Box 252C,  
HOBART, TAS. 7001

Milk composition and energy content was measured in two related marsupials, Bettongia gaimardi and Potorous tridactylus. Although protein content was consistently higher in bettong milk, lactational trends in both species are similar to those reported for other marsupials. The much faster relative growth rate of the bettong may be correlated with the increased protein and perhaps with a higher milk intake. Differential growth rates of pouch young in the field and captivity are likely to be due to the higher phase of nutrition of captive mothers.

Energetics of Lactation in *Antechinus swainsonii* and *A. stuartii*.

H.M. CROWLEY, Dept. Zoology, ANU.

The energetics of lactation is presently being investigated in the two species of *Antechinus* using the turnovers of Oxygen-18 and tritiated water to indicate the water turnover and metabolic rates of free-living lactating females. The time budgeting of the females is also being examined using radiotelemetry at different times throughout the year. There is a general trend for the teat number (and hence the maximum litter size) of the females to increase with altitude from 8 on the coast to 10 in the mountains. The energetics of lactating females from coastal and high altitude areas are being investigated to determine the effect of varying litter size and habitat.

BLOOD OXYGEN TRANSPORT IN THE KOWARI, *Dasyuroides byrnei*.

J.F. Hallam, R.A.B. Holland & T.J. Dawson, U.N.S.W., Kensington

As part of a continuing investigation into the limits to aerobic energy production in the kowari, we examined the respiratory potential of its blood.

The mean P50 of the kowari's blood (47 Torr) is higher than any previously reported and correlates with body mass. The mean Bohr effect (-.36) is smaller than predicted for an animal of this size whilst carbonic anhydrase is at expected levels. 2,3-diphosphoglycerate moderates the action of the single haemoglobin present and levels are high (8.9  $\mu$ moles/ml R.B.C.)

High haematocrits (55%) and haemoglobin concentrations (17g/100ml) ensure that the kowari's blood equips it well to deal with the demands of a highly energetic lifestyle.

SHAPE OF THE OXYGEN-HAEMOGLOBIN EQUILIBRIUM CURVE IN THE  
ADULT TAMMAR WALLABY (Macropus eugenii).

Elisabeth A. Tibben and Robert A. B. Holland.

School of Physiology and Pharmacology, University of New  
South Wales, Kensington, NSW, 2033, Australia.

Oxygen-haemoglobin equilibrium curves (dissociation curves) have been determined on the blood of adult Tamar Wallabies. When the curves were plotted by the Hill equation,  $\text{Log} (\text{sat.}/(100-\text{sat.}))$  against  $\text{Log } P_{O_2}$ , they showed in most, but not in all, cases a bend in the middle range of saturation. The Hill coefficient, or slope of the plot ( $n_H$ ), was higher in the upper part of the curve than in the lower part. The difference between upper and lower  $n_H$  appeared greater at lower temperatures. Typical values for  $n_H$  were 2.40 (lower) and 3.05 (upper) at 25°C and 5.77%  $CO_2$ . The bend disappeared when the red cells were stripped of 2,3-DPG. The value of  $n_H$  reflects the number of Hb subunits interacting with respect to oxygenation, and its increase at higher saturations is attributed to a change in 2,3-DPG binding to the Hb tetramer as oxygenation proceeds.

RESPIRATORY FUNCTION IN THE LITTLE PENGUIN, *Eudyptula minor*.

Stewart Nicol and Colin Stahel\*, Department of Physiology, University of Tasmania.

\* Kal Life Systems, Caulfield, Vic. 3162

The little penguin shows no true panting response to heat, and at thermoneutral and lower temperatures there is a constant, very high parabronchial oxygen extraction.

Experiments in a diving tank showed little penguins to dive on inspiration, and most of the post-dive recovery to occur in a single breath.

Although little penguins have an oxygen carrying capacity similar to other birds they have a very low red cell count ( $1.66 \times 10^{12} \cdot l^{-1}$ ) and very large red cells ( $MCV = 229 \mu m^3$ ). Such large red cells must have important implications for gas exchange.

Hill plots of the oxygen dissociation curve are very linear but have a high slope (3.2). Although the Bohr effect is low the high Hill coefficient and low buffer value of non-bicarbonate buffers would facilitate oxygen unloading during dives.

