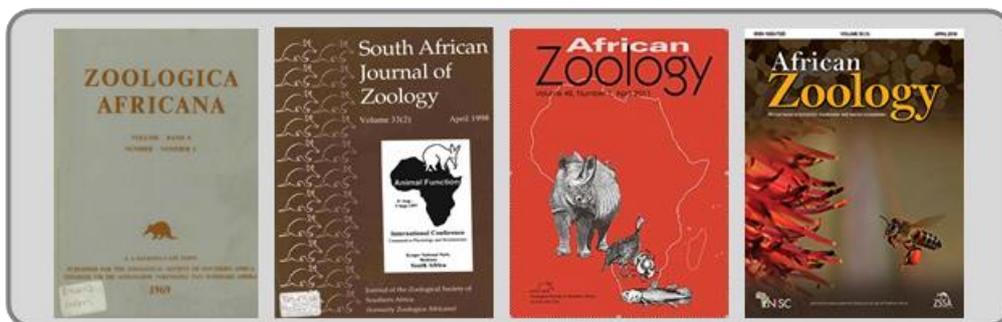




CELEBRATING 60 YEARS OF AFRICAN ZOOLOGY

39th ZSSA Congress
Skukuza, Kruger National Park
7 – 10 July 2019



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To celebrate ZSSA's 60th anniversary, a special conference issue will be published.

Original scientific contributions and critical reviews that focus principally on African fauna will be considered. Research from other regions that advances practical and theoretical aspects of Zoology will also be considered. All submissions will be subject to peer review.

Issue to be published in the third issue of African Zoology 2020.

Congress participants are encouraged to contact the editors, Prof. Carol Simon (csimon@sun.ac.za) or Prof. Theresa Wossler (wossler@sun.ac.za), to discuss publishing in African Zoology.

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Plenary Speakers



Prof Nigel Bennett
University of Pretoria



Nigel is a professor of zoology at the University of Pretoria (UP) and also occupies the Department of Science and Technology/National Research Foundation (NRF) Research Chair in the field of Mammalian Behavioural Ecology and Physiology and the UP Austin Roberts Chair of African Mammalogy. Nigel's research focus is on ecology, animal physiology and behaviour using the African mole-rat as his model animal. He and his co-workers have investigated the ecological and physiological factors that affect the control of reproduction and the evolution of sociality. Unlike other researchers investigating cooperative breeding in mammals, he has done so from a variety of

perspectives. The strength of this multi-faceted approach is that it has led to an integrated understanding of reproductive suppression in mole-rats of a type that has not been achieved for any other taxa or group of taxa. His research has set the benchmark for our understanding of phylogenetic and ecological constraints regulating reproductive success and social evolution in mammalian species. His research record ranks him among the best researchers studying social regulation of reproduction in any group of mammals in the world. Nigel obtained his BSc Hons. in 1983 from the University of Bristol in the United Kingdom. After completing his PhD at the University of Cape Town in 1988, he was employed as a junior lecturer and senior researcher in zoology at the institution until 1995 when he was appointed as a senior lecturer in the department of zoology and entomology at the UP. He was promoted to full professor in 2001. Nigel holds an A rating by the National Research Foundation. He has been a visiting Professor at the School of Chemical and Biological Sciences, Queen Mary College, University of London since 2005 and more recently a visiting Professor at the Department of Zoology, King Saud University, Saudi Arabia. He has been awarded the UP Chancellor's Medal for his research twice as well as receiving the Exceptional Academic Achiever Award for the past sixteen years. He is a fellow of the Zoological Society of London, a fellow of the Royal Society of South Africa and a member of the Academy of Sciences of South Africa. He has been the recipient of the Gold medal from the Zoological Society of Southern Africa and the Havenga Prize for outstanding contributions to Life Sciences awarded by the Academy of Science and Arts of South Africa. UP awarded him the University of Pretoria Commemorative Research Medal for being one of the top 100 scientists in 100 years of its existence. In 2015 he was awarded an NSTF ESKOM-sponsored award for his outstanding contribution to Science, Engineering and Information Technology as a developer of research capacity, in 2016 he was made a fellow of the African Academy of Sciences, and in 2017 the University recognised him with the Vice Chancellor's award for outstanding postgraduate supervision. Nigel has served as President of the Zoological Community of Southern Africa for two years. He is editor-in-chief of the *Journal of Zoology*, London and a past editor of *Proceedings of the Royal Society of London Biological Sciences B*. In 2013 he took on the handling editor position at *Biology Letters* another Royal Society journal. Nigel has published 365 papers in international peer-reviewed scientific journals, co-authored a specialist book published by Cambridge University Press and has penned twelve chapters in books. Nigel is the world leader in African mole-rat biology and in particular reproductive physiology.



Prof Barry Lovegrove
University of KwaZulu-Natal



Barry is Professor Emeritus at the University of KwaZulu-Natal. He obtained his PhD under the supervision of Gideon Louw from the University of Cape Town in 1987, where after he undertook post-doctoral studies at the University of California, Los Angeles, and Phillips University, Marburg, Germany, the latter as an Alexander von Humboldt Fellow. Barry is an evolutionary physiologist. He spent his whole career trying to understand the diversity of metabolic adaptations in birds and mammals. His work culminated in the book *Fires of Life: Endothermy in Birds and Mammals* (Yale University Press). In 2017 Barry gave

the prestigious Irving-Scholander Memorial Lecture in Fairbanks, Alaska in anticipation of the book's release. Barry is also the author of *Living Deserts of Southern Africa* (Fernwood Press), which he is currently updating. Barry is an NRF A-rated scientist.



Prof Hugh MacIsaac
University of Windsor, Canada



Hugh is professor and senior Canada Research Chair in Aquatic Invasive Species at the Great Lakes Institute for Environmental Research, University of Windsor, Canada. Previously Hugh was Fisheries and Oceans Canada Invasive Species Research Chair, and Director of the Canadian Aquatic Invasive Species Network, a consortium of ~35 faculty across Canada. Hugh is a Distinguished Research Fellow of the Sino-Canada Research Center on Plateau Lakes at Yunnan University, China. Hugh has authored over 200 peer-reviewed papers and books. Hugh is interested in a

variety of issues pertaining to invasive species, including analyses of vectors and pathways of introduction, genetic characterization and evolution, and impacts and mitigation. He developed conceptual and empirical models to describe how alien invasive species colonize the Laurentian Great Lakes and other aquatic ecosystems. Recent work addresses use of genetic markers to identify source and destination patterns, and how the problems of false positives and false negatives are affected with this approach.

Presentation Abstracts

MONDAY 8 JULY**Plenary****Teasing apart the mechanisms of socially-induced infertility in non-reproductive naked and Damaraland mole-rats occurring in harsh arid environments.****N.C. Bennett¹***¹Mammal Research Institute, Department of Zoology and Entomology, University of Pretoria, Pretoria, South Africa.*Presenting author e-mail: ncbennett@zoology.up.ac.za

The naked and Damaraland mole-rats are eusocial subterranean mammals that inhabit harsh arid environments. These two species exhibit an extreme reproductive skew with a single reproductive female responsible for procreation. Non-reproductive female colony members are physiologically suppressed while in the confines of the colony and exhibit reduced concentrations of luteinising hormone (LH) and a decreased response of the pituitary, as measured by the release of bioactive LH, to an exogenous dose of gonadotropin releasing hormone (GnRH). Removal of the reproductive female from the colony results in an elevation of circulating plasma LH and an enhanced response of the pituitary to a GnRH challenge in non-reproductive females which is comparable to that of the reproductive female, implying control to reproduction in these individuals by the reproductive female. This renders these two mole-rat species ideal models to investigate the physiological and behavioural mechanism that regulates the hypothalamic-pituitary-gonadal axis. We know less about the control of reproduction at the level of the hypothalamus. The immunohistochemistry of the GnRH system of both reproductive and non-reproductive female Damaraland mole-rats has revealed no significant differences with respect to the morphology, distribution and numbers of immunoreactive GnRH perikarya. However, the GnRH perikarya of non-reproductive females revealed a higher degree of immunoreactivity and the presence of beads of GnRH along the length of the neurons, intimating a block to the release of GnRH. Endogenous opioid peptides are usually implicated in reproductive failure in organisms that undergo stress. We examined whether the endogenous opioid peptide beta-endorphin was responsible for the inhibition of release of the GnRH from the neurons indirectly by measuring LH concentrations in these non-reproductive females following single, hourly and eight hourly injections of the opioid antagonist naloxone. The results imply that the endogenous opioid peptide beta-endorphin is not responsible for the inhibition of GnRH release from the perikarya in non-reproductive females. Preliminary data examining the distribution of kisspeptin immunoreactivity in the hypothalamus of reproductive and non-reproductive females suggest a possible role for this recently discovered neuropeptide that is important in the release of GnRH for the control of reproduction in socially suppressed Damaraland mole-rats. In the non-reproductive female naked mole-rats there is less Kisspeptin expression than their breeding counterparts in the arcuate nucleus suggesting inhibition of manufacture of the neuropeptide. Recent evidence suggests that suppression of reproduction in the naked mole-rat appears to be brought about by the phenomenon of hyperprolactinaemia. The ovaries of females are prepubescent and the testes are azoospermic, which would be indicative of a shut down in the hypothalamic-pituitary-gonadal axis. Various models of reproductive control are discussed.

**Session 1: Physiology
(Main Hall: Ndlopfu)****Integration of thermal sensitivity into the pace-of-life syndrome in *Agama atra*.****K. Alujević¹, M. Logan², J. Streicher³, S. Clusella-Trullas¹***¹University of Stellenbosch, Stellenbosch, South Africa.**²Smithsonian Tropical Research Institute, Panama City, Panama.**³The Natural History Museum, London, United Kingdom.*Presenting author e-mail: kalujevic@sun.ac.za

Individuality in a wide range of fitness-related traits has been well documented in both vertebrates and invertebrates. In ectotherms, life-history traits, energetics, personality, and thermal physiology have been integrated into the pace-of-life syndrome (POLS). Within a population, individuals differ in suites

of correlated traits with 'fast' ('hot') and 'slow' ('cold') phenotypes at opposite ends of the spectrum. However, individuals' behavioural and physiological capacity to respond to environmental stimuli (such as ambient temperature) may alter the strength of these phenotypic correlations. In turn, these correlations can positively affect fitness or result in trade-offs among phenotypes in thermally variable contexts. This study tested these relationships by examining the thermal dependence of physiology-performance-personality correlations in the lizard *Agama atra* Daudin, 1802. We quantified the thermal sensitivity of sprint-speed, standard metabolic rates and three behavioural traits (activity, emergence and boldness) of 20 lizards from a single population. We tested for the repeatability of multiple behaviours resulting in personality types and examined their association to thermal reaction norms of metabolism and sprint speed. With selection acting on individual phenotypic variation, measuring the strength of these correlations and its temperature dependence should provide insight into the maintenance of different 'life-strategy' phenotypes in different natural contexts.

Impact of solar radiation on the thermal responses of hair-coat sheep raised in a semi-arid region of Brazil.

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We investigated the impact of solar radiation on the heat balance of hair-coat sheep raised under natural conditions in a semi-arid region of Brazil. Ten adult Morada Nova ewes (32.8 ± 3.7 kg, mean \pm SD) were randomly exposed to, or protected from, solar radiation between 07:00 and 16:00 for assessment of rectal (T_R), and hair coat surface (T_{hc}) temperatures, and respiratory rate (R_R), over twenty consecutive days. From 10:00 to 14:00, solar radiation ranged from 550 ± 60 to 1100 ± 30 W m⁻², and mean radiant temperature varied from 45 ± 4 to 55 ± 8 °C in the full sun (exposed), and from 30 ± 2 to 37 ± 3 °C in the shade (protected). When exposed to solar radiation, ewes absorbed up to 350 W m⁻² of thermal energy by long- and shortwave radiation. From 10:00 to 14:00, the R_R , T_R , and T_{hc} of ewes exposed to solar radiation were 20 breaths min⁻¹, 1.2 °C, and 15 °C higher ($P < 0.05$) than those of sheep in the shade. Solar radiation therefore imposed a significant heat load on the sheep, with implications for their welfare and management.

Basking in aardvarks: an energy-saving behaviour for nutritionally compromised large mammals?

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Basking is commonly used by small mammals for thermal comfort, maintenance of body temperature in the cold, and rewarming from torpor. The use of exogenous heat to increase body temperature passively reduces the energy requirement for endogenous heat production. Here, through the use of biologging to obtain long-term records of body temperature and activity in free-living aardvarks, we provide the first direct evidence for observed basking being used by a large mammal to increase body temperature. Through field observation and camera trapping, we recorded 39 basking events in five aardvarks in poor body condition following droughts in the Kalahari. Body temperatures, which were low at the start of basking (32.7 ± 1.5 °C), increased by 2.9 ± 2.0 °C over the basking period (duration $3:51 \pm 3:01$ h). By increasing their body temperature by basking rather than through endogenous heat production, aardvarks saved energy equivalent to 13% of their daily intake. Although basking outside the burrow requires a trade-off with increased predation risk for a normally nocturnal aardvark, it is likely

to provide critical energy savings for survival and may be a behaviour common to other large mammals with negative energy budgets.

Monkeys get kicked when they're down: increased injury rates during fevers.

R.S. Hetem^{1,2}, R. McFarland^{2,3}, D. Mitchell², L. Barrett^{2,4}, S.P. Henzi^{4,5}, S.K. Maloney^{2,6}, T. Bonnell⁴, C. Young⁵, A. Fuller²

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Fevers during infection, and the associated sickness behaviours, often are considered an adaptive response by the host. Yet, within a social context, it may be advantageous to suppress sickness behaviours such as lethargy and anorexia to improve reproductive success or social status. We implanted data loggers to measure core body temperature of free-living vervet monkeys (*Chlorocebus pygerythrus*) and conducted concurrent behavioural observations. We detected 88 spontaneous febrile episodes in 39 individuals (21 males) over a 7-year period. Fevers lasted between 2 and 17 days and were characterized by an upward displacement of the nycthemeral rhythm of body temperature by $\sim 1^{\circ}\text{C}$, with an average maximum body temperature of $40.6 \pm 0.5^{\circ}\text{C}$. Relative risk of injury during the fever tripled compared to 10 days prior to the onset of a fever. Monkeys appear to be able to detect when conspecifics are sick and act to reduce the competitiveness of those individuals. Knowledge of how social factors modulate the welfare of infected animals is an important aspect to consider in understanding ecological implications of disease.

The effect of hot weather on body condition and time-activity budgets in an arid-zone specialist, the Red Lark, *Calendulauda burra*.

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Organisms living in hot, arid environments face strong pressure to minimise water loss and energy requirements and thereby avoid mismatches between supply and demand. Desert birds experience strong trade-offs between thermoregulation and foraging during high temperatures, which drive progressive reductions in body mass during sustained hot weather. These have previously been documented in two species, Southern Pied Babblers (*Turdoides bicolor*) and Southern Yellow-billed Hornbills (*Tockus leucomelas*). We investigated whether maximum daily air temperature (T_{max}) influences body condition in a quantitatively similar manner in an arid-zone specialist, the Red Lark (*Calendulauda burra*). Heat-dissipation behaviour (panting and/or wing-spreading) was strongly influenced by T_{max} , with the larks spending $\sim 50\%$ of their time heat-dissipating at a $T_{\text{max}} = \sim 35^{\circ}\text{C}$. Our data show that males struggle to regain enough mass at 34°C to offset overnight mass loss and experience zero diurnal mass gain at $T_{\text{max}} > 39^{\circ}\text{C}$. Among females, however, mass gain and T_{max} were much more weakly correlated. Our data reiterate the importance of studies of the temperature-dependence of behaviour and the fitness consequences for arid-zone birds. Understanding the impacts of chronic *versus* acute heat exposure for Red Larks will allow for more robust modelling to assess the impact of climate change on this threatened desert species.

Seasonal effects of faecal glucocorticoid (fGCM) and triiodothyronine (fTM) metabolites in a model strepsirrhine primate.**C. Long^{1,2}, A.S.W. Tordiffe¹, M.L. Sauther³, F.P. Cuozzo⁴, J. Millette³, A. Ganswindt^{2,5}, J. Scheun^{2,5}**¹Department of Paraclinical Sciences, Onderstepoort Veterinary Campus, University of Pretoria, Pretoria, South Africa.²National Zoological Gardens of South Africa, South African National Biodiversity Institute, Pretoria, South Africa.³Department of Anthropology, University of Colorado, Boulder, Colorado, United States of America.⁴Lajuma Research Centre, Louis Trichardt, South Africa.⁵Mammal Research Institute, Department of Zoology & Entomology, University of Pretoria, Pretoria, South Africa.Presenting author e-mail: channen1221@gmail.com

The dramatic decrease in primate populations globally has been linked to anthropogenic activities. Thus, it is imperative that we study primate physiological responses to environmental changes in order to understand adaptability and enhance species conservation strategies. Our study used a TSH challenge and handling event conducted upon two (1 male, 1 female) thick-tailed bushbabies (*Otolemur crassicaudatus*) to determine and validate the most appropriate enzyme immunoassays (EIAs) for monitoring faecal glucocorticoid (fGCM) and triiodothyronine hormone (fTM) metabolites as biological markers of stress and metabolism in this species. We also examined annual seasonal effects on fGCM patterns among free-ranging bushbabies (male: n = 76; female: n = 110) from the Lajuma Research Station, Soutpansberg Mountains. The TSH challenge and biological validation resulted in a significant increase in hormone concentrations in both study animals (fTM: male = 71,9%, female = 67,85%; fGCM: male = 591%, female = 204%). For free-ranging females, results revealed the covariate best explaining variation in fGCM concentrations was season ($p = 0,05$), while rainfall significantly affected variation in fGCM concentrations among males ($p = 0,04$). Our findings indicate that changes in the natural environment can significantly impact the expression of biological markers of stress in this primate species.

