Wildlife Environmental Physiology
School of Physiology, Wits University

Wildlife Environmental Physiology (WEP) is an area of research within the Brain Function Research Group in the School of Physiology at the University of the Witwatersrand. Our research focuses on the ecophysiology and thermoregulation of African, Australian and Arabian mammals, as well as the physiological responses of wild mammals to global climate change and game capture procedures.

Updates on current research projects

Thermoregulation in free-living cheetah

Cheetah are famed for their incredible speed. But these speeds come at the cost of high metabolic heat load. Being diurnal hunters, cheetah also have the added limitation of environmental heat load. Brenda investigated the effects of these heat loads on body temperature and activity of cheetah for her MSc. Body temperature and activity were measured by implanted data loggers in six free-living cheetah in Namibia. Each cheetah also was fitted with a radio collar, allowing Brenda to track them, monitor their behaviour and observe them hunting, for seven months. The body temperature and activity data currently are being correlated with environmental conditions, behaviour and hunting. From preliminary analysis we can say that body temperature rises rapidly, from about 37°C up to 40°C, during a short hunting sprint. Brenda still is analyzing the data and hopes to complete her dissertation next year.

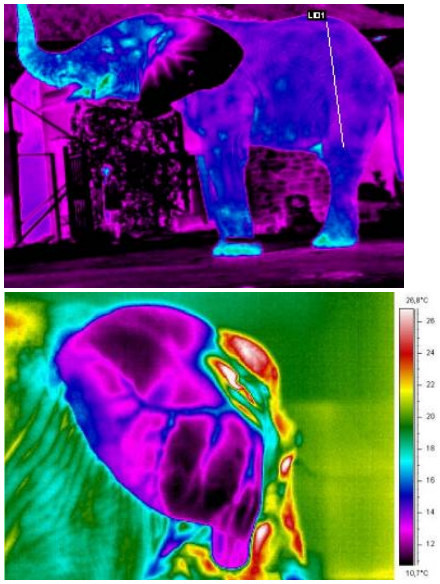
Brenda de Witt (dewitt.brenda@gmail.com)

Water conservation strategies of large African antelope

Survival in arid environments requires optimal management of body water for homeostasis and thermoregulation. Arid-adapted species are expected to face increasing physiological challenges as climate change is likely to result in arid areas in southern Africa becoming hotter and drier. Maartin will investigate the relationship between the use of a thermoregulatory effector, selective brain cooling, and microclimate choice and the implications for energy and water balance in antelope in arid zones. Behavioural thermoregulation, such as the selection of appropriate microclimates, may occur at the expense of foraging. Since arid-zone antelope are nutritionally stressed during the dry season, foraging and water intake may take preference over microclimate selection at these times. The aim of Maartin's study, therefore, is to identify the trade-offs which have led to antelope successfully inhabiting arid zones in South Africa. In the first project of his study, Maartin aims to quantify the potential water savings associated with selective brain cooling in a laboratory ungulate, before investigating water conservation strategies in three sympatric wild antelope species. Maartin's PhD protocol has been approved and the laboratory-based project is expected to start in February 2009.

Maartin Strauss (Strauwm@unisa.ac.za)

Using infrared thermography to assess thermoregulation in African elephants



African elephants inhabit environments that often exceed body temperatures in summer. Their large body size, and subsequent small surface area to volume ratio, presents a physiological challenge when it comes to dissipating heat gained from metabolic activity and the environment. Despite this challenge, Philippa's data has shown that elephants are able to regulate their body temperature, at around 36.4°C, within a range less than 1.5°C. Infrared thermography, together with measures of body temperature, can assist our understanding of how elephants are regulating their body temperature within this narrow range. Infrared thermography is a technique used to determine skin temperature by measuring infrared radiation.

The aim of Nadine's MSc is to use infrared thermography to assess the vasomotor state of semi-tame African elephants by recording infrared images across different parts of the body during different times of the day. Nadine will begin data collection early in 2009.

Nadine Torrao (NadineTwenty5@gmail.com)

Body temperature changes during the menstrual cycle in baboons

Trevor investigated whether female baboons exhibit the archetypal increase in body temperature during ovulation, which occurs in human females, by concurrently measuring abdominal and ovarian temperatures, and correlating these against faecal and urinary steroid hormone concentrations and external reproductive morphological changes, during the menstrual cycle. The external reproductive changes, such as the anogenital swellings and menstrual bleeding, indicate that the baboons had an average menstrual cycle length of 37.6±4.5d compared to that of humans, which is 28±4d. There was a post-surgical irregularity in the length of the cycles, but after an average of 60d they became regular. A cyclic pattern was evident in both abdominal and ovarian temperature measurements. Trevor still is busy analyzing the hormone concentrations to confirm a relationship between the body temperature changes, the external reproductive changes and hormonal changes.

Increasing stages of the anogenital swelling during the menstrual cycle

Trevor Nyakudya (trefelaz@yahoo.co.uk)

Pulmonary dysfunction during opioid-induced respiratory depression in ungulates

Charles is investigating the contribution of pulmonary vasoconstriction to the respiratory depression induced when antelope are immobilized with opioids. The first study will be to determine the mechanism of action of opioid-induced pulmonary vasoconstriction in goats. The goats will be instrumented with pulmonary arterial catheters to detect changes in pulmonary haemodynamics. Certain pharmacological agents, hypothesized to reverse pulmonary vasoconstriction, also will be administered to the immobilized goats. The contribution of pulmonary vasoconstriction to opioid-induced respiratory depression will be assessed by evaluating arterial blood gas changes and changes in alveolar-arterial gas exchange indices before, during and after immobilization and drug administration.