## ACCLIMATION BY AN ANTARCTIC FISH TO LOW AMBIENT OXYGEN

Wells RMG, Grigg GC, Beard LA and GW Summers

The cryopelagic Nototheniid fish *Pagothenia borchgrevinki*, endemic to Antarctic waters, is able to adjust the respiratory properties of its blood during experimental exposure to low oxygen. An increase in oxygen capacity is accompanied by the release of red blood cells from the spleen. An increase in oxygen affinity is accompanied by a decrease in red cell organic phosphates. These changes are similar both qualitatively and quantitatively to responses made by tropical and temperate fishes living in waters subject to seasonal or periodic deoxygenation. Because the antarctic fish live in and have evolved in an oxygen-rich environment, we suggest that compensatory adaptation to low ambient oxygen seen in fish is more likely to be a general piscine characteristic, perhaps a general vertebrate characteristic, than a specialisation to life in low oxygen environments.

### Respiratory adaptations in freshwater crayfish from Tasmania

R. Swain, Dept. of Zoology, Univ. of Tasmania

The respiratory adaptations of the stream-dwelling *Astacopsis franklinii* and the burrowing, amphibious *Parastacoides tasmanicus* have been investigated. Oxygen utilisation rates, heart rates, and scaphognathite beating rates were determined during progressive external hypoxia. All rates, as well as critical oxygen tension, were substantially lower in *Parastacoides*. Differences were also observed in derived variables: extraction efficiency and branchial flow rate. Branchial morphology was also investigated. Gill surface area is significantly greater in *Parastacoides* despite a reduction in gill number. An increase in space, especially in the posterior section, is found in the branchial chamber of *Parastacoides* which is independent of the s.a. increase.

HYPOXIA AND BLOOD LACTATE LEVELS IN THE MARINE YABBY Callinassa australiensis (DECAPODA, THALASSINIDEA).

B.D. PATERSON  
Department of Zoology,  
University of Queensland.

Callinassid burrowing shrimps are known to be quite tolerant of hypoxia and anoxia. Studies of ventilatory beating of the abdominal appendages (pleopods) in C. australiensis show no significant response to declining oxygen tension. Pleopod ventilation remains sporadic during anoxia and shows no increase in rate upon re-oxygenation of the environment.

Lactate accumulates only very slowly in the blood during anaerobiosis (because of the generally low metabolic rate) and disappears relatively quickly (for a decapod crustacean) upon resumption of aerobiosis. The lack of a behavioural aversion to anoxia may indicate that the species exploits its facultative anaerobic capacity in the burrow environment.

ACID-BASE REGULATION AND TRANSEPITHELIAL IONIC TRANSFER IN CARP DURING AND AFTER EXPOSURE TO ENVIRONMENTAL HYPEROXIA.

N. A. Andersen\*, J. B. Claiborne\*\* and N. Heisler

Max-Planck-Institute für Experimentelle Medizin Göttingen, FRG

\* Department of Physiology University of Tasmania

\*\* Department of Biology Georgia Southern College, Georgia, USA

Transepithelial ion transfer of H<sup>+</sup> equivalents and/or bicarbonate between the animal and the environmental water is the predominant mechanism of acid-base regulation in water-breathing fish. To maintain electroneutrality every transepithelial ion transfer has to be accompanied by transfer of a co-ion of the opposite charge or by counter exchange with an ion of the same charge.

We investigated acid-base regulation in carp (*Cyprinus carpio*) before, during and after exposure to 500 torr environmental hyperoxia. The carp were fitted with an indwelling dorsal aorta catheter, and kept in a recirculated setup which allowed determination of net ionic transfer between the fish and the environmental water.

Effects of Acid Water on Ionic and Acid-Base Balance in  
New Zealand Freshwater Crayfish

Dr H.H. Taylor,  
Department of Zoology, University of Canterbury, NZ.