A comparison of African clawless otter *Aonyx capensis* behaviour and stress hormone levels in rural and peri-urban areas.**T.L. Majelantle¹, A. Gandswindt¹, T. McIntyre^{1,2}**¹Mammal Research Institute, Department of Zoology and Entomology, University of Pretoria, Pretoria, South Africa.²Department of Life and Consumer Sciences, University of South Africa, Pretoria, South Africa.Presenting author e-mail: tshepiso.majelantle@zoology.up.ac.za

In a time of increasing environmental change caused by anthropogenic disturbance, the need for understanding animal adaptations to man-made environments increases. Using non-invasive methods, we aimed to compare the behaviour (group size and time of activity) and faecal glucocorticoid metabolite (fGCM) concentrations as a measure of stress in African clawless otters (*Aonyx capensis*) occurring in a peri-urban area, Millstream Farm, and rural areas, Verloren Vallei Nature Reserve (Verloren) and Cobham Nature Reserve. We found a significant difference ($p = 0.007$) between group sizes in the peri-urban area (n = 112; range = 1 – 5) and rural areas (n = 29; range = 1 – 3). Additionally, there was a significant difference in otter activity time ($p = 0.033$, activity overlap = 66.5 ± 8.33 %) between Verloren and Millstream farm. Millstream Farm otters were nocturnal (91% of records at night) whereas Verloren otters were mostly nocturnal (76% of records at night). Finally, fGCM concentrations of animals from Millstream (n = 20; 0.468 ± 0.539 $\mu\text{g/g DW}$) and the rural areas (n = 20; 0.245 ± 0.219 $\mu\text{g/g DW}$) differed significantly ($p = 0.019$). These results suggest that African clawless otters display behavioural and physiological responses to adapt to man-made environments.

Carry-over effects of sublethal temperatures: oxygen consumption in two lineages of the intertidal mussel, *Perna perna*.

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Climate change effects are usually studied in the context of the effects of lethal temperatures on the physiology of an animal but not the effects of sublethal temperatures. Studying sublethal temperatures can give insight into the subtler effects of climate change which can cause carryover effects. Carryover effects happen when exposure to sublethal conditions affects the sensitivity of an animal to subsequent stress. This investigation used *Perna perna* (Linnaeus 1758) as a model organism to investigate the effects of exposure to sublethal temperatures on oxygen consumption by animals. We used two distinctly related genetic lineages of *P. perna* with different physiological characteristics to test for generality. Three preconditioning treatments were used: field fresh, constant temperature and fluctuating, sublethal temperature. Oxygen consumption was measured across a gradient of increasing temperatures allowing us to measure Q_{10} . We ran the experiments on both lineages. Results showed that, for both lineages, Q_{10} under the Fluctuating, sublethal temperature treatment was significantly higher than for the constant temperature and field fresh treatment groups, which did not differ. While there was no difference between the independently evolved lineages, repeated exposure to sublethal stress resulted in significantly higher sensitivity to high temperatures, with implications for understanding climate change effects.

Getting down and dirty: The reproductive strategy of female Mahali mole-rats, *Cryptomys hottentotus mahali* (Rodentia: Bathyergidae).

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The Mahali mole-rat (*Cryptomys hottentotus mahali*) is a cooperatively breeding rodent that exhibits a reproductive division of labour. Reproduction is confined to a single breeding female, the queen. Other non-reproductive females (NRFs) within a colony are reproductively suppressed. The main objective of this study was to determine if Mahali mole-rats breed seasonally or not and if they are induced or spontaneous ovulators. In addition, we evaluated if there was any evidence of relaxation of reproductive suppression in any NRFs throughout the year. Female Mahali mole-rats were captured over 12 consecutive months and a further 15 NRFs were removed from their natal colonies and were then subjected to three treatments: housed alone, allowed only chemical contact with a vasectomized male, and in direct contact with a vasectomized male. All animals were euthanized and the morphometry and histology of the ovaries and plasma progesterone and urinary progesterone concentrations of all females was then evaluated. The presence of pregnant females throughout the year was a clear indication that the Mahali mole-rat is an aseasonal breeder. In addition, the Mahali mole-rats were deduced to be induced ovulators. Furthermore, no relaxation of reproductive suppression was observed in NRF Mahali mole-rats members confined to the colony.

Session 2: Physiology (Main Hall: Ndlopfu)

Does heterothermy correlate with fitness outcomes in mammals?

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An increase in the amplitude of the 24-h rhythm of body temperature in mammals can be induced by energy and water deficits. Since performance traits are also impacted by energy and water, we investigated whether variability in the body temperature rhythm provides an indication of investment in growth. We measured the core body temperature of 25 sub-adult alpacas (*Vicugna pacos*) for a year using temperature loggers. Each month, the animals were weighed, and a blood sample collected for

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leptin and insulin measurement. We used cosinor analysis to determine the average daily mean, minimum, and amplitude of core body temperature for each month. Body mass gain per month was lower in months that were cooler, and the average minimum daily core body temperature (a measure of heterothermy) was lower in those same months. The minimum core body temperature was a strong predictor of the average monthly gain in body mass. Insulin and leptin were significantly related to mass gain, but the effect size was small. We propose that the pattern of the 24-h body temperature rhythm could provide an index of animal fitness in a given environment.

Rewarming from torpor in seven insectivorous bat species along altitudinal gradients in South Africa.

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Physiological flexibility in thermoregulatory abilities can determine the extent to which animals can adapt to increasing anthropogenic stress and global temperatures. Many insectivorous bat species in South Africa are widely distributed along large altitudinal gradients. One strategy integral to the success of these bat species is daily torpor, which saves energy by reducing metabolic activity and thermoregulation for several hours. However, rewarming to arouse from torpor expends a great deal of energy. Although many factors including temperature, roost conditions, body size and phylogenetic history influence the use of torpor, little is known about the intra- and inter-specific variability in arousal from torpor. We investigated variability in arousal from torpor in seven bat species that occupy broad altitudinal ranges and that vary in roosting ecology, body size and family group membership. We exposed individuals to 15°C overnight and induced arousal the following morning whilst monitoring body temperature with infra-red thermal imaging. Our results suggest that rewarming rates may be phylogenetically constrained, and species differ in their ability to adapt to local micro-climates. These data show the differential physiological plasticity of bat species and identify those most vulnerable to future climate change.

Phenotypic flexibility in the heat tolerance and evaporative cooling capacity of a model Afrotropical passerine bird in response to short-term thermal acclimation.

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Recent studies have revealed considerable flexibility in avian thermoregulatory traits, suggesting birds could show adaptive physiological responses to changing climates. We investigated flexibility in the ability of a model Afrotropical passerine bird (the white-browed sparrow-weaver, *Plocepasser mahali*) to handle high air temperatures (T_a). We allocated birds from three populations along a climatic gradient to three acclimation temperature (T_{accl}) groups (daytime $T_{accl} \approx 30, 36$ and 42°C respectively; $n \approx 10$ per site per T_{accl}). After an acclimation period of 30 days, heat tolerance and evaporative cooling capacity was quantified by exposing birds to progressively higher T_a until they approached severe hyperthermia (body temperature [T_b] = 44.5°C ; T_a range: $38-54^\circ\text{C}$), while measuring metabolic rate and evaporative water loss (open flow-through respirometry), and T_b (temperature-sensitive PIT tags). Capture site was not a significant predictor of any thermoregulatory variables or hyperthermia threshold T_a (HTT_a). However, HTT_a was significantly higher and T_b significantly lower in birds exposed to the hottest T_{accl} compared to those from milder treatment groups. This suggests the ability to handle high T_a is plastic in sparrow-weavers, and that previously documented intra-population variation in the heat tolerance and evaporative cooling capacity of this species is the result of phenotypic flexibility rather than localized genetic adaptation.

Are Kalahari pangolins facing nutritional stress in the face of climate change?**W. Panaino^{1,2}, F. Parrini², R. Hetem^{1,3}, L. Meyer^{1,4}, M. Picker⁵, D. Smith⁶, G. van Dyk⁶, A. Fuller¹**¹Brain Function Research Group, School of Physiology, University of the Witwatersrand, Johannesburg, South Africa.²Centre for African Ecology, School of Animal, Plant and Environmental Sciences, University of the Witwatersrand, Johannesburg, South Africa.³School of Animal, Plant and Environmental Sciences, University of the Witwatersrand, Johannesburg, South Africa.⁴Department of Paraclinical Sciences, University of Pretoria, Pretoria, South Africa.⁵Department of Biological Sciences, University of Cape Town, Cape Town, South Africa,⁶Tswalu Kalahari Reserve, Northern Cape, South Africa.Presenting author e-mail: wpanaino@gmail.com

As a consequence of their specialised diet on one species of harvester termite, aardvarks in the Kalahari are at risk of starvation in the face of hotter and drier conditions associated with climate change. It is unknown how other myrmecophagous mammals in the Kalahari will respond to changes in climate and resource availability. We therefore measured body temperature (using implanted miniature data loggers), behaviour and diet of free-living ground pangolins (*Smutsia temminckii*) over two years in the Kalahari. Our body temperature data, coupled with prey availability data, reveal that winter, following a dry summer, is a period of nutritional stress for pangolins in the Kalahari. In contrast to aardvarks, pangolins predominantly foraged on three prey species, namely *Crematogaster* and *Anoplolepis* ants, and *Trinervitermes* termites. The predicted field metabolic rate (FMR) for an 8 kg pangolin in an arid habitat is 3718 kJ/day (95% CI: 1530 – 9014 kJ/day). Prey analyses revealed that *Crematogaster*, *Anoplolepis*, and *Trinervitermes* contained 0.015, 0.035, and 0.016 kJ of energy respectively per individual prey item. We discuss whether pangolins meet their daily energetic requirements throughout the year and how they may adjust their activity to conserve energy.

Comparison of the body temperature patterns of three large, arid-zone antelope.**W.M. Strauss^{1,2}, R.S. Hetem^{1,3}, D. Mitchell¹, S.K. Maloney^{4,1}, A. Fuller¹**¹Wildlife Conservation Physiology, Brain Function Research Group, School of Physiology, University of the Witwatersrand, Johannesburg, South Africa²Department of Environmental Sciences, University of South Africa, Johannesburg, South Africa³School of Animal, Plant and Environmental Sciences, University of the Witwatersrand, Johannesburg, South Africa⁴School of Anatomy, Physiology and Human Biology, The University of Western Australia, Crawley, AustraliaPresenting author e-mail: strauwm@unisa.ac.za

Maintaining homeothermy requires a mammal to use energy and water. Nutritional or water stress therefore may be reflected by an increased amplitude of the 24 h rhythm of body temperature. Using implanted data loggers, we measured body temperature simultaneously in three ungulate species with varying water dependencies, gemsbok *Oryx gazella*, red hartebeest *Alcelaphus buselaphus* and blue wildebeest *Connochaetes taurinus*. The animals were free-living in the Northern Cape Province of South Africa during the hot dry season and the hot wet season. The maximum body temperature of individuals of our three study species differed between seasons ($F_{1,15} = 50.6$, $P < 0.0001$). However, there was an interaction between season and species ($F_{1,15} = 4.2$, $P = 0.03$), with the gemsbok and blue wildebeest having higher maximum body temperature during the hot dry season. Both minimum body temperature ($F_{1,15} = 56.2$, $P < 0.0001$) and the amplitude of body temperature ($F_{1,15} = 124.2$, $P < 0.0001$) changed with season, with lower minimum body temperatures during the hot dry season resulting in a greater amplitude of body temperature rhythm in all three species. The observed patterns of body temperature may reveal reduced water availability in dry periods, and reduced food availability in all three ungulate species.

How hornbills handle heat: sex-specific differences in evaporative cooling in the Southern Yellow-billed Hornbill.

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Southern Yellow-billed Hornbills (*Tockus leucomelas*; hereafter SYBH) inhabiting arid regions of southern Africa can experience summer air temperatures (T_a) regularly exceeding 40°C while breeding. Breeding male and female SYBHs experience markedly different microclimates; the female seals herself in a tree cavity and moults all her flight feathers, a period during which she and the chicks are entirely reliant on the male for provisioning. The unusual reproductive biology of SYBH provides an opportunity to test the hypothesis that avian thermal physiology has evolved in response to sex-specific variation in microclimates during the breeding season. Using open flow-through respirometry, we measured resting metabolic rate (RMR), total evaporative water loss (TEWL) and core body temperature (T_b) in male and female SYBH at high T_a . We show that, once body mass differences are taken into account, female SYBH have significantly lower TEWL (~11%) and RMR (~14%) than males at high ambient temperatures ($T_a > 44^\circ\text{C}$), despite T_b not differing. Females thus use less water and energy than males to defend similar T_b values. These findings support the notion that female SYBH have evolved more efficient evaporative cooling than males, and provide further insights into variables that will affect this species' responses to climate change.

Detecting torpor at high temperatures using thermoregulatory profiles: Bats as a case study.

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Recent claims that some mammals can suppress their metabolism at high temperature, hereafter "hyperthermic torpor", are largely met with scepticism. Thus, we sought to find corroborating physiological evidence within the well-established body of mammalian thermoregulation literature to substantiate the use of hyperthermic torpor. We chose bats as our study model and adopted an indirect approach to compare the lower- (T_{lc}) and upper (T_{uc}) limits of thermoneutrality between heterotherms and homeotherms, as well as their body temperature (T_b) and rate of evaporative water loss (EWL) at these thermal limits. Heterotherms ($24.2 \pm 4.3\text{g}$) were smaller than homeotherms ($61.2 \pm 16.8\text{g}$) but, once phylogeny was considered, mass had no effect. There was no difference in T_{lc} , T_{uc} or EWL ($p > 0.05$) between bat groups, but heterotherms maintained lower T_b s at both of these limits. Notably, T_{uc} exceeded normothermic T_b in heterotherms. Based on the principles of heat exchange, we argue that heterotherms retard heat storage at T_{uc} and offset Arrhenius effects through hyperthermic torpor. Our results suggest that hyperthermic torpor may be more common than currently appreciated and seemingly manifests as a hyper-extension of T_{uc} , at least in the case of bats.

The effect of humidity on evaporative cooling efficiency in a passerine bird.

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At air temperatures (T_a) exceeding body temperature (T_b), efficient evaporative cooling is crucial to defend a normothermic T_b . Previously the focus has been on evaporative water loss (EWL) in arid environments, neglecting the effects of humidity. Efficiency of evaporative cooling is decreased by increasing humidity due to the ambient air becoming saturated with water vapour. White-browed Sparrow-weavers (*Ploceospasser mahali*) were used as a model species to determine the effect of humidity on evaporative cooling efficiency. The effect on T_b and resting metabolic rate (RMR) were also considered due to the energetic cost of panting. Open flow-through respirometry was used to expose

birds to combinations of temperatures between 35°C and 42°C and water vapour densities between 6 g.m⁻³ and 26 g.m⁻³. The effect of T_a was significant in all the thermal physiology variables considered. Increased humidity showed a decrease in EWL and increases in both RMR and T_b . The efficiency of evaporative cooling decreases with increased humidity. This indicates that defending a body temperature below ambient temperature is increasingly difficult at higher humidity. Humidity is thus an important factor in determining how efficiently birds evaporative cool to cope with ambient temperatures. This complex relationship is important to incorporate in future studies.

The histomorphological evaluation of the effect of selenium in the testes of *Oreochromis mossambicus*.

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Selenium is a non-metallic element essential in small quantities for the normal development and physiological functions in animals, including fish. However, at higher concentrations and long-term exposure, selenium may be harmful to juvenile and adult fish. The aim of this study was to evaluate the effect of selenium on fish testes exposed to different selenium concentrations. This study was divided into two exposure periods: 4 and 21 days respectively. For each exposure period adult *Oreochromis mossambicus* fish were exposed to two concentrations of sodium selenate: 0.104µg/l and 0.069µg/l respectively and eight fish were used per concentration. At the end of the exposure period, fish were dissected. The testes were excised and examined both macroscopically and microscopically for any alterations, if any, that may have been caused by exposure to selenium. No abnormalities were observed on the external side of the testes. However, histomorphological results revealed degeneration of different stages in development of the testicular tissue due to selenium exposure. Noticeable histomorphological alterations included interstitial fibrosis and degeneration of the seminiferous tubules which increased with the exposure period to selenium. The progressive deterioration of the germ cells and the loss of Leydig and Sertoli cells may eventually lead to infertility in fish.

Session 3: Biodiversity conservation and ecosystem resilience (Breakaway Room: Ndau)

Drivers of fine-scale avian functional diversity with changing land use: an assessment of the effects of eco-estate housing development and management.

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Changing land use, especially urbanisation, effects species and functional diversity. Eco-estates are a form of urban-housing development that is suggested to partially negate the effects of landscape development. We assessed avian functional diversity (FD) at four eco-estates (previously sugarcane) and one sugarcane plantation along the KwaZulu-Natal (KZN) North Coast, South Africa. We determined whether the differing development, management types, and the effects of Ecological Land-use Complementation (ELC) at each site influenced avian FD. Point-count surveys were conducted within varying levels of land cover (natural to anthropogenic/sugarcane) at each site. The influence of differing land-cover covariates on all three components of FD (functional richness, evenness, and divergence) were determined through a series of general linear models. Sections of the respective sites with increased natural land cover, mainly in the form of indigenous forest and coastal thicket/dense bush, showed improved avian FD in comparison to those with increased anthropogenic development. Negative effects of increased anthropogenic development may be offset through interconnection with or incorporation within natural land cover. Each FD component was influenced dynamically by seasonal changes and depending on land-cover type. Eco-estates improved avian FD where natural habitats were emphasised and connected. We suggest future development and management strategies for eco-estates and agricultural land in coastal KZN follow ELC, to improve local ecosystem functioning.