The pharmacological agents which successfully prevent opioid-induced pulmonary vasoconstriction in the goats, then will be investigated in impala. Charles also will investigate if the serotonergic ligands Leith used to reverse pre-existing opioid-induced respiratory depression can prevent opioid-induced respiratory depression when given in conjunction with immobilizing agents in impala. Charles' protocol has been approved and he currently is working on study logistics. Both studies will commence in 2009.

Charles Vermeulen (charles.vermeulen@students.wits.ac.za)

Cooling hyperthermic animals during capture

Joanna is investigating different practical and effective methods to cool hyperthermic animals after capture. She will be measuring abdominal, rectal, subcutaneous and skin temperatures and heat transfer in immobilized blesbok during different cooling interventions. It proved difficult to capture blesbok for the study, but they recently were captured with the help of the National Zoological Gardens and surgery to implant the abdominal and subcutaneous temperature-sensitive data loggers is scheduled for the second week of December. Data collection will begin in January 2009. Joanna currently is preparing for surgery.

Joanna Sawicka (joannasawicka@hotmail.com)

New research project

Sleep and brain temperature regulation in ostriches

Why study sleep in ostriches? Ostriches belong to the most basal group of the avian phylogenetic tree. All birds studied to date exhibit unequivocal signs of slow-wave sleep (SWS) and rapid-eye movement (REM) sleep. A study of sleep in ostriches might shed light on the evolutionary history of these two basic states of sleep in birds. If SWS and REM sleep are present in ostriches then it would suggest that these states were present in the most recent common dinosaur ancestor to birds. Conversely, the absence of one or both states would suggest that they evolved only after the appearance of the neognathae lineage of birds, much in the same way that the basal monotremes appear to lack the cortical signs of REM sleep present in placental and marsupial mammals.

The study also will investigate whether sleep in ostriches is regulated in a manner similar to that observed in other birds and mammals, where sleep loss is compensated for by an increase in the intensity of sleep as measured by low-frequency EEG power density. If sleep in ostriches is regulated differently it would suggest that these

sleep regulatory systems evolved only after the appearance of the neognathae lineage. Another objective is to determine how brain temperature changes as a function of behavioural state. In mammals brain temperature is elevated during wakefulness and REM sleep but declines during SWS. Whether or not similar fluctuations in temperature occur in the avian brain is unclear.

The study will be undertaken by John Lesku and Niels Rattenborg from the Max Planck Institute for Ornithology in Germany, in collaboration with us and the National Zoological Gardens. Niels and his colleagues recently published the first study on sleep in a wild animal. Surgery to implant the miniature data loggers, for measurement of EEG and brain temperature, in free-ranging ostriches will take place in February 2009.

Andrea Fuller (andrea.fuller@wits.ac.za)

Updates on completed research projects

Thermal and respiratory responses to capture

For his PhD, Leith investigated the thermal and respiratory responses to capture in impala. A paper on the cause of capture-induced hyperthermia was published by the Journal of Wildlife Diseases earlier this year. Another paper on the thermal, cardiorespiratory and cortisol responses of impala to chemical immobilization with four different drug combinations has been recently published in the Journal of the South African Veterinary Association. Leith's last PhD paper on the effects of serotonin agonists on opioid-induced respiratory depression in immobilized impala has been submitted to the Veterinary Journal of Anaesthesia and Analgesia; a previous investigation on the effects of two serotonin agonists on opioid-induced respiratory depression in immobilized goats was published in the American Journal of Physiology Regulatory Integrative & Comparative in 2006. Leith currently is in the process of putting together the final touches of his thesis.

Leith Meyer (leith.meyer@wits.ac.za)

The effects of climate change on ungulates

For her PhD, Robyn investigated the effects of habitat transformation and extreme temperatures, associated with climate change, on the thermal physiology of free-living ungulates. A paper on the effects of habitat transformation on the physiology of Angora goats in the Eastern Cape, and two papers exploring thermoregulatory adaptations of the Arabian oryx and Arabian sand gazelle in Saudi Arabia, currently are with coauthors. Robyn has submitted a paper on the thermal physiology of Angora goats to the journal Animal. Robyn currently is in the process of writing the literature review for her thesis.

Robyn Hetem (robyn.hetem@wits.ac.za)

Thermoregulation in African elephants

For her MSc, Philippa investigated the 24h rhythm of body temperature, the role of thermoregulatory behaviour in controlling body temperature and the influence of climatic variables on body temperature and thermoregulatory behaviour in tame, free-living elephants. Measurements of body temperature were obtained by getting the elephants to swallow miniature temperature-sensitive data loggers; a paper describing this technique will be submitted to the Journal of Thermal Biology shortly. Philippa submitted her MSc dissertation entitled "Thermoregulation in African elephants" in October, and currently is under examination.

Philippa Hidden (hiddenpips@yahoo.com)