Ionic and acid-base regulation was examined in Paranephrops zealandicus collected from neutral water and P. planifrons from two naturally acidic locations of mean pH about 6 and 4. After acclimation to neutral tapwater, exposure to pH 4 for 1 to 7 days caused a remarkably small haemolymph acidosis (0.05 - 0.1 pH) which was essentially respiratory in origin. The response of these Parastacoidea contrasts with similar treatment of many Northern Hemisphere Astacoidea which show acidosis of 0.5 - 0.8 units and death due to uptake of environmental strong acids. Step changes between pH 7 and 4 showed reversible inhibition of  $^{22}\text{Na}$  influx by 22% and 41% in P. planifrons collected from pH 4 and 6 respectively and by 55% in P. zealandicus. The results are discussed in relation to general differences between Parastacoidea and Astacoidea in their patterns of ionic regulation.

**Blood Metabolism: Interacting effects of temperature and pH and implications as regards to ectotherms and blood storage.**

M. Guppy and R. Sabaratnam

The pH of blood, *in vivo* and *in vitro*, shows an inverse relationship with temperature. ( 0.016-0.02 units per °C). The pK of the imidazole group of histidine also changes with temperature in the same order. These co-ordinated changes result in a constant  $\alpha$ -imidazole ( $[\text{imid}]/\{[\text{imid}] + [\text{imid} \cdot \text{H}^+]\}$ ) over a range of temperatures.

Proteins are sensitive to the value of the  $\alpha$ -imid of their histidine groups. Therefore a constant  $\alpha$ -imid with temperature cancels a potential qualitative effect of temperature change on efficiency and regulation of metabolism.

Preliminary studies have shown (a) that the buffers used in blood storage do not overcome the tendency of the pH of blood components to change with temperature, and (b) that the metabolism of mammalian red cells may be sensitive to small (0.2) changes in pH between 25 and 15 °C.

PHOSPHATE REGULATION AND PAROTID SALIVARY SECRETION IN THE RED KANGAROO  
by A.M. Beal, School of Zoology, University of N.S.W., Kensington, 2033,  
Australia.

During the parasympathetic stimulation, phosphate concentrations in red kangaroo parotid saliva fall with increasing flow rate from  $28.6 \pm 1.59$  to  $8.9 \pm 0.48$  mmol/l. Adrenergic stimulation augments salivary phosphate concentrations apparently by increasing secretion at the end organs. Kangaroos regulate their plasma phosphate levels within a wide range (1.28-3.40 mmol/l; N=160) which may affect incorporation of phosphate into the saliva. Increasing plasma phosphate from 2.5 to 8.9 mmol/l increased salivary phosphate by approximately 1 mmol/l whereas reducing plasma phosphate from 2.5 to 1.6 mmol/l reduced salivary phosphate by 1.3 mmol/l. Neither porcine nor salmon calcitonin given intracarotid at rates of up to 1.5 and 3.0 U/min respectively had any effect on plasma or salivary calcium and phosphate concentrations. Likewise, intracarotid infusion of rat PTH 1-34 or human PTH 1-34 at rates of 350-460 pmol/min for 60 min caused no changes in plasma or salivary calcium and phosphate concentrations. The only observed effect of PTH was a small but significant increase in haematocrit.

Sodium Regulation in the Amphibious Landcrab  
Cardisoma hirtipes

Adult C. hirtipes burrow in and around freshwater streams and seepages on Christmas Island spending long periods in and out of water. The crab is of marine origin and retains marine larvae. Sodium loss to freshwater is very high due largely to production of isosmotic urine. It is balanced by sodium absorption from the water utilising a high affinity uptake mechanism ( $K_m = 0.16$  mmol/L) with a high  $V_{max}$  ( $1-2 \mu\text{mol g}^{-1} \text{h}^{-1}$ ). This high turnover pattern of regulation compares unfavourably with true freshwater crustaceans which typically show much lower turnover rates for sodium.

P. Greenaway, School of Zoology, UNSW



12  
110  
WATER AND SODIUM FLUXES IN SEABIRDS  
B. Green\* and N. Brothers  
\*CSIRO Wildlife and Ecology, Canberra

Sea birds inhabit an environment replete with water and sodium, as is their food. Isotope turnover studies on a range of sea birds indicate that seawater ingestion can be substantial. The efficacy of nasal salt glands is discussed in the light of total sodium and water influxes.

X-ray microanalysis of sea turtle salt gland

A.T. Marshall

Analytical E.M. Laboratory, Department of Zoology, La Trobe University, Bundoora, Victoria 3083.