Dispersal of invasive *Lantana camara* by native bird species in KwaZulu-Natal, South Africa.

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Alien invasive plant species are a major problem globally, threatening ecosystem functioning and biodiversity. Their spread is facilitated by native bird species through mutualistic relationships. Studies of seed dispersal of alien invasive plants are important for effective management. In this study, the role of native bird species in the dispersal of a highly invasive shrub *Lantana camara* was investigated. A total of 56 bird species were observed visiting *L. camara* with only 28 species consuming the fruit. Visitation frequencies were significantly higher ($p < 0.05$) for small and medium-sized frugivorous species. The Dark-capped Bulbul *Pycnonotus tricolor* was the most observed frugivorous bird species visiting and was likely the main disperser of *L. camara*. Interestingly, two non-frugivorous birds, the White-bellied Sunbird *Cinnyris talatala* and the White-browed Scrub-robin *Cercotrichas leucophrys* showed relatively high visitation frequencies to *L. camara*. Of the 28 species that ingested fruit, potential dispersal distances ranged from 9 to 45 km. Long dispersal distances were rare, limited by relatively rare large frugivorous birds. Level of frugivory and body size were the main traits that influenced dispersal effectiveness. These results emphasize the importance of evaluating the role of bird species in the dispersal of alien invasive plant species.

Predicted distributions of avian specialists provide a framework for conservation and connectivity of endangered forests under future climate change.

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Forested regions are of global importance for a multitude of ecosystem functions and services and are critical for global biodiversity. Anthropogenic climate change compounds negative effects of land-use change on forest persistence and forest-dependent biodiversity. Planning for connectivity is key in mitigating climate-change effects and facilitating species' dispersal ability throughout remnant habitat and climatic-niche tracking. We hypothesised that three forest-specialised and habitat-specific bird species would be efficient surrogates for promoting connectivity and conservation of each of South Africa's three threatened forest classes, as each is range-restricted to its respective forest type. We created ensemble models of species' distributions and incorporated core home- and breeding-range patches into a hybrid model of least-cost pathways and Ecological Circuit Theory mapping. We predicted the likelihood of niche persistence for each species under future climate-change scenarios, and the efficacy of our connectivity modelling to facilitate range expansion or climate-niche tracking. The projected habitat loss under climate change impacted core-habitat patch distribution, size, and connectivity, exacerbating habitat fragmentation and increasing dispersal resistance. Forest systems at mid- to high elevations were projected to experience highest levels of habitat contraction. Ecological resilience to disturbance and climate change was dependent on connectivity, facilitating species' ability to track climate niches.

Modelling the spatial and temporal distribution of fire occurrence from satellite imagery in Hwange National Park, Zimbabwe.

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We analysed the spatial-temporal distribution patterns of fire in Hwange National Park (HNP) from remotely sensed data for the period 2010 to 2016 and modelled the factors that influence the probability of fire occurrence. Fire product data were used to validate the burnt and the unburnt classification. To predict the probability of fire occurrence, presence-only fire data were run in MaxEnt model against five environmental variables (annual rainfall, temperature, elevation, NDVI and distance from roads). We further computed the Getis-Ord (G_i^*) in Arc Map 10.3 to identify fire hotspots. By correlating the two

variables with Simple Linear Regression, the results showed that there was no relationship between the fire detection incidences and the trends of burnt areas. Areas in the northwest and northeast of the park were identified as fire hotspots. Overall, the probability of fire occurrence was mostly influenced by annual rainfall (42.9 %) in the MaxEnt model (AUC = 0.76). Annual rainfall of the preceding year could be useful in predicting future annual burnt area estimates in protected areas. We recommend area-specific fire management interventions to reduce the impacts of fire in protected areas.

Ecosystem services and disservices by birds, bats and monkeys change with macadamia landscape heterogeneity.

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The relative importance of ecosystem services and disservices can change with landscape structure in a poorly understood way. We compared the impact of biological control, provided by bats and birds, with that of crop-raiding by vervet monkeys in South African macadamia orchards. Bats, birds and monkeys benefit from patches of natural vegetation adjacent to orchards. With exclusion experiments (four treatments: day, night, day + night, control) we quantified the relative importance of pest control and crop-raiding, comparing two different landscape settings of the orchards - natural and human-modified. Crop-raiding occurred only in natural landscapes and caused yield losses of about 26%. Biocontrol by bats and birds was higher near natural vegetation, but still detectable in human-modified landscapes, with yield loss protection of 60%. Benefits of pest-controlling bats and birds hence outweighed disadvantages of crop raiding. Management practices to prevent crop damage, such as guarding or removal of natural vegetation, would also limit access for bats and birds and the economic benefits provided by their pest control. Education and information for farmers is crucial, as many are unaware of the benefits birds and bats provide, or the fact that these benefits can outweigh the disadvantages of monkeys' raiding crops

Who's out there? Bat diversity in forests of the Eastern Cape and southern KwaZulu-Natal, South Africa.

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Biogeographical information of bats is needed to better assess their diversity and relative abundance in South Africa. There is a lack of surveys in Eastern Cape forests where basic diversity assessments have not been performed. Bats were surveyed at 19 forests (Scarp, Mistbelt and Dune groups) within the Eastern Cape and southern KwaZulu-Natal Provinces, wherein 590 individuals were captured in harp traps (32 trap-nights) and mist nets (84 trap-nights). A total of 19 species from five families were collected, with new distribution records for six species. Ecological niche modelling is presented for species with extensions to known distribution ranges. Species identification was performed utilizing morphology, genetic barcodes, and echolocation call parameters (Fc, Fk, Fmin, duration). A species richness gradient is evident from high in Scarp forests (16 species), to low in Dune forests (4 species). A combination of acoustic and capture-based surveys is necessary to estimate true species richness. Accurate identification of echolocation calls from acoustic monitoring is limited by the availability of regional call libraries. The first call library for South African forests and the Eastern Cape Province was compiled from hand-released bats caught during this survey. The library forms the foundations for further acoustic surveys of South African forested habitats.

Predation in agricultural rodent pest control: Underutilized ecosystem service or unrealistic expectation?

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Rodents remain a key pest of grain crops globally. Due to the environmental risks and rodenticide resistance in rodents there has been an increased interest in ecologically based rodent control (EBRM). Predation is a key component of EBRM that is often neglected. We use data from field studies and simulation models to investigate the effect of predation on crop losses. Results from crop simulation models indicated that crop losses are impacted by rainfall, planting density and rodent seed predation. The greatest impact of rodent seed damage (2-40% yield decline) occurred under high rainfall and rodent densities of 10-30 rodents/ha. Under low rainfall, crop damage was less prevalent since available soil water seems to drive crop yields. Using published literature on avian and mammalian predators we found that these species often incorporate rodents in their diet. Mammalian carnivores detected on crop lands can incorporate up to 80% of rodents in their diet. Cropland camera trapping indicated that these areas can have high diversity of mammalian carnivores of which several are rodent specialists. From drive transects we also found that cropping landscapes have large avian predator communities. Combined these results show that there is an untapped potential of predation in controlling rodent pests.

Finding Africa's rarest rabbit: camera clusters and occupancy modelling of the riverine rabbit, *Bunolagus monticularis*.

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Monitoring the distributions of rare species is critical to biodiversity conservation. However, these are often cryptic and difficult to detect using conventional methodologies. We explore the efficacy of intensive camera trapping surveys at detecting the presence of the critically endangered riverine rabbit (*Bunolagus monticularis*) within the Sanbona Wildlife Reserve, South Africa. The first array was extensive, comprising of 146 camera traps in 2 km intervals covering an area of 540 km² and failed to detect rabbits. The second was intensive, with 150 cameras placed in clusters of 5 within 15 ha blocks, conforming to rabbit mean home range size and covering a total area of 108 km². Fifty-seven independent recordings of riverine rabbit were detected from this array. Single season occupancy analysis revealed that the best predictor of riverine rabbit presence was the absence of hares (*Lepus spp.*). Furthering this investigation, we employed a multispecies occupancy model which showed that terrain ruggedness, predator relative abundance and proximity to degraded land were the most important drivers of both riverine rabbit and hare distribution. These findings represent an important step toward understanding fine scale predictors of presence in one of the world's rarest mammal species.

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Hippopotamus population counts using a drone.

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Accurate population surveys are an essential step for successful game reserve management and species conservation. Conducting comprehensive game counts on foot can be difficult and inaccurate, especially with changing climatic conditions and reclusive animals. In contrast conducting aerial counts using planes and helicopters can be very expensive. We are investigating aspects of the ecology of the common hippopotamus (hippo) *Hippopotamus amphibious* in Ndumo Game Reserve (NGR), Northern KwaZulu-Natal, South Africa. With the ongoing drought, changing vegetation and difficult terrain we have used technology to assist with population estimates and size classes of hippo in NGR. Here we present initial findings using combined techniques, including a DJI Phantom 3 Advanced drone, for monthly NGR population estimates of hippo. These data also show changes in spatial ecology and population dynamics of hippo within the reserve. Although there has been significant human disturbance around NGR, the hippo population within the reserve seems to be stable. In addition, we are able to justify the use of off-the-shelf drones for conducting research on hippo populations.

Multi-scale patterns of tick occupancy and abundance across an agricultural landscape in southern Africa.

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Land use change can influence the prevalence and distribution of ticks due to their intimate relationship with vertebrate hosts from which they acquire blood meals and with the physical environment which provides suitable vegetation when off-host. Given the risks to human and animal health associated with tick-borne pathogens, there is a need to understand the influence of environmental drivers on tick distribution. Here, we assess how landscape features, neighbourhood effects, and edges influence tick occupancy and abundance across an agricultural landscape in southern Africa. We found that *Rhipicephalus appendiculatus* and *R. simus* increase in abundance closer to protected savanna, while *Haemaphysalis leachi* increase in abundance closer to homesteads. The composition of the landscape surrounding savanna patches differentially influenced the likelihood of finding each tick species; *H. leachi* was more likely to be found in savanna patches surrounded by subsistence agriculture while *Rhipicephalus* spp. was more likely to be found in savanna surrounded by sugarcane monocultures. The availability of hosts in commercial agriculture, subsistence agriculture, and savanna likely drives the distribution of ticks at multiple scales. Understanding how anthropogenic land use can influence where ticks occur is useful for assessing public and animal health risks associated with ticks and tick-borne diseases.

Session 4: Taxonomy, systematics and evolutionary biology (Main Hall: Ndlopfu)

Parasite evolution: Who is getting on the boat?

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Parasites are often dependent on their hosts for dispersal and subsequent gene flow. The dispersal ability of parasites, however, differ markedly between species and this is the result of complex interactions between host life history, parasite life history and biogeography. In an attempt to better understand the mechanisms involved in parasite dispersal (and subsequent evolution), I review several case studies focusing on phylogeographic patterns of host and their associated parasite taxa occurring in the southern African region. From these case studies, the following emerged (a) genetic connectivity among geographic populations of ectoparasites are mostly dependent on the ability of ectoparasites to

survive in the off host environment and not so much on the vagility of their hosts (b) the evolution of species specific parasites that occur permanently on a host are not only driven by host related factors but also species specific parasite traits and biogeography (c) parasites who are restricted in their dispersal, and that do not live permanently on the host, are good candidates to show significant phylogeographic co-divergences with their host (d) vicariance and other abiotic factors can play a significant role in parasite evolution irrespective whether parasites are generalist or specialist.

The importance of fine-scale sampling in detecting alpha taxonomic diversity among saproxylic invertebrates: A velvet worm (Onychophora: *Opisthopatus amaxhosa*) template.

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The phylogeography and social structure of the narrow endemic velvet worm species *Opisthopatus amaxhosa* were investigated using fine-scale sampling in the Eastern Cape province of South Africa. In addition, *Opisthopatus* specimens sampled separately were included in a new phylogeny. A total of 89 specimens from 18 sample localities were collected at three forest patches for *O. amaxhosa*, an additional six *Opisthopatus* sample localities were included. For *O. amaxhosa*, we sequenced the *COI* locus, but only a subset of specimens were sequenced for two nuclear loci, *18S rRNA* and the *fushi tarazu* intron (*FTz*). Phylogenetic analyses using maximum likelihood and Bayesian inferences revealed two highly divergent clades. These two clades shared no maternal haplotypes, were characterised by high sequence divergence and high *FST* values and fixed nuclear difference for the *18S rRNA* locus. The *FTz* intron was invariant. Scanning electron microscopy between the clades revealed fixed ventral and dorsal scale numbers. This provides evidence for a novel species at a fine scale. Divergence time estimations suggest divergence during the late Pleistocene. The social structure was male-biased, and sample sites exhibited genetic variance. The inclusion of new specimens within *Opisthopatus* revealed no novel lineages. Fine-scale sampling appears more important to detect alpha diversity.

Vertebrate evolutionary hotspots of South Africa.

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Biodiversity hotspots are biogeographic regions with high levels of species richness, endemism and threats. Analyses of phylogenetic diversity have shown that hotspots represent substantial amounts of evolutionary history and often contain multiple species with high genetic divergence and diversity, i.e. acting as evolutionary hotspots. South Africa's terrestrial global biodiversity hotspots, famous for their plant species richness and endemism, also harbour a large number of endemic vertebrates. Here we present a review of the literature, including our own phylogeographic research, to address (i) whether the three global biodiversity hotspots are faunal evolutionary hotspots and (ii) whether other parts of South Africa should similarly be prioritized for conservation action. We find that the biodiversity hotspots foster high speciation rates in many taxa, as well as acting as important refugia during periods of climatic change (acting as "cradles" and "arks"). These regions furthermore show significant intraspecific diversity and prominent phylogeographic breaks, characterizing key biodiversity areas within hotspots. We illustrate the importance of endemic links across the Cape Fold Mountains, Drakensberg and bioregions in the northern provinces of South Africa as examples of the discovery of additional priority areas for conservation.

Investigating the phylogeography and venom composition of rinkhals, *Hemachatus haemachatus* (Elapidae), across South Africa.**E. Brand¹, I.A. Engelbrecht², J.J. Calvete³, D. Pla³, G.J. Alexander⁴, C.L. Sole¹**¹Department of Zoology and Entomology, University of Pretoria, Pretoria, South Africa.²South African National Biodiversity Institute, Pretoria, South Africa.³Evolutionary and Translational Venomics Unit, Instituto de Biomedicina de Valencia, Carrer de Jaume Roig 11, Valencia, Spain.⁴School of Animal, Plant and Environmental Sciences, University of Witwatersrand, Johannesburg, South Africa.Presenting author e-mail: elme.brand@zoology.up.ac.za

The rinkhals, *Hemachatus haemachatus*, is a monotypic species of Elapid snake that is endemic to southern Africa. This species shows great phenotypic variation across its distribution. Anecdotal evidence also suggests that populations from different regions vary in venom composition. As rinkhals occur across different ecotypes, we aimed to assess whether there are genetic differences as well as differences in venom composition between populations from different localities within South Africa. Sampling covered a large portion of the distribution of this species, 70 tissue and 16 venom samples were collected. Cytochrome b and 16S gene regions were sequenced from which phylogenetic relationships were inferred. Locality data were plotted onto a South African map to infer phylogeographic patterns. Venom was subjected to RP-HPLC, densitometric analysis of SDS-PAGE lanes under non-reduced and reduced conditions, in-gel digestion of electrophoretic bands and analysis of each tryptic digest by MS/MS. Genetically, all samples appear to form part of a single population that is divided into two broad mitochondrial lineages. This pattern possibly arose from two refugial populations that were separated, and gene flow has subsequently been re-established. Preliminary venom analyses indicate six possible clusters that are geographically isolated.

Cryptic diversification of a rupicolous forest dwelling gecko (Gekkonidae: *Afroedura pondolia*) in a biodiversity hotspot.**T. Busschau¹, W. Conradie², S. Daniels¹**¹Department of Botany & Zoology, University of Stellenbosch, South Africa.²Port Elizabeth Museum, Humewood, Port Elizabeth, South Africa.Presenting author e-mail: theob@sun.ac.za

During the study we assess the phylogeographic structure and test species delimitation methods in the forest living Pondo flat gecko (*Afroedura pondolia*) across their distribution in the Eastern Cape and KwaZulu-Natal provinces of South Africa. Phylogenetic results from the combined mitochondrial and nuclear DNA sequence data derived from four partial loci (ND4, Cytb, PRLR and RAG1) suggest the presence of four monophyletic and geographically discrete clades. We applied four species delimitation methods (ABGD, GMYC, PTP and STACEY), the results of which were largely incongruent in the number of putative species, resulting in either an overestimation or underestimation of operational taxonomic units nested within *A. pondolia*. Multivariate morphological analyses indicate statistically significant differences between the four clades, corroborating the presence of four species within *A. pondolia*. Divergence time estimates suggest that cladogenesis was driven by forest fragmentation from the late Miocene to the Plio-Pleistocene with the onset of more pronounced xeric climatic conditions resulting in forest fragmentation. Factors causal to the observed biogeographic patterning are discussed.