The lachrymal salt glands of hatchling sea turtles can be stimulated to secrete at very high rates, approaching those of avian salt glands, by Na or K loading. X-ray microanalysis of frozen-hydrated glands reveals very high intracellular  $\text{Cl}^-$  concentrations ( $79 \text{ mmol l}^{-1}$ ) in the principal cells of the secretory tubules. High intracellular  $\text{Na}^+$  ( $34 \text{ mmol l}^{-1}$ ) and decreased  $\text{K}^+$  ( $145 \text{ mmol l}^{-1}$ ) concentrations seem to be associated with secretory activity whilst low  $\text{Na}^+$  ( $13 \text{ mmol l}^{-1}$ ) and high  $\text{K}^+$  ( $164 \text{ mmol l}^{-1}$ ) concentrations seem to be associated with decreased secretory activity. In active glands the luminal  $\text{Na}^+$  and  $\text{Cl}^-$  concentrations are substantially lower than the concentrations in the secreted fluid. This possibly indicates ductal modification of the secretion.

THE MECHANISM OF CUTANEOUS WATER TRANSPORT  
IN THE TREE FROG *Litoria caerulea*.

by P. Arena. The School of Zoology, University of NSW.  
P.O Box 1. Kensington. NSW, 2033.

The mechanism of the cutaneous transport of water in the tree frog *Litoria caerulea* was investigated. The rates of water uptake by frogs dehydrated to 80% of their standard weight were measured in non-ionic and ionic solutions varying from zero osmolality to near iso-osmotic with the body fluids.

The rate of water uptake from solutions of NaCl was consistently higher than from sucrose solutions of equivalent osmolalities. *L. caerulea* exhibited a net water uptake from sucrose solutions of osmolalities up to 295 mmol kg<sup>-1</sup>. Net water uptake from NaCl solutions was possible from solutions of up to 382 mmol kg<sup>-1</sup>. A solute - linked mechanism enhancing water uptake was inferred from these results.

Malpighian Tubule Function in Crickets (*Teleogryllus oceanicus*)

P. Cooper, A.T. Marshall, and G. Rippon  
Dept. of Zoology, ANU

Fluid secretion in isolated Malpighian tubules of black field crickets (*Teleogryllus oceanicus*) have been examined in response to varying osmotic pressure, ion concentration and hormonal control. Isolated tubules will continue to secrete for 6-12 hours. Fluid secretion is apparently independent of bathing osmotic pressure between 300 and 550 mOsm kg<sup>-1</sup>, the fluid secretion being relatively isosmotic with the bath. No change in osmotic pressure of secretion was observed over 2-3 hours of time. Fluid secretion was inhibited by high potassium concentration (>50 mmol l<sup>-1</sup>), and by the addition of amiloride (1 mmol l<sup>-1</sup>). These studies suggest that fluid secretion in these tubules is sodium dependent.

## KIDNEY FUNCTION IN EMUS DURING DEHYDRATION AND NESTING

T. J. Dawson, S. K. Maloney and E. Skadhauge.

School of Zoology, University of N.S.W. Kensington.

During dehydration and nesting the water losses of the emu are much reduced. While the characteristics of the excreta are determined by the cloaca-rectum, this organ operates on fluid from the kidneys and the gut. We have examined what happens in the kidney. Glomerular filtration rate was decreased by half in dehydrated and nesting birds. Ureteral urine flow rate was similarly decreased to 15-25% of the controls. While GFR and UFR were similar in the nesting and dehydrated birds the patterns of electrolyte excretion were different. The pattern in the nesting birds was not different from that in control birds but there was marked ionic and osmotic concentration in the dehydrated birds.

## THE EFFECT OF PROLACTIN ON RENAL FUNCTION IN FERAL CHICKENS.

Juliet R. Roberts, Department of Physiology, University of New England, Armidale, N.S.W. 2351.

The role of prolactin in the water and electrolyte balance in avian species is uncertain. Renal function was measured in 7 conscious, restrained feral chickens by the constant infusion of 0.1% inulin in hypotonic sodium chloride. Urine and plasma samples were collected for a control period, a bolus injection of 3 I.U. ovine prolactin was given and ovine prolactin (5.5 I.U. per 100 ml) added to the infusate. The prolactin infusion had no significant effect on glomerular filtration rate, urine flow rate, fractional excretion of  $K^+$  or free water clearance. However, the fractional excretion of  $Na^+$  and  $Cl^-$ , and osmolar clearance were significantly higher during prolactin infusion.

**The influence of ambient temperature, seed composition and body size on water balance and seed selection in coexisting desert rodents.**

A. J. Hulbert and Richard E. MacMillen

Department of Biology, University of Wollongong, Wollongong, AUSTRALIA 2500 and Department of Ecology and Evolutionary Biology, University of California, Irvine, CA 92717, U.S.A.

**Abstract**

The water balance of three different sized coexisting species of heteromyid rodents of the deserts of south western U.S. (*Dipodomys merriami* ca. 39g; *Perognathus fallax* ca. 23g; *Perognathus longimembris* ca. 9g) was assessed while consuming two different diets (either wheat or hulled sunflower) at ambient temperatures of 15-30°C. The metabolism of wheat as the sole food source was calculated to provide a greater metabolic water production (MWP) than the consumption of sunflower seed because of their different composition. The state of water balance was assessed by measuring urine concentrations and body weight maintenance on each diet at each temperature. Both measures showed that (i) all species were able to maintain a more positive water on the higher MWP seed, (ii) for all species there was an ambient temperature above which water balance could no longer be maintained, (iii) that this temperature was higher with the higher MWP food source and (iv) water regulatory efficiency was negatively correlated with body mass. *Dipodomys* showed a reduced digestive efficiency compared to *Perognathus*. When presented with both seeds *Dipodomys* showed no preference for either seed irrespective of the state of water balance whilst the *Perognathus* species showed a tendency for an increased preference for the high MWP food source at the higher ambient temperatures. The ecological implications of these findings are discussed.

## A Particle Separator for Nutritional Research

P.S. Barboza, D. Freudenberger, N. Taman and I.D. Hume

Department of Biochemistry, Microbiology and Nutrition, University of New England, Armidale, 2351

Particle size can be used in nutritional studies to elucidate the mechanism of digestion or to isolate dietary components from a sample. A particle separator can isolate fine material such as seeds from the larger stem and leaf particles, and also assess a range of particle sizes and their concentrations in dry matter. Although commercial particle separators can be imported their cost is often prohibitive. A much cheaper workshop-built system using standard sieves was devised from a design by Allen et al (1984). The system separates 1 g (dry matter) samples onto six 10 cm diameter brass sieves (Endecotts Pty Ltd) using a flow of water under set pressure in a shaking frame. Maximal separation is achieved within 10 min on six sieves from 2.36 mm to 75  $\mu$ m mesh. The material collected on each sieve can be transferred to tared filter papers or sintered glass crucibles for dry matter and chemical analysis.

1. Allen, M.S., Robertson, J.B. and Van Soest, P.J. (1984) A comparison of particle size methodologies and statistical treatments. In Techniques in Particle Size Analysis of Feed and Digesta in Ruminants. Ed. P.M. Kennedy. Canadian Society of Animal Science.

## Digestive Function in Wombats: Vombatus ursinus (the Common Wombat) and Lasiorhinus latifrons (the Southern Hairy Nosed Wombat)

P.S. Barboza,\* I.D. Hume,\*\* and R. Busby\*

\*Department of Biochemistry, Microbiology and Nutrition, University of New England, Armidale, 2351

\*\*Department of Zoology, Sydney University, N.S.W. 2006

Wombats are grazing animals which digest fibrous material by fermentation in the hindgut. Vombatus ursinus inhabits mesic areas whereas Lasiorhinus latifrons inhabits the semi-arid zone. The two species have similar digestive systems but the colon of V. ursinus accounts for 58% of the surface area of the tract contrasting with 37% in L. latifrons. Conversely the rectum accounts for 28% of the area in L. latifrons but only 10% in V. ursinus.