A review of the *Pseudobarbus afer* (Peters, 1864) species complex (Teleostei, Cyprinidae) in the eastern Cape Fold Ecoregion of South Africa.**A. Chakona¹, P.H. Skelton¹**¹South African Institute for Aquatic Biodiversity, Grahamstown, South Africa.Presenting author e-mail: a.chakona@saiab.ac.za

The Eastern Cape redefin, *Pseudobarbus afer*, has long been considered to be a single widespread and variable species occurring in multiple isolated river systems in the Cape Fold Ecoregion. Molecular data of individuals from populations previously assigned to *P. afer* revealed existence of four deeply divergent taxonomic units. Our study provides new diagnosis for *P. afer* s.s, revalidate *P. senticeps*, and describes a new species *P. swartzi*. The three species exhibit subtle differences which explains why they were previously considered to represent a single variable and widespread species. *Pseudobarbus senticeps* differs from both *P. afer* and *P. swartzi* by having fewer (i.e. larger) scales and

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presence of a lateral stripe which terminates in a conspicuous triangular blotch at the base of the caudal fin. Long barbels which reach or surpass the vertical through the posterior edge of the eye further separate *P. senticeps* from *P. afer* s.s. which possesses simple short barbels which do not reach the vertical through the posterior margin of the eye. *Pseudobarbus afer* s.s differs from *P. swartzi* sp. nov by possession of fewer scale rows along the lateral line and around the caudal peduncle and a distinct mesh or net-like pigmentation pattern on latero-ventral scales.

Osteohistology and life history of the Mesozoic bird, *Confuciusornis sanctus*.

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Mesozoic birds are generally quite rare and are hardly known from multiple individuals. However, with the discovery of the exceptional localities of the Early Cretaceous Jehol Group of northeastern China, thousands of *Confuciusornis sanctus* specimens preserving both skeletal material and plumage, as well as other soft tissues, were discovered. Remarkably, some of these individuals have distinctive ornamental rectrices, whilst others lack such ornamentation. Here we investigate the bone microstructure of 22 long bones sampled from 14 *Confuciusornis sanctus* specimens to assess life history patterns of this basal pygostylian bird. Analysis of the bone histology of the various bones revealed differences in the histological structure of their bone walls. One of the birds without tail feathers had medullary bone, which permitted its identification as a female bird. Based on the bone histology present in the specimens studied, we separated the examined specimens into five histological age classes. We found that size and age were not strictly correlated, which suggests that they have a high degree of developmental plasticity. Our findings further showed that like several other basal birds (such as, *Jeholornis*, *Sapeornis*, and enantiornithines), *Confuciusornis* experienced rapid growth during early stages of ontogeny, and thereafter grew episodically to reach skeletal maturity.

Adaptive genetic variation at three loci in South African vervet monkeys, *Chlorocebus pygerythrus*.

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Vervet monkeys (*Chlorocebus pygerythrus*) are one of the most widely distributed non-human primate species in South Africa, inhabiting a large variety of habitats. Different environmental factors, such as pathogen diversity, observed in different habitats could drive varied levels of selection at fitness-linked loci. The well-studied Toll-like receptor (*TLR*) gene family plays an integral role in vertebrate innate immunity. In this study, we assessed the level of genetic variation at partial sequences of two *TLR* loci (*TLR4* and *7*) and a reproductively linked gene, *acrosin* (*ACR*), across different habitat types within the vervet monkey distribution range. Low levels of genetic variation for all three gene regions were observed, with only two polymorphic sites identified for *TLR4*, three sites for *TLR7* and one site for *ACR*. *TLR7* variation was positively correlated with high mean annual rainfall, which was linked to increased pathogen abundance. The observed genetic variation at *TLR4* might have been influenced by numerous factors including pathogens and climatic conditions. The *ACR* exonic regions showed no variation in vervet monkeys, possibly due to a selective sweep. The knowledge gained from this study can guide future research projects, as well as help conservation agencies with management planning involving this species.

A taxonomic overview of *Brevipalpus phoenicis* “species complex” (Geijskes, 1939) (Acari: Tenuipalpidae): A South African perspective.**P.A. Maake¹**¹*South African National Biodiversity Institute (SANBI), Biosystematics & Research Collections, Pretoria National Botanical Garden, Brummeria, Silverton, South Africa.*Presenting author e-mail: A.maake@sanbi.org.za

When reviewing South African (SA) Tenuipalpidae, only seven species of genus *Brevipalpus* were reported. Evidence showed a major concern that these well-defined species were consistently misidentified and decades of host-association and distributional data could be erroneous. Such records continued to complicate species identification and the separation of closely related species. This study aimed to use taxonomic approaches to investigate cryptic species within *B. phoenicis* complex and clarify systematic inconsistencies previously reported. Over 90 specimens of *B. phoenicis* complex collected and others loaned from the National Collection of Arachnida were observed with the Phase Contrast Zeiss Axioscope microscope whilst 25 freshly collected individuals were studied with Quanta Scanning Electron microscope. The findings show that *B. phoenicis* species complex could currently be represented by at least five species in SA; two of quarantine importance, as compared to the previous belief that only *B. phoenicis sensu stricto* was represented. This is with the exception of the known records of *B. californicus*, *B. Iewisi* and *B. abovatus* species in the country. The damages caused by these mites observed across various crops shows that the outcome of this research is critical and these mites should be treated with higher importance due to their economic reputation as pests of agricultural and indigenous plants.

A comprehensive anatomical description of the most complete specimen of *Endothiodon bathystoma* (Anomodontia, Therapsida), from the late Permian of the Karoo Basin of South Africa.**I.E.M. Maharaj¹, A. Chinsamy-Turan¹, R.M.H. Smith^{2,3}**¹*University of Cape Town, Department of Biological Sciences, Rondebosch, Cape Town, South Africa.*²*Iziko South African Museum, Cape Town, South Africa.*³*University of Witwatersrand, Johannesburg, South Africa.*Presenting author e-mail: iyraem@gmail.com

Dicynodonts were herbivorous non-mammalian synapsids that were abundant from the middle Permian to the Early Triassic periods. The genus *Endothiodon* is well known from late Permian deposits of the Karoo Basin of South Africa. It is characterised by replacement waves of internal tooth rows on the premaxilla and dentary; longitudinal ridges from the premaxilla to the pineal crest; and a pineal foramen on a prominent boss. Postcranial remains are rare in *Endothiodon* collections. However, the most complete skeleton of *Endothiodon* (SAM-PK-K011271) was recently recovered from the uppermost *Pristerognathus* Assemblage Zone of the Karoo Supergroup, comprising of cranial and nearly all postcranial elements preserved in articulation. The research presented here comprehensively describes the skull and postcranial anatomy of this specimen, which permitted its identification as *E. bathystoma* and as the second largest *Endothiodon* individual in the South African collections. We suggest that *E. bathystoma* was likely a barrel-bodied animal with longer forelimbs than hindlimbs. We also find the phalangeal formula to be 2-3-3-3-3, in keeping with that of other dicynodonts. Our study provides an ideal foundation for further studies to address skeletal reconstruction, biomechanical functioning, and other aspects of the palaeobiology of *E. bathystoma*.

TUESDAY 9 JULY

Plenary

African Palaeozoology: A Forsaken Science?**B.G. Lovegrove¹**¹*School of Life Sciences, University of KwaZulu-Natal, Scottsville, Pietermaritzburg, South Africa.*Presenting author e-mail: lovegrove@ukzn.ac.za

The diversity and abundance of African mammals is unsurpassed anywhere on Earth. Their ecology, physiology and behaviour have been well studied relative to mammals on other continents. Here I suggest that this acquisition of knowledge has forsaken what can and should be learned from the extinct assemblages of African mammals. South Africa, in particular, is sanctuary to fossil assemblages of Permian and Triassic archaic mammals that is also unsurpassed anywhere on earth. Although palaeontologists have been magnificent in unearthing and describing these archaic mammals, mostly therapsids, their collaboration with zoologists with experience in ecology, physiology and behaviour, would go a long way towards making better sense of the morphologies that they have described. Moreover, the contemporary mammals of Africa are composed of Afrotherians and placental mammals, both invaders from other continents at various times during the Cenozoic (66 mya to present). Very little is known about the interactions between these groups during the Cenozoic that could help to understand modern assemblages. Given the availability today of excellent tools for phylogenetic reconstructions of ancient traits, the discipline of palaeozoology is potentially poised for the development of a comparatively new geographically based scientific discipline.

**Session 5: Behavioural ecology
(Main Hall: Ndlopfu)**
Geographic variation in the foraging behaviour and habitat use of female Cape fur seals and the influence of oceanographic regimes.**J.A. Botha¹, S.P. Kirkman², A.T. Lombard³, J.P.Y. Arnould⁴, M.A. Meyer², G.J. Hofmeyr⁵, P.G.H. Kotze², S. McCue², P.A. Pistorius¹**¹*Department of Zoology, Nelson Mandela University, Summerstrand, Port Elizabeth, South Africa.*²*Department of Environmental Affairs, Branch Oceans and Coasts, Cape Town, South Africa.*³*Institute for Coastal and Marine Research, Nelson Mandela University, Port Elizabeth, South Africa.*⁴*School of Life and Environmental Sciences, Deakin University, Geelong, Australia.*⁵*Port Elizabeth Museum at Bayworld, Humewood, Port Elizabeth, South Africa.*Presenting author e-mail: bothaja@gmail.com

Understanding how animals utilise habitats and resources within their ecological niche is central to the study of ecology. For marine predators, identifying areas of increased foraging activity aids species conservation and management, as well as developing a more holistic understanding of ecosystem functioning. Where separate populations of conspecifics experience different local environmental conditions, variability in habitat use is expected. In the context of global climate change, this information is necessary to predict population-level plasticity. The Cape fur seal (*Arctocephalus pusillus pusillus*) is endemic to southern Africa with breeding colonies spanning a broad geographic range. Consequently, separate populations often experience contrasting local environmental conditions and levels of prey availability. We assessed foraging behaviour and habitat use of 35 adult female Cape fur seals from three breeding colonies experiencing different oceanographic regimes. Drawing on over 160 individual foraging trips, we investigated inter- and intra-population foraging strategies, habitat use and diving behaviour. Inter- and intra-population differences in foraging behaviour and habitat use were apparent but marginal. Both pelagic and benthic foraging strategies were evident across the species range, reflecting the generalist nature of Cape fur seals. Results are further discussed with regards to potential environmental drivers and prey availability throughout the sampled range.

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Mind the gaps: assessing continent-wide knowledge on small African carnivores.

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Small African carnivores (<15 kg) make up 35% of extant small carnivores worldwide, and eight of the world's 13 terrestrial carnivore families have representative species meeting this criterion in Africa. In spite of this diversity, studies on larger species seem to dominate African carnivore research. To both quantify research bias and highlight knowledge gaps, we undertook a thorough literature review of all published works until April 2014 on African carnivores. We identified 6,270 publications; 63% of them focused on at least one of the 10 large African carnivore species, while 37% focused on at least one of the remaining 81 small species. Utilizing titles and abstracts, we scored papers across 21 categories to identify particular areas of research lacking for individual species. For small carnivores, a majority of research has focused on peripheral inclusion of species in broader studies (e.g. carnivoran phylogenies, morphological evolution), evolution of sociality in mongooses, and distributional records/observations. Little to no research exists on the fundamental ecology or conservation status of most small African carnivores. We therefore strongly encourage more research to increase our understanding of the ecological roles of this understudied group of small predators, as particularly promoted by ASCaRIs (African Small Carnivore Research Initiatives).

More than eating dirt: a review of avian geophagy.

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Geophagy, the ingestion of earth varying in particle size from stones to soils rich in clay, is a relatively widespread behaviour across avian taxa. We reviewed its occurrence in birds and its hypothesised adaptive functions in birds. Of the ~30 avian orders, 23 exhibit geophagy. However, it has only been documented in ~260 species (~2% of birds) so is relatively uncommon. Ingestion of stones and other large particles (grit) is recorded in 54 extant families across the avian phylogeny and appears to be ancient in birds and has evolved several times. Clay ingestion is recorded in 14 phylogenetically scattered families and may have evolved repeatedly. Furthermore, at least nine families exhibit both clay and grit ingestion. Six hypothesised functions of avian geophagy involve digestion and nutrition. Ingested grit may provide (1) essential minerals, particularly sodium or calcium, but it appears to primarily (2) improve mechanical digestion of food. Consistent with this gastrolith hypothesis, ~86% of species ingesting grit consume "hard" food. In contrast, ingested clay appears to be for sodium or other nutrient intake and /or protecting birds from ingested plant secondary compounds. Consistent with this, ~88% of species ingesting clay eat fruit.

Exploratory behaviours and diet breadth of a wild canid reveal low repeatability.

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Animal personality is defined as consistent behavioural differences between individuals across time and contexts, quantifiable as repeatability estimates (R) ranging between 0–1, with higher estimates indicative of distinct personalities. Assessing repeatability is the first step towards determining how natural selection will act upon a trait and ultimately, how adaptable a population will be to environmental change. We examined diet breadth i.e. types of prey consumed, and a suite of exploratory behaviours:

speed, total distance, tortuosity or movement paths, and proportion of home range, covered by Bat-eared foxes over two years. We also investigated correlations—termed behavioural syndromes, between these traits. We did not find evidence for repeatability in diet breadth ($R = 0.02$) and tortuosity ($R = 0.04$), indicating that individuals ate similar prey types and had equivalent movement pathways. Repeatability was low but significant in the remaining movement traits, with estimates ranging between 0.07 – 0.10. There was no significant correlation between diet breadth and exploratory behaviours, suggesting that variation in traits is unlikely to constrain each other's optimal functioning. Considering this species' apparent lack of behavioural diversity in exploratory and foraging habits, we predict that the population may not be adaptable to rapid environmental changes in their distribution range.

Inter- and intra-specific temporal partitioning in spiny mice (*Acomys cahirinus* and *A. russatus*).

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Animal species have evolved different activity patterns that are of adaptive value. For example, temporal partitioning may reduce inter-specific competition thus facilitating species coexistence, or reduce intra-specific competition, thus affecting population structure. These activity patterns are controlled by an internal biological clock. We have been studying temporal partitioning in two closely related rodent species of the genus *Acomys*: The nocturnal common spiny mouse (*A. cahirinus*) and the diurnal golden spiny mouse (*A. russatus*). When held under laboratory conditions, both species are nocturnal, but under natural conditions *A. russatus* is competitively excluded to diurnal activity by *A. cahirinus*. This temporal partitioning facilitates their coexistence through resource partitioning: diets of both species comprise mainly of arthropods. Since different arthropod species have different activity patterns, being active during different parts of the diel cycle expose the two species to different prey worlds, thus reducing resource overlap and affecting community structure. We also found intra-specific variation in activity patterns in both species: specific individuals tend to arrive to food patches during different hours of the night (*A. cahirinus*) or day (*A. russatus*). The order of arrival is significantly correlated to the internal biological clock period, which is genetically determined, thus affecting population structure.

Longitudinal biometric analyses of a large nocturnal primate, *Otolemur crassicaudatus*: Sex and environmental effects.

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Our unique longitudinal study of South African thick-tailed galagos collected biometric data across a six-year period (2013-2018) at the Lajuma Research Centre. Biometric data (linear lengths, circumference and skin fold measurements), were assessed for 129 *Otolemur* captured in Havahart traps. Compared to females, adult males were heavier, had greater body fat, greater linear measurements and muscle mass (circumference data) for most measurements (one-way ANOVA using Tukey post-hoc analyses; $p < .05$). Subadults males were heavier and had greater upper and lower limb measurements, while females had greater body fat measurements. Biometric values varied by year, indicating some years (e.g. 2013, 2014) were more stressful. Adult weight data were also compared to published body weights on 40 *O. crassicaudatus* living in a forest strip on the Wallace Dale Farm in 1977. Lajuma adults were significantly lighter than published data on Wallace Dale adults ($t = 6.694$; $p < .0001$). Overall, in this species, sexual dimorphism in linear measurements manifests early on, and males may have a different developmental trajectory than females. Longitudinal data also indicate these nocturnal primate's growth and body condition are affected by environmental factors such as temperature and rainfall and anthropogenic effects such as depauperate plant and animal communities on farms.

The spotted hyena and mesocarnivores: Co-occurrence inside and outside protected areas.

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Anthropogenic habitat change has a strong influence on the behaviour of wildlife. To understand such behavioural change, we used camera traps and single-season two-species detection models to investigate the co-occurrence of the spotted hyena (*Crocuta crocuta*) with three mesocarnivores in a hunting area, ranch and national park in Zimbabwe. We predicted that mesocarnivores would show temporal overlap variation and avoidance of habitats with spotted hyenas in the three land-use types. The detection probability of the serval (*Leptailurus serval*) increased in the presence of the spotted hyena in the ranch as a function of low leopard (*Panthera pardus*) detection while that of the African civet (*Civettictis civetta*) increased in the safari area (n = 19) and the ranch (n = 45) during the wet and dry seasons, respectively, as a function of rocky habitats and mixed vegetation. Detection of the black-backed jackal (*Canis mesomelas*) varied negatively as a function of road network in the park when the spotted hyena was detected. Coefficients of overlap were high for all pairs of species implying high probability of co-existence. Although mesocarnivores increased activity in the hunting area and ranch, changes in land management and top predator introductions should consider how habitat use by small carnivores is affected.

Good vibrations: a link between the morphology of the mechanosensory bill-tip organ, sediment usage and foraging behaviour of ibises.