Wombats of both species fed pelleted diets of straw and maize retained the particulate digesta marker  $^{103}$ Ruthenium Phenanthroline and the solute digesta marker  $^{51}$ Chromium-EDTA longer than sheep, kangaroos and horses. The pattern of excretion of both markers was pulsatile with the fluid marker emerging first. The mean retention time of both markers was longer in L. latifrons than V. ursinus; particles - 67 h and 48 h respectively; solutes - 46 h and 31 h respectively. These results suggest that L. latifrons, the xeric species, passes food more slowly along a shorter fermentation region than V. ursinus to attain similar digestibilities. Slow passage through a prolonged rectal region also allows more thorough resorption of water and ions in L. latifrons.

Feed Intake and Digestion of Increasingly Fibrous Diets in  
the Eastern Wallaroo (*Macropus robustus robustus*),  
Euro (*M. r. erubescens*), and Western Feral Goat

David Freudenberger and Ian Hume\*

Dept. Biochemistry, Microbiology and Nutrition  
University of New England, Armidale  
\*Biological Sciences, University of Sydney

Three individuals of each species were placed in indoor metabolism cages, randomized in a latin square and were given *ad libitum* three pelleted rations containing either 40%, 60%, or 80% barley straw. The rations were formulated to 1.5% nitrogen by the additions of lucerne (10%), maize and soya bean meal.

Apparent dry matter (DM) digestibilities decreased with increasing straw content. However, digestible DM intakes were unaffected by straw content. All the animals compensated for decreasing DM digestibility by increasing DM intake. Digestible DM intakes were 30-40% greater in the goats than in the macropods due to greater DM digestibilities in the goats.

Neutral detergent fibre (NDF) and acid detergent fibre (ADF) digestibilities were greater in the goats than in the macropods. NDF and ADF digestibilities were depressed, particularly in the euros, on the 40% straw diet.

Selective Retention of  $^{226}\text{Ra}$  in the Tissue of the Freshwater  
Mussel *Velesunio angasi*: Evaluation of Two Hypotheses

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Previous studies have shown that, although  $^{226}\text{Ra}$  is taken up into the tissue and accumulates in granular deposits as an analogue of Ca, the ratio of  $^{226}\text{Ra}:\text{Ca}$  in the tissue increases with age in mussels accumulating these elements under natural conditions. This result suggests that the biological half-life for Ca is shorter than that for  $^{226}\text{Ra}$  in the tissue. Two hypotheses to explain this phenomenon are;

a)  $^{226}\text{Ra}$  is retained in the granular deposits as they exchange with body fluids owing to its lower solubility compared to Ca and/or,

b) because there is greater discrimination against  $^{226}\text{Ra}$  than Ca across the mantle compared to the tissue, as indicated by the lower  $^{226}\text{Ra}:\text{Ca}$  ratio in shell,  $^{226}\text{Ra}$  is selectively retained in the body fluids and returned to the granular deposits.

Consequent experimental and field studies to evaluate these interpretations have provided evidence to support hypothesis (a) and to discount hypothesis (b).

## THE VESTIBULAR APPARATUS OF THE NEWBORN MARSUPIAL.

Robert Gemmell, Bradley Peters and John Nelson.  
University of Queensland and Monash University.

The senses required by the newborn marsupial to travel from the uterus to the pouch have interested scientists for many years. Hartman in 1920 was the first to suggest that the newborn opossum was capable of sensing gravity. In this study the ultrastructure of the ear of the newborn northern native cat, Dasyurus hallucatus, was examined. The presence of sensory cells within the vestibular region of the ear, along with Merkel cells (mechanoreceptors) around the mouth region and of sensory cells within the olfactory epithelium would suggest that gravity, touch and olfaction assist the newborn marsupial in locating the pouch and the teat.

### Sperm production in the tammar

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Earlier studies have highlighted differences in sperm structure between marsupials and eutherian mammals and other aspects of sperm production have received less attention.

Estimates of the duration of spermatogenesis, sperm production rate, number of extragonadal sperm reserves and the duration of sperm transit through the epididymis of the tammar indicate that they are of the same order of magnitude as in the eutherians which have been studied. Further, sperm maturation in the epididymis of the tammar involves loss and gain of certain proteins as has been described in eutherians. However, unlike the process in most eutherians tammar sperm shed their cytoplasmic droplets in the epididymis and they are phagocytosed by the epididymal epithelium. Subsequently sperm are stored in the cauda epididymidis of the tammar in an environment which has a lower osmotic pressure and concentration of organic compounds than in the eutherian mammals which have been studied.