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Many probe-foraging bird species possess a sensory system known as remote-touch, enabling them to locate submerged prey items by detecting vibrations in the substrate. Remote-touch is facilitated by a bill-tip organ, made up of mechanosensory receptors embedded in bony pits at the tip of the bill. Though the general structure of the bill-tip organ is conserved, there is some interspecific variation in its microstructure. We use three species of ibises as a model to investigate the link between the morphology of the bill-tip organ and the birds' foraging ecology. We found an increase in the extent of pitting in the beak with increased aquatic habitat use, which is hypothesized to be linked to the transmission of vibrations in different sediments. We measured the physical properties of the soil in which the three species were observed foraging and observed and classified their specific foraging behaviours. Our data indicates that the interspecific differences in the bill-tip organ are linked to different probing techniques as well as the use of different sediment types. Species with higher degrees of pitting were found to probe most successfully and in more saturated sediments. This is in accordance with our hypothesis that a higher relative number of sensory pits in the beak is closely associated with foraging sediment characteristics, indicating that the microstructure of the bill-tip organ is a fair proxy for understanding fine scale habitat requirements of ibises.

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Co-occurrence modelling highlights negative conservation implications for two competing spiral-horned antelope, bushbuck and nyala.

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Fencing of Protected Areas (PAs) has a myriad of management implications, including herbivore overpopulation, which may result in competitive exclusion. There has been conjecture that nyala (*Tragelaphus angasii*) may outcompete bushbuck (*T. sylvaticus*), under poor management practices. Using camera-trap data, we assessed factors influencing spatio-temporal activity patterns and co-occurrence of both species within three PAs of the Maputaland Conservation Unit, South Africa. Bushbuck appeared to have gone locally extinct within one of our survey areas, likely because of competitive pressures. Our results indicated a segregation of activities; bushbuck was more nocturnal, particularly in areas with higher nyala occupancy. Bushbuck occupancy was higher than nyala within two survey areas: where nyala were present but populations were managed, and where leopard (*Panthera pardus*) populations were highest. Co-occurrence was most likely in these two survey areas, indicating a threshold of nyala occupancy up to which bushbuck were tolerant, and that nyala presence was important, particularly in conjunction with high leopard density. Where leopard density was low, the cascading effect was of high nyala occupancy, with subsequent competitive exclusion of bushbuck. Our results have critical management implications for PAs, including reserve carrying capacity, preserving native-species assemblages and habitat management.

Singing a different tune: evidence of dialects in the Short-clawed Lark.

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Bird vocalisations are known to be a good means of separating taxa, mostly when there are few external morphological differences. Random field observations of the Short-clawed Lark's eastern population have noted dialectal differences in the territorial calls of males within its range. Vocalisations play an important role in species recognition, territoriality and mate choice which, in turn, can have implications on the taxonomy and effective management of species of conservation concern. We investigated regional variation in the territorial calls expressed by male birds occurring across the eastern population's range. Univariate and multivariate statistical analyses were performed to determine if there are any statistically significant differences amongst the calls as well as the possibility that groupings may exist. The results revealed three clear groups: an eastern (including the putative transition area), a western and a northern population, with the northern birds clearly distinct from the western and eastern birds. Canonical Discriminant Function Analysis (CDFA) showed an overlap with overlaid group central between the east and transition areas, while the north was found to discriminate mostly between the other three areas. The results therefore clearly revealed the existence of dialects within the eastern population also revealed the non-existence of a transition zone.

Session 6: Human dimensions of wildlife (Main Hall: Ndlopfu)

(Wild)life in the big city: urban expansion and its consequences for health in Cape Town's caracal, *Caracal caracal*.

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As the urban-wildland interface expands, wildlife populations are increasingly confronted by novel changes in their environments. In the rapidly developing Cape Town region of South Africa we have been studying how caracal mount ecologically adaptive responses in a rapidly changing landscape. Here we investigate (i) the prevalence of tick-borne blood pathogens, and (ii) adaptive immunogenetic variation in caracal across Cape Town's mosaic of natural, urban and agricultural areas. Molecular analyses of blood samples revealed potentially important health costs for urban caracal. Pathogen prevalence, diversity and rates of co-infection were higher in urban cats compared to their rural counterparts. Of particular interest was the presence of an emerging zoonosis, *Babesia venatorum*, together with a species of *Anaplasma* previously described from domestic dogs in South Africa. Despite their isolation, Cape Town's caracal maintain comparative levels of immunogenetic variation at MHC Class I loci. Tests for relationships between MHC alleles and tick-mediated pathogens indicated a number of strong positive associations with *Babesia* infection. We discuss our findings within the global context of rapidly increasing urbanization, where understanding factors affecting wildlife health and population genetic change in both adaptive and neutral DNA markers is critical to ensuring the persistence of biodiversity.

Influence of anthropogenic land-use changes on the occupancy of long-crested eagles in an agricultural-urban landscape mosaic.

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Anthropogenic land transformation in the form of agricultural intensification and urbanisation are recognised as significant contributors to habitat loss for many species globally. To investigate the influence of land use types on Long-crested Eagle (*Lophaetus occipitalis*) habitat occupancy, we conducted road surveys once a month from August 2017 to April 2018 in the Midlands of KwaZulu-Natal Province, South Africa, corresponding to nine survey occasions per site. Detection probability and occupancy were 0.22 ± 0.03 and 0.62 ± 0.10 , respectively. In the top three competing models, detection was a function of savanna alone or an interaction between savanna and either natural forest or exotic tree plantations. Occupancy, however, was a function of cropland alone and had positive effect ($\beta = 4.71 \pm 2.28$). The covariates 'savanna' and 'cropland' had the greatest support in terms of summed model weights ($w_i = 0.91$ and 0.89) for site detection and occupancy, respectively. These eagles appear to be benefiting from wildlife friendly management of cattle farms (savanna) as well as croplands. This study demonstrated that agricultural landscapes can support native species when their heterogeneous nature is maintained.

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Does anthropogenic mortality influence jackal *Canis mesomelas* body size and condition?

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Jackals are hunted to reduce livestock predation. Anthropogenic mortality is heterogeneous, with farms experiencing high mortality and reserves with little or no mortality. We test whether heterogeneous mortality induces phenotypic variation by comparing morphometric measurements and body condition, collected from 375 carcasses, between lightly hunted reserves (i.e. high density) and heavily hunted farms (i.e. low density). Following life-history theory, we predict that jackals on reserves will invest in increased body size to increase competitive ability. Alternatively, under maladaptive habitat selection, morphometric variation should be absent/reversed, with jackals on farms displaying equivalent/larger body sizes. Further, given the reduced densities on farms and concomitant increases in resources, we predict that individuals will invest in increased body condition allowing them to reach reproductive condition quicker. Jackal body size was similar between treatments which suggests that growth may be deterministic and not influenced by heterogeneous mortality. Further, jackals on farms were in better condition than equivalent age classes on reserves. The lack of body size variation, and better body condition of jackals in low density farm populations is consistent with maladaptive habitat selection. Farms may represent attractive habitats for jackal, which may benefit from reduced density-dependent regulation to improve body condition and reproductive capacity.

Age and sex-related mortality of bats from wind energy facilities in the Eastern Cape province of South Africa.

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Wind turbines pose a serious threat to volant vertebrates, including bats, due to casualties resulting from barotrauma or direct collision with the turbine structure. The Mammal Department of the Durban Natural Science Museum serves as a national repository for bat carcasses collected during post-construction monitoring at various wind energy facilities throughout South Africa. In this study we examined >120 museum-prepared specimens originating from wind energy farms in the Eastern Cape province, South Africa. Species most afflicted by wind turbines were *Neoromicia capensis* (Cape Serotine bat) and *Tadarida aegyptiaca* sensu lato (Egyptian Free-tailed bat). We evaluated sex, reproductive status and relative age (juvenile, sub-adult, adult), from external anatomy. Assignment of relative age was further refined by assessing the degree of tooth eruption, as well as the wear on occlusion surfaces of molars of prepared crania. Results are presented as age- and sex-related biases in mortality of *N. capensis* and *T. aegyptiaca* s.l. These results are also used to determine the potential cumulative impacts of bat mortality at wind energy facilities in South Africa. Such information can better inform conservation strategies and improve mitigation measures at operational wind farms in South Africa.

Insights into bird species composition and richness of Mopani and Sekhukhune district through SABAP2 atlasing by rural youths: Benefits and challenges.

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Citizen Science data has become the backbone for informing development activities in many countries due to lack of funding and personnel to collect foundational data through the entire landscape. Coverage by citizen scientists is coarse in “far from urban centres” areas, where most volunteers are based. Remote areas however, are data deficient although often targeted for development. Mopani and Sekhukhune Districts have such areas, with sparse coverage by South African Bird Atlas Projects and a rise in mining and agricultural activities. We used data collected by rural youth over a year, following intensive three months training, to estimate bird species composition and richness for three chosen sites. Fifteen youth recording birds following SABAP2 atlasing protocol generated over 10000 records, covering 90 pentads and recording up to 206 species. We report on the overall average species richness, birds of interest to tourists and threatened birds for the three sites Giyani, Tzaneen and Burgersfort. Despite challenges of reaching remote areas and lack of internet to respond to queries, the atlasing effort by the youth managed to fill SABAP2 atlasing gaps in the region. Because this youth is mostly unemployed, more funding is required to sustain the atlasing momentum into the future.

The economic impact of National Park visitor spending on local economies: cases of Kafue and South Luangwa National Parks.

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The Kafue and South Luangwa National Parks are two of Africa’s socio-ecologically important conservation areas boasting a high diversity of wildlife. The aim of this study was to evaluate the economic value and impact on human communities, and therefore provide a way to inform stakeholders of the value of these parks apart from conservation purposes. A series of on-site intercept survey for visitors’ daily expenditures were conducted at randomly selected tourism facilities throughout the parks. A total of 80 surveys from both parks were successfully completed. To evaluate the economic impacts of visitor spending in these national parks, the Money Generation Model 2 (MGM2) that was adapted to evaluate local economies and to include country specific multipliers, was applied. The party (group) of visitors’ spending averages per night for both national parks ranged from US\$795 to US\$2,662. The total economic value generated in local areas equals US\$23.6 million for Kafue and US\$110.5 million for South Luangwa. The number of jobs supported by this industry includes 592 and 2,810 in local regions of Kafue and South Luangwa respectively. The study showed that wildlife-based tourism provides an important contribution to local economies and provides business and employment opportunities at local levels, especially for a park that is popular with tourists.

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How resilient are bats to anthropogenic change? Land use effects on insectivorous bat ensembles in commercial and small-holder agricultural landscapes in Limpopo, South Africa.

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Land use changes pose a major threat to the biodiversity of species worldwide. At two different scales we elucidated land use effects on bats in a richness hotspot in northern Limpopo, South Africa. At a broader scale, using acoustic data, we compared alpha and beta diversity and functional composition of bat ensembles from three locations situated within 30-100 km of each other, a nature reserve, a macadamia-growing area and two adjacent rural villages. Species richness of the anthropogenic landscapes exceeded that of the nature reserve but their ensembles were depauperate in clutter-feeding bats. This effect was partly offset in the rural villages by the ubiquitous and surprising prevalence of three sonotypes of the rare, clutter-feeding bat, *Kerivoula* spp. At a finer scale, to test the effect of vegetation structure on bat ensembles, we sampled bat diversity during wet and dry seasons at twelve sites each from the two villages. We recognised three land use categories, settlements, agriculture and rangelands. Bat diversity was quantified by manual identification of a subset of sites, followed by the use of scans and filters in Analook to identify robust species-groups. Analysis was conducted by rarefaction diversity estimates and additive hierarchical diversity partitioning. While bat abundance was far higher in settlements compared with agricultural and rangeland habitats, gamma diversity of bats in the two villages was almost entirely due to alpha diversity at point detectors.

A novel sampling strategy for illegal trade pangolin confiscations using morphological characteristics.

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Pangolins are the most illegally trafficked mammal in the world and are distributed only in Africa and Asia. Declines in Asian pangolin populations have resulted in increased illegal trade of African species (*Phataginus tricuspis*, *P. tetradactyla*, *Smutsia gigantea*, *S. temminckii*) to supply Asian markets. High volumes of illegal trade confiscations of pangolins and their scales (e.g. up to 8.9 tonnes) from trafficking require cost-effective and representative sampling for reliable forensic investigation. This study aimed to develop a sampling strategy for confiscations based on morphological characteristics of African species. Pangolin scales from two illegal consignments with 20 bags were sorted into scale morphotypes based on published and newly identified distinct species characteristics using shape, colour and size. Scale classification revealed five basic scale morphs in African pangolins, with tail scales being the most distinguishing feature. This was very evident in *P. tricuspis* that has distinct body and tail scales. Although, morphological analysis of *S. temminckii* specimens (n = 14) suggested moderate variation, these differences could not be explained by age or gender possibly due to sample size. Our results suggest that pangolin scale morphology can be reliably used to establish guidelines for routine species identifications in confiscations for forensics.

Home ranges of Cape porcupines on farmlands, peri-urban and suburban areas in KwaZulu-Natal, South Africa.

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Cape porcupines, *Hystrix africaeaustralis*, are one of the South African mammalian species that are increasing their distribution range and abundance with anthropogenic changing land-use. Knowledge of the home range of this species can provide important ecological information and explain their ability to persist in a range of land-use types. We investigated the home ranges of 15 radio-tagged Cape porcupines on farmlands, peri-urban and suburban areas in KwaZulu-Natal, South Africa. Using the 95

% Kernel Density Estimator (KDE), Cape porcupines had an overall estimated mean home range of 39.37 ± 6.33 ha ($n = 9$), ranging from 13.19 to 67.19 ha. When compared with other *Hystrix* species, Cape porcupines had the lowest estimated home range size. Individuals on farmlands had the smallest mean estimated home range area (24.57 ha), relative to peri-urban (34.61 ha) and suburban (45.18 ha) sites. Variation in the home range sizes of Cape porcupines with differing anthropogenic land-use type showed their behavioural flexibility in response to habitat heterogeneity and forage availability in each. Our results suggest that Cape porcupine ranging ecology is influenced by food resource distribution and availability in various land-use types.

Urban vervet monkeys and humans in conflict – a cause for concern?

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Despite the common destructive effects of urbanisation on biodiversity assemblages, certain species thrive in urban environments. One mammalian species that thrives in a peri-urban environment is the vervet monkey, *Chlorocebus pygerythrus*. The species is now common in urban areas of the KwaZulu-Natal (KZN) Province, South Africa with increased contact between humans and vervet monkeys, often leading to human-monkey conflict. We analysed the recorded vervet monkeys admitted to a rehabilitation centre in eThekweni Municipality, KZN from 2011 to 2019. Number of admitted vervet monkeys increased over the years and most were juveniles. Motor vehicle accidents were the main cause of admission and many monkeys succumbed to their injuries. We suggest that wildlife rehabilitation centres in priority areas use the data in community education programs. The trends found also serve as a foundation for human-vervet conflict resolution programs.

Session 7: Taxonomy, systematics and evolutionary biology (Breakaway Room: Nda)

Spatial genetic structure of *Mastomys natalensis* in a rapidly expanding sugarcane-savanna matrix in Swaziland.

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Spatial genetic structure genetic diversity are key population characteristics that can inform management given the rapid alterations in natural habitats driven by human activities such as monocultural agriculture. We evaluated how movement, genetic diversity and genetic structure respond to savanna habitats alteration using a generalist African rodent pest, *Mastomys natalensis* as a model, in a 25km² savanna-sugarcane matrix located north-east of Swaziland. We collected and genotyped 14 microsatellite loci from 254 individuals, captured and tracked movement of 96 individuals across boundaries of savanna, sugarcane and subsistence agriculture. Data on 14 microsatellites revealed high genetic diversity, no population differentiation, inbreeding and panmixia based on isolation by distance, Bayesian structure analysis ($K = 1$), spatial autocorrelation analysis, Moran's Eigenvector Map analysis. We used generalized linear models to show that individual pairwise internal relatedness increases with distances to savanna habitat patch. Movement tracking data indicated that boundaries between these land uses does not affect movement of this generalist. These findings indicate high dispersal rate, while the panmixia illustrated high population connectivity suggesting a very large effective population size and geneflow. These findings may inform pest and zoonotic disease management plans on the scale necessary for effective management outcomes.

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Absence of extinction filtering in small mammals of the Eastern Cape forests.

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Southern African forests are divided into the scarp, coastal and Afromontane mistbelt forests. Following the last glacial maximum (18000 years ago, which caused climatic extinction filtering of small mammals), the scarp forests are hypothesised to have acted as refugia for small mammals which replenished adjacent forests. Here we tested this hypothesis by comparing the population genetic structure of forest dwelling dark-footed forest shrew, *Myosorex cafer* (N=56) and the generalist four-striped mouse, *Rhabdomys dilectus* (N=58), sampled from 14 forest localities. The demographic analysis, genetic diversity and population structure analysis (Analysis of molecular variation, AMOVA) were done using the mitochondrial COI (630 bp), control region (450bp) and *cyt b* (1100 bp). The concatenated dataset suggests a recent population size expansion for both taxa (*M. cafer*: Tajima's D: -1.53683, P>0.10; *R. dilectus*: Tajima's D: -1.38123, P<0.05). However, AMOVAs for *M. cafer* revealed a moderate differentiation within groups (46.82%), and among groups, 33.8% resulting on moderate Fst (0.53185, p=0.10655±0.01123). In contrast, *R. dilectus* has high variation within populations (80.40%, Fst: 0.19602, p=0.000±0.000). These data indicate higher connectivity between subpopulations of *R. dilectus* and limited dispersal for *M. cafer*. However, no evidence of climatic extinction filtering small mammals is supported by our results.

Trombiculid mites parasitizing rodents: their diversity and distribution on and off the host.