Testicular regulation of epididymal function is via the systemic circulation and the excurrent ducts of the testis, however, the lymphatic route which has been demonstrated in the rat, ram and boar is absent in the tammar.

## Levels of plasma testosterone and free corticosteroids in a wild population of Tasmanian Devils

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In the wild, Tasmanian Devils (*Sarcophilus harrisii*) exhibit a synchronised mating season of approximately three weeks. Samples of plasma were taken over the annual cycle from both male and female Tasmanian devils and analysed for corticosteroids and testosterone. Concentrations of peripheral testosterone in males remained at 0.5 to 2.5 ng/ml throughout the year. There was no increase prior to, or during the breeding season. This is in contrast to other dasyurids. Free-corticosteroid levels showed no change over the breeding season in males but showed a post-pregnacy decrease in females.

## PROSPECTS FOR THE ARTIFICIAL BREEDING OF MARSUPIALS

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Present methods allow only very limited manipulation of marsupial reproduction and this is a major constraint on research and breeding. This paper reports progress in inducing female reproductive activity and in the storage of spermatozoa for artificial insemination. The monovular brush-tailed possum can be superovulated (10-15 eggs/ovary) by a combined treatment of gonadotrophin (PMSG) followed by gonadotrophin releasing hormone (GnRH). Trials are in progress to determine the appropriate method and timing of artificial insemination after induced ovulation. The method is being established with freshly ejaculated semen prior to testing the fertility of frozen sperm. Possum sperm are highly tolerant of freezing in liquid nitrogen if 10-17% glycerol is present as a cryoprotectant. Data will also be presented on ovulation induction studies in polyovular marsupials.



GLUCOCORTICOIDS IN THE PLATYPUS  
I.R. McDonald, Physiology Dept., Monash University

Opiomelanocorticotrophic cells in the pituitary of  
the Australian Lungfish.

Jean Joss, Macquarie University and  
Robert Dores, University of Denver.

Cells of the adenohypophysis of Neoceratodus, unlike those of Protopterus and Lepidosiren, have not been previously described. Only Lepidosiren paradoxa has had several of these cells immunocytochemically identified. Using several histological staining techniques seven cell types could be distinguished in the adenohypophysis of adult Neoceratodus. Three of these were immunocytochemically shown to be opiomelanocorticotrophic. The enzymic breakdown of this large precursor molecule was demonstrated to differ between the three cell types. The corticotrophes are in general agreement with those demonstrated in Lepidosiren.

EXPERIMENTAL ALTERATION OF SEXUAL DIFFERENTIATION IN THE  
TAMMAR WALLABY: MORPHOLOGY AND ENDOCRINOLOGY.

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The reproduction of female tammars is highly seasonal but that of males is not. This study was designed to determine whether the difference is established during early life as a result of exposure to the developing testes. At day 10 after birth, when the sex can be distinguished externally, testes were removed from 5 males and placed under the flank skin of 5 females, while other groups of 5 males and 5 females were subjected to surgery without interfering with the gonads. The grafts remained palpable for 3 to 6 months.

During 5 years none of the testis-grafted females ever produced a young, whereas all 5 sham operated females did each year. The treated females developed a mixture of male and female reproductive structures which indicate that the testis at day 10 cannot prevent development of Mullerian duct derivatives or pouch, but is required for development of the prostate, penis and accessory glands. In females it can also permanently alter the hypothalamus to prevent ovulation in later life.

A key event in females during seasonal quiescence is a peak of prolactin at dawn and this is abolished within 5 days of an alteration in photoperiod to short day. This enables the corpus luteum to resume activity, as indicated by a pulse of progesterone by day 10. We tested the ability of males and testis-grafted females to show a similar response in prolactin to a reduction in daylength from 15L:9D to 12L:12D. Four intact males, one castrate male and 4 testis-grafted females showed prolactin pulses on the first photoperiod, like the 4 control females, and in all the pulse was absent 7 days after the light change. However, only the control females displayed a progesterone pulse and gave birth subsequently.

We conclude that the difference in seasonality between males and females is not due to differences in their response to photoperiod in the pituitary, but is due to the special inhibition of the corpus luteum by prolactin.