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Chigger mites (Trombiculidae) is a group of temporary parasites that are habitat as opposed to host specific. Little is known with regard to the diversity and ecology of these mites in South Africa. The study aims were to record the 1) diversity of chiggers on rodents and 2) effect of habitat type on the species composition. Rodents (n = 184) were trapped in three landscape types (natural, crop and urban) in the Savanna Biome during January and September in 2015. Eleven chigger species, including four new, were recorded from 77 rodents (42%). New species and new locality records were identified. Six chigger species were recorded in natural, 10 in crop and four in urban habitats. Four species were shared between the three habitat types. *Microtrombicula mastomyia* dominated crop and urban habitats, but not natural. The occurrence of chiggers was higher in urban compared to natural and crop landscapes. Chiggers were often found on the ear. Evident from the study is that habitat transformation does not necessarily result in fewer chigger species but rather a change in species composition.

Is South Africa ready for metabarcoding?

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Metabarcoding is a new method of rapid biodiversity assessment that combines two technologies: DNA based identification (DNA barcoding) and high-throughput DNA sequencing. It uses universal PCR primers to mass-amplify standard DNA barcodes from whole collections of organisms or from environmental DNA. It has the potential to revolutionize biodiversity research. But is South Africa ready to embrace this new technology? In this talk, I provide an overview of the status of the DNA barcode reference library in South Africa. Using examples from some recent metabarcoding studies in my lab, I will provide comment on the future of metabarcoding in South Africa.

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Ecological niche modelling and phylogeography reveal the past and future of *Myosorex varius* (Soricidae: Crocidurinae).

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Myosorex varius, the southern African forest shrew, inhabits the mesic eastern and coastal areas of South Africa. This species occupies a wide range of biomes and was assumed to be a generalist. However, a phylogeographic study uncovered distinct genetic sub-populations occupying different areas of the species' range. In this study, MaxEnt was used to model the ecological niches of the species and its sub-populations to identify their specific climatic requirements. These niches were then projected into the past using climatic data from the last glacial maximum and the last interglacial to see how historical climate fluctuations contributed to the formation of the present sub-populations. The niches were also projected into the future using climate models for 2070 under various emissions scenarios to see how future climate change will affect the distribution of the species and its sub-populations. The most likely scenario for the formation of the sub-populations is reduced gene flow in combination with differential environmental selection. Future climate change can be expected to result in range reduction and reduced connectivity, which could threaten the health of the species, particularly in combination with other anthropogenic causes of habitat loss.

Species delimitation methods over and underestimate species diversity relative to morphology in a bee-fly subfamily.

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Knowledge of species boundaries is critical for biodiversity science, but delimiting these boundaries is an arduous task. Using genetic data and the phylogenetic species concept, single-locus species delimitation methods promise to accelerate the cataloguing of diversity in little-studied groups. However, studies have shown that the array of methods available often produce discordant species delimitations, with some methods outperforming others in certain scenarios. This study aimed to explore the discordance among various single-locus species delimitation methods and, at the same time, to elucidate the diversity, systematics and phylogeographic relationships of a poorly described bee-fly subfamily (Bombyliidae, Mariobezziinae). We accomplished this by applying various species delimitation methods to a Col barcode dataset and reconstructing the evolutionary history of bee-flies collected along a South-North transect in the Greater Cape Floristic Region. Not only did we find extensive discordance among species delimitation methods, but also disagreement between the phylogenetic species delimited by these methods and morphological species delimited by previous taxonomic work. Specifically, species delimitation methods suggest that morphology overestimates species diversity in some genera and underestimates it in others. This study highlights the potential and pit-falls of single-locus species delimitation methods as a tool to accelerate the description earth's biodiversity.

Under the trapdoor: Unravelling the phylogenetic relationships and phylogeography of cork-lid trapdoor spiders, *Stasimopus* Simon, 1892 (Araneae, Mygalomorphae, Stasimopidae) in the Karoo.

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The Karoo BioGaps collaborative project was established to assemble baseline biodiversity data on various taxa in the Karoo region of South Africa, to support decision making regarding land-use change. This is vital in light of the land transformation occurring in the Karoo. Trapdoor spiders are long-lived and sensitive to habitat destruction making them a valuable conservation tool. The aim of this study was to perform an assessment of the phylogeographic relationships of Cork-lid trapdoor spiders (Ctenizidae: *Stasimopus* Simon, 1892) in the Karoo BioGaps study area. 118 individuals were collected from 60 surveyed sites over two years. Phylogeographic insights were drawn from three gene regions

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and suggest substantial undescribed diversity. There is also a novel pattern of an east-west divide present in these spiders and has been observed in other arachnids. There were between 9 and 12 species found in the sampled region. According to current literature only five known for the region, indicating either new locality data for already described species or novel undescribed species. Most of the potential species found are short-range endemics which makes them vulnerable to change. The conservation status of *Stasimopus* should be reconsidered as well as their inclusion in environmental impact assessments.

Comparative phylogeography of two co-distributed coastal forest endemic terrestrial snails, *Gittenedouardia spadicea* and *Maizania wahlbergi*.

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Terrestrial snails are suitable organisms to study phylogeographic patterning because of their low vagility, and general habitat specificity. Molecular phylogeography of two co-distributed land snails *Gittenedouardia spadicea* and *Maizania wahlbergi* were investigated using mitochondrial DNA (cytochrome oxidase subunit 1) sequences. These two species primarily inhabit dune, scarp and coastal forests along the coast and interior of the Eastern Cape and KwaZulu-Natal provinces. Evolutionary inferences for the two species were derived from tree topologies, haplotype networks, and pairwise distance methods. The result of each species was used to compare spatial events and presence of vicariance or boundaries responsible for the contemporary distribution and genetic patterns within species. Intraspecific genetic distance shows evidence of genetic divergence within species, with no gene flow between populations of either species. Both haplotype networks showed significant number of unsampled or extinct haplotypes within species. The phylogeny of *M. wahlbergi* shows evidence of two distinct clades; a KwaZulu-Natal and Eastern Cape clades. Similarly, *G. spadicea* also shows two clades, while a clade comprised of a genetically distinct population from Kei Mouth River suggesting the presence of an undescribed species. Dating of the tree topologies is required to determine the factors that are responsible for the observed phylogeographic patterning in both species and help us understand the role of historical processes on the geographical and genetic distribution of South African mollusc community.

Scaling of morphology and ultrastructure of hearts among wild African antelope.

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The mechanical work rate of the heart varies considerably among mammals. However, the morphological and ultrastructural characteristics of the heart that allow for this variation is largely unknown. We used perfusion-fixation, transmission electron microscopy and stereology to assess the morphology and ultrastructure of the heart as a function of body mass across six species of wild African antelope differing 20-fold in body mass. We found that relative heart mass decreases with body mass according to a power equation with an exponent of -0.12 ± 0.07 ($\pm 95\%$ CI). Likewise, capillary length density, mitochondrial volume density, and mitochondrial inner membrane surface density also decrease with body mass with exponents of -0.17 ± 0.16 , -0.06 ± 0.05 , and -0.07 ± 0.05 , respectively. These trends are likely to be associated with the greater mass-specific mechanical work rates of the hearts in smaller antelopes compared to those in larger antelopes. Finally, we found proportionality between quantitative characteristics of a structure responsible for the delivery of oxygen (total capillary length) and those of a structure that ultimately uses that oxygen (total mitochondrial inner membrane

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surface area). This provides support for the economic principle of symmorphosis at the cellular level of the oxygen cascade in an aerobic organ.

Molecular characterisation of Avian Haemosporidian parasites in the Kruger National Park.

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Avian Haemosporidian parasites of the genera: *Plasmodium*, *Haemoproteus* and *Leucocytozoon*, are widely distributed vector-borne blood parasites that affect most birds, and can have serious negative effect on their avian hosts. A large number of these parasites has been described worldwide, but studies in South Africa are lacking and if existing, often make use of the traditional microscopy technique. In the present study, we present the use of nested PCR targeting the parasite mitochondrial cytochrome b gene (*cyt-b*), to describe the diversity of these parasites in various avian species sampled in the Kruger National Park. Preliminary analyses suggest the presence of all three genera in the Park with varying prevalence and diversity. The presence of three previously undescribed *Leucocytozoon* haplotypes was observed infecting red-billed oxpeckers. We present phylogenetic analyses of all haplotypes as well as preliminary results on the prevalence of these parasites inside the Park. We discuss these findings in the context of host-parasite relationships and draw attention to the need for disease prevalence maps, necessary for biodiversity conservation.

Biogeography and conservation of narrow range endemic animal species in South Africa.

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South Africa is a megadiverse country with three declared biodiversity hotspots. This biodiversity is however, under severe threats associated with habitat loss. Given the urgent need for conservation prioritization, we are carrying out an assessment of narrow range endemic (NREs) species to identify sites and species that are potentially important for conservation action. Since there is no globally accepted definition of a narrow range endemic, the International Union for Conservation of Nature (IUCN) Red List criteria for distribution are used here, where NREs that meet the levels for the category of Vulnerable are considered to be narrow endemics, i.e. species with extent of occurrence of less than 5000 km² or area of occupancy of 500 km² irrespective of whether they meet the IUCN Red List requirement for a decline in these parameters. Distribution data from atlases and museum for butterflies, millipedes, terrestrial molluscs, frogs and reptiles will be used to identify NREs. The NREs will be categorised as palaeoendemics, neoendemics or edaphic endemics. Maps of the NREs will be overlaid across taxa and environmental features to answer these questions: 1) which areas are important for NREs, and are there localities that overlap across taxa? 2) What are the drivers or evolutionary history of narrow range endemism?

Validation of microsatellite markers for forensic analyses of *Gyps africanus* and *Gyps coprotheres*.

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The decline in vulture population numbers in South Africa has been linked to habitat loss through agricultural intensification, poisoning incidences and traditional medicine use. Although a number of genetic studies have been done on the genetic diversity of vultures, most of the available technologies

have not been validated for forensic applications. The International Society for Forensic Genetics has developed a set of recommendations for use in wildlife forensic genetic investigations to ensure robust, reliable and reproducible results. This study aims to evaluate and validate genetic markers and criteria for species identification and individualisation of four South African species (*Gyps coprotheres*, *G. africanus*, *Gypaetus barbatus* and *Necrosyrtes monachus*) that are reproducible in local and regional forensic assessments. A full genome dataset of *G. coprotheres* generated using Next Generation Sequencing (NGS) was available for species specific novel primer designs that were combined with published markers for verification. A number of parameters (e.g. Ar, PIC and HWE) were tested to determine marker informativeness using two species (*G. africanus* and *G. coprotheres*) and their allele frequency databases. Preliminary results indicated high polymorphisms and sufficient discriminatory power for forensic application. This research approach will therefore provide criteria on marker selection and design as well guidelines for use in forensic analyses of vulture species in South Africa.

Session 8: Behavioural ecology (Main Hall: Ndlopfu)

Birdcall lures improve passerine mist-net captures at a sub-tropical African savanna.

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Field research techniques are constantly evolving to meet the needs of the scientific community. There is a growing need for field biology studies to shift towards increasing efficiency and quality of results while simultaneously decreasing cost in both the researcher's time and resources. I tested the efficacy of using multiple recorded birdcall lures (n = 172 species) to improve mist-net captures at a sub-tropical African savanna setting. Capture success was compared between passive and birdcall enhanced mist-nets during winter and summer seasons. Results suggest that the use of birdcall lures significantly increase the total number of birds caught in both seasons and also increases the diversity of passerine species. Conventional passive mist-nets without an audio lure were initially productive but their capture rate subsequently decreased as sampling days progressed. Birdcall lure enhanced mist-nets had a constant capture output during the summer season. The most responsive birds to audio lures were gregarious species (e.g. *Pycnonotus barbatus*, *Dryoscopus cubla*, *Prionops plumatus*, *Phoeniculus purpureus*, *Turdoides jardineii* and *Lamprotornis chalybaeus*) and the aggressive *Dicrurus adsimilis* and *Acridotheres tristis*. I conclude that birdcall lures can be used to improve mist-net captures especially for studies focusing on gregarious and aggressive passerines in sub-tropical African savannas.

Exploring mesopredator responses to resource supplementation: jackal diet in the presence and absence of cheetah.

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Interactions between apex predators, mesopredators and impacts on trophic dynamics have been well documented. However, the influence of apex predators, through the provision of carrion, on the foraging ecology of African mesopredators is poorly understood. To investigate such resource supplementation by apex predators for mesopredators, we compared the diet of jackal at replicated sites with and without cheetah in the Eastern Karoo, South Africa. Scat samples were macroscopically categorized into six broad dietary categories: mammal, reptile, bird, fruit, forage and insect. Mammalian prey was further identified to species and grouped into six functional dietary categories: carnivore, large ungulate, small ungulate, small mammal, and unknown mammal. Jackal diets were dominated by mammal prey, with limited overall differences in the biomass of mammals consumed by jackal at sites with cheetah and without cheetah. Mammal consumption, however, showed greater variation between seasons in the absence of cheetah, suggesting that carrion provision may dampen seasonal variation in jackal diets. This suggests that resource supplementation provided by predator-derived carrion is an important factor influencing jackal foraging ecology, reducing seasonal resource limits. The emergent hypothesis that jackal may show demographic responses (increased fecundity, survival, density) to this supplementation needs to be tested.

Comparative diets of Cape and small-spotted genets in an area of sympatry: evidence for trophic competition?

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The diets of Cape genet (*Genetta tigrina*) and small-spotted genet (*G. genetta*) were studied through scat analysis at the Great Fish River Reserve (Eastern Cape, South Africa). A total of 276 fresh scats (44 of *G. tigrina*, 232 of *G. genetta*) were collected at 43 latrines from September 2017–August 2018. Scat depositors' identification was achieved through 1–2 camera-traps permanently monitoring the latrines. Small mammals and arthropods were the main prey of both species, in terms of percentage occurrence, volume and weight. Plant material, seeds/fruit pulps, birds, reptiles, carrion and human leftovers only acted as supplementary or trace foods. Small mammal and arthropod consumption peaked in winter and summer, respectively. Intermediate diet diversity and low niche breadth indices were obtained for all seasons. Diet overlap between pairs of seasons was low to high for *G. tigrina*; and intermediate to high for *G. genetta*. Both species are rather specialised feeders whose diets overlap substantially and vary opportunistically according to variations in main prey availability – as determined in a previous study. Trophic competition is expected to be high between both species, and *G. genetta* might be the best competitor, as it is by far the most abundant species in the reserve.

Movement patterns of Kelp Gulls in several South African colonies.

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Kelp Gull (*Larus dominicanus*) numbers have recently increased worldwide, and as opportunistic feeders, they can predate on other threatened species. To understand their role and impact in the trophic food web, it is crucial to understand their foraging ecology. Kelp Gulls are known to forage on a wide variety of natural prey as well as food derived from human activities, but knowledge about their foraging ecology in South Africa remains very limited. Here we show GPS tracks from 73 Kelp Gulls incubating in six different colonies between 2017 and 2018. Foraging distances and trip durations varied across colonies, with birds breeding in proximity to a landfill having shorter trips, relying more on anthropogenic food than birds breeding further away from anthropogenic food sources. These results suggest that even though Kelp Gulls are generalists, their diet is influenced by the availability of food sources in the vicinity of their colony and that more urban colonies are more likely to feed on anthropogenic food sources in comparison to colonies in more natural environments. The impact on population health of South African Kelp Gulls of feeding on anthropogenic sources is currently being investigated.

Possible ethological and ecological causes of a shift in ancient Egyptian iconography of African animals.

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Ancient Egyptians represented animals vastly in the iconography throughout the Pharaonic period and beyond. Some species were indigenous and common in Egypt, some could have been native, but rare, others were certainly brought from abroad, mainly from Africa. On the oldest monuments however, some unexpected species are depicted seemingly in their native environment, which would suggest that the most anciently noted zoogeographical range of the species was significantly extended into north Africa. The most puzzling phenomenon is the sudden disappearance of these species from the iconography. The animals in focus are: the African wild dog (*Lycaon pictus*) and the Secretarybird (*Sagittarius serpentarius*), contemporary in South Africa, observation of which may help to assess the reasons of the ancient shift. Moreover, the two species do not seem to ever have been juxtaposed in

Egyptology. This disappearance may reflect cultural shifts or, more likely, local extinctions or range shifts of these two species. The key may be some observations of the modern comparative material, which may be verified and perhaps also advised by the professional audience of the 39th ZSSA Congress.

Highlights from the Global Environmental Change Programme of the Durban Research Action Partnership.

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The Durban Research Action Partnership (D'RAP) is a research partnership between the University of KwaZulu-Natal and eThekweni Municipality, Durban. Through D'RAP, collaborative, focused research is conducted within the eThekweni Municipal area across a range of disciplines. These research programmes aim to generate knowledge and learning to address gaps between scientific research, policy development and management in a local government context. We detail highlights of the Global Environmental Change (GEC): Durban Metropolitan Open Space System (DMOSS) Research Programme (2015 to 2018). This phase of research has produced valuable baseline data, such as bird and mammal species diversity in conserved forest patches, base nitrogen levels, suggestions for managing human-wildlife conflicts, and wildlife biodiversity assessment on eco-estates. Two potential bio-indicators were identified from the research for use in monitoring of the unique KwaZulu-Natal Sandstone Sourveld habitat that occurs in the region. These outputs have highlighted the importance of conserving natural DMOSS areas as a means to conserve biodiversity. The programme also had a unique feature where an embedded researcher was placed within the Municipality. This climate change post-doctoral student analysed how climate information could better be integrated into biodiversity planning. Outputs include the development of a long-term 'environmental change' monitoring programme.

Aspects of the ecology of the invasive rose-ringed parakeets *Psittacula krameri* in eThekweni Municipality.

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The rose-ringed parakeet (*Psittacula krameri*) is one of the world's worst invasive pest species. It is native to parts of Africa, India, and south-east Asia with invasive populations established in approximately 35 countries. In South Africa, it was introduced in the 1970s as part of the pet trade and now it has an expanding unknown population size in several urban and periurban areas. A survey was conducted in several areas in the greater Durban metropolitan, KwaZulu-Natal Province, South Africa to determine aspects of the parakeet's ecology particularly their presence, numbers, breeding and feeding biology. We undertook monthly observations to estimate the population size and to determine the use of roost and feeding sites. We located four major roost sites and 10 feeding sites. The suburb of Durban North had the largest parakeet population with ~1200 parakeets. Numbers of parakeets at four roost sites differed significantly across seasons. Rose-ringed parakeets fed on a variety of food materials, fleshy fruits being the major food item. Consequently, the estimated population size of rose-ringed parakeets and the observed juvenile recruitment showed that they occur in relatively large numbers in the greater Durban area, and that their numbers are increasing, so control measures are required.

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Reproductive behaviour in the roan antelope *Hippotragus equinus*.

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Populations of Roan antelope (*Hippotragus equinus*) are declining drastically throughout Africa, resulting in intensive breeding programs aimed at reintroductions in the natural habitat. Currently, very little data exists on the sexual behaviour and reproductive physiology of this species, limiting the strategies to optimise such breeding programs. We investigated sexual behaviour of 15 captive adult individuals; two reproductively active males and 13 females housed at Lapalala Wilderness, South Africa. The animals were observed for 260 hours during the reproductive periods using *ad libitum*, focal and scan sampling techniques to record the behaviours exhibited by males before and during mating, and by receptive and non-receptive females, respectively. A total of 181 courtships were recorded, 19% led to mounting and each mount lasted between 3-4 s. Females were receptive for 24-72 hours, mostly showing oestrus-elicited behaviours such as “female mounted by the bull” (mean \pm SEM: 60.08 \pm 1.59) and “female urinates” (mean \pm SEM: 41.02 \pm 1.44). In contrast, non-receptive females ran into thick bushes, lay down, assumed a “prayer posture” or ran away when approached by the male. This study showed that courtship is the most important component of sexual behaviour in male, with female receptivity varying by 1-3 days.

Historic genetic population structure of three forest-dependent passerines in the Eastern Cape.

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Recent range declines of South African forest-dependent birds, most notably in the Eastern Cape, have prompted the need to understand the genetic diversity and geneflow of forest birds across regional forest fragments. In this study, the population structures of three co-distributed forest passerines *Pogonocichla stellata* (n=188), *Phylloscopus ruficapilla* (n=82), and *Batis capensis* (n=110), were compared across seven forests from six forest-ecotypes in the Eastern Cape, using hypervariable mitochondrial control region sequences. Forest-dependent *P. stellata* ($H_d = 0.823$; $k = 3.986$) and *P. ruficapilla* ($H_d = 0.856$; $k = 2.215$) colonised South Africa from east Africa during the Plio-Pleistocene epochs, whereas forest-associated *B. capensis* ($H_d = 0.988$; $k = 6.149$) is a southern African near-endemic. AMOVA and ϕ_{ST} analyses revealed moderately high population substructuring in *P. stellata* and *B. capensis*. The highest level of differentiation was detected between southern forests (certain Amatole mistbelt and Albany coastal), and more eastern forests. However, relatively low differentiation was observed in *P. ruficapilla*. These different population structures are likely due to differences in life history traits and/or different evolutionary forces acting upon each species. Understanding past connectivity between forests could improve conservation management of contemporary forest bird populations in the Eastern Cape.

Aspects of the ecology of two terrapin species in KwaZulu-Natal, South Africa.

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South Africa's freshwater systems are under increasing anthropogenic pressures due to a growing population, land-use change and climate change. It is important to understand how organisms reliant on wetland systems are coping with pressures to assess their ability to persist. There is a paucity of general knowledge of terrapin ecology in South Africa, despite their importance in freshwater ecosystems. Measures of movements, regularity, and activity regimes can provide valuable insights into an animal's behaviour, and what is required to ensure populations remain stable. Consequently, we investigated aspects of terrapin (*Pelomedusa galeata*, and *Pelusios sinuatus*) ecology, using several

different techniques. Ten individuals of each species had UHF tags attached to monitor movements and activity patterns at two different field sites in KwaZulu-Natal Province. This showed trends in individual behaviour/movement in relation to environmental variables, especially drought conditions. As well as the two telemetry sites throughout the province non-telemetered animals were permanently marked on their marginal scutes using a standardised numbering system, all specimens had biometric data collected to evaluate general condition, and a tissue sample was collected for genetic analysis. We present our findings on both species' ecology from areas of KZN. Our findings can aid in their conservation and management.

Elephant movement patterns and habitat utilizations in Gorongosa National Park (GNP), Mozambique.

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Elephant movement and distribution were studied in the GNP to identify habitat preferences and variations in habitat use. Data was collected by means of GNP annual reports on human-elephant interactions, informal interviews, direct observation in the field and radio-telemetry data (GPS-VHF). Elephants were often reported in three communities along of southern border of the GNP. These communities were visited to ground truth the evidence of elephant presence. Using the telemetry data, we predicted habitat use kernels using ArcGIS 9.3. Geostatistics were used to analyse the existence of spatial dependence in areas used by elephants through kriging interpolation. Elephants inside the park used habitats dominated by medium brushwood (79% of locations) and outside the park elephants used crop fields. Elephant movements peaked in the rainy season with an area of 1076 km² utilized and 4629 km travelled. There was an increasing trend of elephant movements out of the southern section of the park between September and November. Elephant distributions appear to be driven by the availability of permanent water and at low altitudes in GNP. Although elephants interact with humans in the southern region of the park, they used areas dominated by native vegetation within GNP more often.

Latrine use by syntopic small-spotted and Cape genets: who visits, when, and to do what?

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Latrines are often used for scent communication by both solitary and group-living animals. Using 44 camera-traps, we investigated how Cape and small-spotted genets (*Genetta* spp.) use latrines in the Great Fish River Nature Reserve, Eastern Cape, South Africa. Data were collected from September 2017 to August 2018 (n = 9,877 trap-days). We captured 1,138 videos of genets at 31 latrines, 133 (11.7%) of Cape genets and 1,005 (88.3%) of small-spotted genets. Of the latrines monitored, 48.4% were shared by the two species, and 51.6% were only used by the small-spotted genet. Some individual latrines could be used by up to five different small-spotted genets and two Cape genets. The average percentage of latrines used monthly was 73.1% ± 14.0%, with two activity peaks in latrine use and number of visits: one in September–October 2017 (presence of first litter) and another from April–July 2018 (before and during the main mating season). Latrines were mostly visited at dusk (16:00–20:00; 42.1%) and during the night (20:00–04:00; 39.5%). The behaviours that were recorded at latrines included defecation, sniffing, anal marks and rubs, urination, flank rubbing, trunk scratching, and body shaking. These behaviours need to be quantified and their function(s) investigated.

WEDNESDAY 10 JULY**Plenary****Use and limitations of molecular markers for detection and identification of rare species in aquatic environments.****H.J. Maclsaac¹**¹*Great Lakes Institute for Environmental Research, University of Windsor, Windsor, Ontario, Canada.*
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Detection of rare species is highly problematic in many ecosystems. The advent of new technologies (e.g. acoustic recorders, PIT tagging, automated or GoPro cameras) has allowed zoologists unparalleled insights into detection and location of species in nature. Molecular barcoding, in particular, holds the promise of detecting species with far greater sensitivity (i.e. lower false negative rate) than traditional methods (e.g. microscopy for plankton). Metabarcoding expands the concept and permits molecular characterization at the community-scale. However, as each technology has its own strengths and weakness, it is incumbent on researchers to recognize these before use. In this presentation, I will focus mainly on molecular identification, comparing it to traditional and novel methods and identifying key limitations.

**Session 9: Invasion biology
(Main Hall: Ndlopfu)****Fish invasions from recreational angling: knowledge transfer from the British Isles.****J.R. Britton¹**¹*Department of Life and Environmental Sciences, Faculty of Science & Technology, Bournemouth University, BH12 5BB, United Kingdom.*Presenting author e-mail: rbritton@bournemouth.ac.uk

Recreational angling is an important introduction pathway of non-native fish, being responsible for approximately 12% of global fish introductions. Whilst deliberate introductions are generally of large-bodied sport fishes, accidental introductions of small-bodied, pest fishes also occur. Three case studies from Britain (common carp, *Cyprinus carpio*; European barbel *Barbus barbus*; and topmouth gudgeon *Pseudorasbora parva*) are used to reveal how freshwater systems are altered by both deliberately and accidentally released fishes. The first case study reveals how decision-making today might impact biodiversity in future, given that climate change will lift thermal constraints on the reproduction and recruitment of many British non-native fishes. The second case study indicates how accidental introductions that result from inadequate screening of deliberate introductions can result in serious disruptions to angling, including amenity loss due to eradication operations. The final case study reveals how invasive freshwater fish in Britain result in substantial food-web alterations, including via anglers targeting them using baits based on marine fishmeal that results in individual dietary specialisations and the trophic transfer to apex predators. These case studies thus generate considerable knowledge that can be transferred to other regions to improve decision-making relating to the management of both recreational angling and non-native fish.

**Predicting the ecological impacts of invasive species in a changing world:
Comparative Functional Responses (CFR) and Relative Impact Potential (RIP).****J.T.A. Dick¹, J.W.E. Dickey¹, R.N. Cuthbert¹**¹*Institute for Global Food Security, School of Biological Sciences, Queen's University Belfast, MBC, 97 Lisburn Road, Belfast, Northern Ireland.*Presenting author e-mail: j.dick@qub.ac.uk

Predicting the ecological impacts of invasive alien species (IAS) has been an elusive goal for ecologists and those charged with determining IAS management priorities. However, we have combined the classic functional response (*per capita* effects) with proxies for the numerical response (e.g. invader abundance) to radically improve understanding and prediction of IAS impacts. This is our Relative Impact Potential (RIP) metric, which we demonstrate with examples across taxa/trophic groups. Further, RIP can now be used to predict IAS impacts in the face of climate change, by introducing the Resource Reproductive Qualifier (RRQ), which takes account of both changing predator consumption *and* prey

reproduction with abiotic factors, e.g. temperature. We also outline the application of RIP to assess biotic resistance by natives against incoming IAS, the effect of evolution on invasive species impacts, application to interspecific competition *via* our novel “Competition Spectrum” argument and how RIP can inform biological control. In addition, we have developed the Comparative Functional Response (CFR) metric to better focus this on impact prediction and its use to probe critical behavioural aspects of invader impact, such as predator “novel weapons” and native prey “naivete”. We thus present truly predictive metrics for IAS impacts in a changing world.

Origins matter: Alien versus native species as drivers of recent extinctions.

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Native plants and animals can rapidly become highly abundant and dominate ecosystems, leading some people to claim that native species can also be invasive and are no less likely than alien species to cause strong ecological impacts such as biodiversity loss. We compared how frequently alien and native species have been implicated as drivers of recent extinctions, using a comprehensive global database (the 2017 IUCN Red List). Alien species were listed as a contributing cause of 25 % of plant extinctions and 33 % of animal extinctions, whereas native species were implicated in less than 3 % and 5 % of animal and plant extinctions, respectively. When listed as a putative driver of recent extinctions, native species were more often associated with co-occurring drivers than were alien species, consistent with the hypothesis that natives become disruptive only in association with an environmental disturbance. We propose that most of the extinctions linked to alien species introductions are cases of evolutionary mismatches involving naïve native populations. These results add a new line of evidence that the biogeographic origin (evolutionary history) of a species is a determining factor of its potential to cause disruptive ecological impacts.

Black Bass *Micropterus* spp. invasion status, impacts, fisheries and conflict management in South Africa.

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Fishes of the genus *Micropterus*, commonly referred to a black bass, are popular angling species that have been introduced outside of their North American native range into the Americas, Europe, Asia and Africa. In South Africa, four species were introduced to drive recreational angling opportunities in warmer lowland rivers and impoundments from 1928. Small founder populations did not hamper establishment success and most river basins now contain at least one species. A vibrant sport fishery developed with related expenditure creating employment opportunities in the manufacturing, retail and service industries. Black bass are however aggressive predators and where they have become established, they often have deleterious effects on native fishes. As a result, many conservationists consider black bass as pests and legislated management measures include import and movement controls and eradication from conservation priority areas. These contrasting values make the management of black bass an inherently wicked problem. In addition to providing an overview of black bass invasion status, impacts and fisheries in South Africa, this paper contextualises the legislative and management approaches that are being implemented to reduce the spread and impact of black bass while facilitating recreational fisheries.

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From sea to source: Connecting fish, rivers and people.

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Around the world there are thousands of migratory fish that provide an essential role in sustaining the river ecosystem balance and supporting human populations that depend on them for food and income. Notwithstanding the immense value of these migratory fish, they are among the most vulnerable and imperilled animal groups. According to the Living Planet Index, migratory fish populations have declined 41% since the 1970's, largely due to threats from physical barriers, water quality, flow modifications and overfishing. Most of what we know about migratory fish is, however, biased towards developed countries. In Africa, the current status of migratory fish populations and their conservation needs is still very much unknown. In a recent review of 249 freshwater fishes from southern Africa, approximately 130 were identified to need migration for their survival. In this presentation, we will give an overview of the status and migration routes of these fishes, of the research and conservation trends uncovered, and how this all compares to global trends. Insights from the global edition of the "From Sea to Source 2.0" (Brink et al., 2018) will also be given, with case studies from various fish passage, river restoration and conservation projects around Africa.

Does intra-individual behaviour determine invasion success and ecological impact?

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Biological invasions are a driver of biodiversity loss worldwide. Management of invasive species relies upon robust prediction of settlement, establishment and ecological impact conferred on the native communities. There is increasing evidence that non-random subsets of populations are more likely to exhibit traits that facilitate the invasion process and success of an individual within its new range. The African sharptooth catfish (*Clarias gariepinus*) has been successfully introduced to many freshwater systems. Sharptooth catfish exhibit mixed growth rates within cohorts despite intensive selective breeding to reduce this. We test whether consistent intra-cohort growth rate variability may pre-determine invasion success through inherent differences in behaviour and density dependent resource utilisation. Further, we hypothesise that due to sharptooth catfish being found across variable environments the co-selected for traits of growth rate and behaviour is an ecologically stable strategy to maximise survivorship. Thus, different ecological scenarios may facilitate the survivorship and success of different growth groups within the same cohort. Using a long-term mesocosm design we will establish whether the differences seen in the laboratory translate into complex community effects. This is essential for improving prediction of invasion dynamics and targeting mechanical removal efforts to avoid harvest-based trait changes.

Does habitat structure mitigate predation impact of *Micropterus salmoides* and *Micropterus floridanus*?

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Owing to the vulnerability of freshwater systems to invasions, habitat complexity has been shown to mitigate predation pressures on native prey communities. Predation risk is often lower in more complex habitat influencing prey communities to use complex habitat as refugia in the presence of predators. In this study, functional responses were used to predict and compare the impacts of the invasive *Micropterus salmoides* and *M. floridanus* across habitat complexities. *Oreochromis mossambicus* fry were used as focal prey. Both predators displayed a potentially population-destabilising Type II functional response across the habitat complexities, characterised by high levels of proportional consumption at low prey densities. At zero habitat complexity, the attack rate was higher for Largemouth Bass than Florida Bass ($z = 480113$, $p < 0.001$), but the handling time was shorter for Florida Bass compared to Largemouth Bass ($z = 15.16$, $p < 0.001$). The attack rates between Largemouth Bass and Florida Bass at high habitat complexity did not differ ($z = 0.11$, $p = 0.90$), but the handling time was shorter for Florida Bass ($z = 3.51$, $p < 0.001$). Florida Bass exhibited a superior *per capita* effect in both habitat complexities comparative to Largemouth Bass.

Common carp in South Africa – exploring invasion using formal and informal records.

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Common carp (*Cyprinus carpio*) are one of the most widely translocated fish species. Although they have been present in South Africa since the 18th century, little is known about the distribution and ecology of this species in the country. This is remarkable given that carp are a problematic pest in many parts of the world. We used both formal and informal distribution records collected from published literature, biological surveys, angler tournament records and online forum posts, to understand the dispersal of the common carp. Maps were populated in ArcGIS 10.3.1 and MAXENT analysis used to predict the potential distribution ranges. Records confirmed the model's predictions that all major watersheds were potential carp habitat. Few of South Africa's protected areas were not on-line to invaded waters. Including informal records increased the number of waterbodies recorded as invaded, particularly in dams, and in the Gauteng and Free State provinces. Catch-per-unit-effort (CPUE) data from tournament catches were used to understand the state of invasion. Some waters had apparently stable carp populations, whilst the data from others indicate shifting communities with declines in bass numbers recorded alongside increased carp catches. These findings emphasize the importance of informal records in the study of invasive species.

Session 10: Aquatic ecology (Main Hall: Ndlopfu)

The spatial ecology of adult *Labeobarbus marequensis* and their response to flow and habitat variability in the Crocodile River, Kruger National Park.

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The population of yellowfish within the Crocodile River, Kruger National Park, South Africa have shown a notable decline over the last decade. With the increase in water use and flow alterations, this change is concerning to the well-being of yellowfish that have shown sensitivity to these changes. We evaluated the spatial movement of *Labeobarbus marequensis* by attaching radio transmitters to 16 adult fish and tracking them from August 2009 to July 2012 in the Crocodile River. Monthly monitoring surveys acquired 1 620 manual and 64 499 remote observations. Results showed that adult *L. marequensis* did not participate in any migrations. Habitat preferences of *L. marequensis* were deep runs and fast glides, and there was a disproportionately high use of submerged boulders as a cover feature. Tagged individuals also made use of rapids and pools, however, avoided shallow, sandy, slow glides. There was a reduced activity response of tagged individuals to rapid changes in water discharge. Continued changes in flow and instream habitat might negatively impact the Crocodile River *L. marequensis* population. Continual monitoring of the effect of altered flows and associated habitat availability for *L. marequensis* is needed to better understand the effect of water resource use in the Crocodile River.

A quiet life in a ferocious river: spatial ecology of freshwater eels *Anguilla* spp. in the Thukela River.

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Four freshwater eel species (*Anguilla* spp.) occur in southern Africa. While spawned at sea, African eels spend most of their lives in freshwater. In KwaZulu-Natal, all four eel species occur in sympatry. They occupy a great variety of habitats, and their preferences are believed to vary between species and age cohorts. We investigated the spatial ecology of a community of Anguillids in the Thukela river using radio telemetry methods. Twenty yellow eels were surgically implanted with radio-tags from October 2018 to January 2019. *Anguilla mossambica* (n = 2), *A. bengalensis* (n = 8) and *A. marmorata* (n = 10). All individuals were tracked daily implementing a stratified temporal pattern. The location and associated habitat features were recorded for each tracking event. Preliminary results show restricted movements for all tagged individuals within a 3 km reach of the river: only two individuals showed home ranges that exceeded 0.5 km between two tracking sessions. Preliminary results include significant interspecies behavioural responses to flow, water quality and habitat variability. These preliminary findings characterise aspects of the previously unknown ecology of these elusive species and will contribute to understanding the importance of river connectivity and the conservation of these socio-ecologically important, but vulnerable fishes.

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Marine research needs in the face of global change.

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The threat of global change to natural systems and the ecosystem services that they provide is well recognised. Two of the main drivers of such change are biological invasions and climate change. The impacts of these drivers are broad, with consequences from the genetic to the ecosystem level. In response to these threats there is a clear need to prevent, mitigate and manage these impacts, but this dependent on an understanding of their causes and the mechanisms through which they manifest. This study reviewed the South African marine invasion and climate change literature to assess the research-base that could support policy development and evidence-based management. In total 133 papers were reviewed, 87% of which considered invasions, notably no studies have considered interactions between these drivers of change. A geographic bias was evident with most studies focused on the west coast. Key research areas requiring attention include (1) routine monitoring for alien species, (2) tracking of species ranges, (3) establishment of native and alien species physiological tolerance ranges and (4) assessment of how biotic interactions may be affected by invasions and a changing climate. Importantly, the need for foundational biodiversity knowledge should not be underestimated.

The response of the ichthyofauna community to multiple environmental stressors in the river ecosystems of the Lake St. Lucia Basin, South Africa.

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The St. Lucia Basin, comprising of the Mfolozi and the Hluhluwe-Mkuze sub-basins is an ecologically important region that presently is experiencing continuous land cover change and increasing water demand. Accordingly, this study sought to evaluate the response of the ichthyofauna population of the river systems to multiple stressors. Using modelling-based analyses species count data were fitted to select environmental variables. The study provided evidence that species and functional feeding guild community structure were significantly influenced by environmental variables. Spatial shifts in the community structure were observed due to changes in stressor levels. Species richness was relatively low at sites possessing deteriorated water quality and/or excessive sedimentation due to exacerbated erosion from the surrounding catchment. Furthermore, alterations to river connectivity negatively influenced migratory species and geomorphic characteristics affected zoobenthivore richness. In addition, seven species historically recorded within the river systems were not recorded during this study. Consequently, the continued unsustainable use of the basins water resources and poor land management practises is likely to shift the ichthyofauna community into a uniform, species-depauperate community, potentially leading to a loss in ecosystem services and functioning. Therefore, it is recommended that appropriate management actions are undertaken to impede this process.

Emergent effects of predator diversity regulate predator-prey interactions: evidence from mesocosm experiments.

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Predation plays an important organisational role in structuring plankton communities. Predator diversity can, however, lead to emergent effects where outcomes of predator/prey interactions are modified. The importance of predator diversity in regulating predator-prey interactions was investigated during a 9-day mesocosm study conducted in the middle reach of an intermittently open/closed temperate southern African estuary. The zooplankton community comprising almost exclusively (> 95% of the total counts) of calanoid/cyclopoid copepods of the genera *Pseudodiaptomus*, *Paracartia* and *Oithona*, were subject to three different early life history fish predator treatments by; 1: *Gilchristella estuaria*, (Gilchrist, 1913; SL 15.3±2.4mm); 2: *Myxus capensis* (Valenciennes, 1836; SL 12.8±3.7mm); and 3: combination of the two predators. Results of the investigation indicate that the presence of the predator contributed to a significant decline in the total zooplankton abundances with a concurrent increase in total

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chlorophyll-a (chl-a) concentrations, consistent with the expectations of a trophic cascade ($P < 0.05$ in all cases). The extent/magnitude of the interaction was, however, strongly treatment dependent with the mixed treatment demonstrating the weakest trophic cascade. Results of the mesocosm experiment indicate the diversity of early life-history fish can through emergent effects, play an important role in mediating predator/prey interactions and the strength of trophic cascades within aquatic ecosystems.

Establishing the fisheries potential of Flag Bosielo dam based on the combined data collected from Flag Bosielo and Loskop dams.

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The status of fish stocks in South Africa remains unclear due to poor fisheries management and lack of catch data. However, the recent initiative to develop the inland fisheries policy by the Department of Agriculture, Forestry and Fisheries (DAFF), supported by the Water Research Commission (WRC) shows the need for fish stock assessments to improve fisheries management and catch data. In this paper, the yield-per-recruit (YPR) and spawner biomass-per-recruit (SBR) models were used to recommend generic harvest strategies for *Labeo rosae* and *Oreochromis mossambicus*. The YPR and SBR analyses demonstrated that for either species YPR is maximised at fishing mortalities of between 0.3 and 0.5 yr⁻¹. SBR analyses demonstrated that SBR is reduced rapidly even at low fish mortalities. At fishing mortality (F) approximating those necessary to maximise YPR, SBR is maintained at above 25% of pristine SBR if fish are selected at ages of 4 years or older. At ages of selection of 5+ years, SBR is maintained even at very high fishing mortalities. As a result, if a fishery were to be initiated, initial mesh size restrictions of 100 mm would be required to minimise the risk of stock collapse for both species.

Trade-offs between age-related reproductive improvement and survival senescence in highly polygynous elephant seals: dominant males always do better.

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Life history trade-off theory predicts that current reproduction negatively affects future survival and reproduction. Studies differentiating between the costs of attending a breeding season and successfully mating with females is lacking for the male component of polygynous populations. We investigated whether trade-offs are present in the highly polygynous male southern elephant seal (*Mirounga leonina*) using 34 years of individual-level data. We compare age-specific survival and reproductive probabilities of breeders (subordinate and dominant) and pre-breeders (males yet to recruit) using multi-event models. Pre-breeders and breeders of overlapping ages had similar survival probabilities, suggesting that there was no attendance cost for early recruits. When comparing subordinate and dominant breeders, we found clear evidence for survival senescence, with subordinate breeders having a higher baseline mortality. In contrast, age-specific reproductive success (measured as social rank) increased with age, with dominant breeders maintaining higher subsequent reproductive success. These opposite trends in breeder survival and reproductive success may indicate a lifetime, population-level trade-off. Thus, breeders experienced actuarial senescence regardless of mating success, with dominant (and possibly high quality) breeders reducing the trade-off between survival and reproductive success. We make several novel contributions to understanding polygynous male life histories and southern elephant seal demography.

Gut content and stable isotope analyses to trace the feeding behaviour among four co-occurring fishes in man-made impoundments.

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With the rise in global biodiversity loss, new and integrative tools are needed to quantify the potential ecological effects of non-native species on recipient food webs. The analysis of food web structures has increased our understanding of the dynamics of organism belonging to different trophic levels and this knowledge has enabled us to have a holistic view of ecosystem functioning. We compared the diet composition of native river goby (*Glossogobius callidus*), roundherring (*Gilchristella aestuaria*), tilapia (*Oreochromis mossambicus*) with that of the alien mosquitofish (*Gambusia affinis*) using gut content analysis and $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ stable isotope analysis. Differences in $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ among taxa group were independently tested. The Bayesian assemblage metrics and standard ellipse areas were calculated using Stable Isotope Bayesian Ellipse (SIBER). MixSIAR was used to assess the probability distribution of each source to a mixture according to uncertainty associated with multiple sources. Stomach content analysis showed that the river goby, tilapia and mosquitofish fed predominantly on benthic resources, while roundherring fed mainly plankton resources. However, stable isotope analysis revealed that the niche space occupied by mosquitofish was broad and overlapped with that of the three species

Biogeography influences endolithic parasitism of coexisting invasive and indigenous mussel species.

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Biotic stress in concert with physical environmental conditions can have significant effects on competitive interactions between invasive and native species. Here, we assessed the impact and prevalence of endolithic parasitism in competing invasive and indigenous intertidal mussel species. We conducted large-scale surveys along three biogeographic regions along 2500 km of the South African coast: the subtropical east coast dominated by the indigenous *Perna perna*, the warm temperate south coast where indigenous mussels coexist with the invasive *Mytilus galloprovincialis* and the cool temperate west coast dominated by the invasive species. The prevalence of infestation increased with mussel size and in the case of *M. galloprovincialis*, we found significantly higher infestation in the cool temperate bioregion than the warm temperate region. For *P. perna*, there was no significant difference in prevalence between the warm temperate and subtropical regions. On the south coast, where the two mussels co-occur, no significant difference in infestation prevalence was observed. Endolithic induced mortality rates through shell collapse mirrored the same patterns as prevalence of infestation. For *P. perna*, identification of endoliths revealed clear grouping by bioregion. The findings show that endolithic cyanobacteria are generalist parasites, affecting indigenous and introduced mussels similarly.

Sacrificial males: the potential role of copulation and predation in contributing to copepod sex-skewed ratios.

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Predation is thought to play a selective role in the emergence of behavioural traits in prey. Here we assess predator–prey dynamics between notonectid predators (backswimmers) and *Lovenula raynerae* (Copepoda), key faunal groups in temperate ephemeral pond ecosystems. Using field and experimental approaches, we test for potential mechanisms driving predation-induced sex-skewed ratios. A natural population of *L. raynerae* was tracked over time in relation to their predator (notonectid) and prey (Cladocera) numbers. In the laboratory, copepod sex ratios were assessed in the absence of predation pressure. Predation success and prey performance experiments evaluating differences between male, female, gravid female and copulating copepod pairs exposed to predation were also examined. Under natural conditions, a female dominated copepod population developed over time, and was correlated to predation pressure. But under predator-free conditions non-sex skewed population demographics persisted. No difference in vulnerability for male, female and gravid female copepods was found, but copulating pairs were significantly more vulnerable to predation. However, only female copepods escaped successful predation on mating pairs. These results suggest that copula may contribute to sex-skewed copepod ratios in the wild. This is discussed within the context of vertebrate and invertebrate predation as differential selective pressures for copepod mating behaviour.

Towards improved quantifications of interaction strengths in temporary ponds.

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Predation profoundly impacts ecosystem structure, function and stability. However, quantification of interaction strengths often overlooks demographic variability within populations. Sex ratios and reproductive status are highly variable over the hydroperiod in temporary aquatic systems and may mediate levels of ecological impact and resource stability. We apply functional responses (FRs) to quantify predation rates of adult males, non-gravid females and gravid females of the calanoid copepod *Lovenula raynerae* towards larvae of the *Culex pipiens* mosquito complex. We then develop a novel metric to forecast population-level impacts across different population sex ratio scenarios. *L. raynerae*

demonstrated Type II FRs irrespective of sex. While male and non-gravid female copepods exhibited similar maximum feeding rates, gravid female feeding rates were substantially higher, implying higher resource demands for progeny development. Ecological impacts of *L. raynerae* on lower trophic groups increased markedly where their abundances increased but, crucially, also as population sex ratios became more biased towards gravid female copepods. We demonstrate that population-level impacts do not only correlate tightly with abundance but may be further modulated by reproductive status variations. Thus, the development of sex-skewed ratios in favour of gravid females during the hydroperiod likely heightens ecological impacts on lower trophic groups.

Standardisation of *Cherax quadricarinatus* sampling gear and abundance data in southern Africa.

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To identify standard freshwater crayfish sampling gear and to standardise crayfish abundance data across southern Africa, we tested the difference between *Cherax quadricarinatus* catch per unit effort (CPUE) of two different trap models and bait in Lake Kariba. The survey compared opera traps baited with maize meal vs collapsible traps baited with dog food. Average *C. quadricarinatus* CPUE was significantly lower (1.16 ± 0.84 ind./trap/night) in opera traps compared to the collapsible traps (4.39 ± 3.61 ind./trap/night). However, there were no significant differences between the two trap types with respect to total length, weight or sex of *C. quadricarinatus* caught. Due to high CPUEs, the collapsible trap baited with dog food should be considered as an appropriate gear for abundance of *C. quadricarinatus*. Standardised data from the region will be compared to abundance data from their native ranges.

Ecosystem responses to rotenone treatment in two reservoirs in the Western and Northern Cape provinces, South Africa.

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Non-native fish removal using rotenone has been demonstrated to be an effective management tool, its effects on non-target aquatic organisms are a cause for concern. During the study treatment and control reservoirs were sampled prior to, and at intervals following, treatment with the piscicide rotenone. Sampling endpoints included water quality parameters, plankton, macroinvertebrates and fish. These endpoints were selected to gain an understanding of the ecological impacts of the treatment at various biological levels and to document the recovery post treatment. The Chalet reservoir was treated with the piscicide rotenone to remove the non-native *Lepomis macrochirus* and the Kranskloof reservoir was treated to remove non-native *Cyprinus carpio*. Results showed that: (1) non-native fish were successfully removed, (2) rotenone took less than two weeks to dissipate, (3) there was no change in the physico-chemical properties of the water over time, (4) water clarity improved following treatment, (5) invertebrate communities recovered within a year, and (6) small zooplankton (Rotifera) dynamics were hard to predict but rotifer abundances had returned to pre-treatment levels within a year of treatment. Phytoplankton community of both reservoirs changed to a community that is typically representative of waters with lower nutrient status. Within each group, there were species changes, but these were likely to be part of the altered predator/prey dynamics resulting from fish removals.

Poster Abstracts

Theme 1: Physiology

1 Endocrine correlates of dispersal in a eusocial mammal: the effect of dispersal on cortisol and prolactin plasma concentrations.

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Naked mole-rats have evolved a cooperative breeding system in which subordinate colony members never reproduce in their lifetime, if they do not leave the colony or overthrow the breeder. Although individuals rarely leave colonies, male disperser morphs have been reported. Non-breeding colony members experience physiological suppression of reproduction, possibly regulated by hyperprolactinemia, and may also show elevated cortisol levels as a result of social stress. Twelve non-reproductive animals (6 males and 6 females) from two colonies were removed and subsequently paired, while 12 control animals remained in their colonies. Blood samples were taken from control and experimental animals before removal, when animals were housed individually and when they were paired. Experimental males showed a significant decrease in prolactin concentration when they were paired with females, but control males and all females showed no significant changes. Stress may have an influence on prolactin levels, therefore, hyperprolactinemia may still mediate reproductive suppression, but its role may be more complex than predicted. Cortisol concentrations only significantly increased in both female groups when experimental animals were removed from the colony and decreased once experimental females were paired with males. Males may thus be physiologically more equipped for dispersal, indicated by their low stress response.

2 Faecal glucocorticoid metabolite concentrations and their alteration post-defaecation in African wild dogs *Lycaon pictus* from South Africa.

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The use of faecal hormone measurements for the non-invasive monitoring of responses to perceived stressors by African wild dogs, *Lycaon pictus*, is widespread. However, the potential influence of time of collection post-defaecation on stress-steroid concentrations in faecal matter has not yet been investigated. In the present study, we determined the rate at which African wild dog faecal glucocorticoid metabolite (fGCM) concentrations change over a 16-day period post-defaecation. We also assessed alternative methods to the freeze-drying of collected material prior to extraction, which requires laboratory access and specialized equipment, by applying field-friendly faecal sample drying methods; utilizing a solar oven, a mechanical meat dryer, and direct sunlight. Approximately, 30% increases in fGCM concentrations post-defaecation were noted from 24 h onwards, followed by a significant 150% increase after 96 h; suggesting that respective faecal material should be collected within the first 24 h of defaecation to ensure comparability of subsequently determined fGCM values. Moreover, while freeze-drying remains the gold standard for the removal of moisture from faecal samples, the use of either a solar oven or mechanical meat dryer proved to be suitable alternatives for the drying of faecal samples on-site without the need for immediate freezing and subsequent cold-chain maintenance.

3 Hot birds in a warming world: heat tolerance and evaporative cooling capacity of birds from the Nama Karoo biome.

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The challenges of surviving and breeding in harsh desert environments are exacerbated for birds by their diurnal habits, and they rely heavily on evaporative heat dissipation for defending body temperature (T_b) below lethal limits during hot weather. Notwithstanding a number of recent studies, our knowledge of phylogenetic variation in avian evaporative cooling efficiency and heat tolerance remains severely limited. Here, we quantified physiological responses to high temperatures among phylogenetically diverse species occurring in the Nama Karoo. We measured T_b , resting metabolic rate and evaporative water loss using flow-through respirometry in birds that experienced a stepped air temperature profile increasing in 2°C increments from 40°C. We recorded the physiological responses of 170 individuals from 16 species across 12 families and 7 orders, doubling the previous number of southern African species for which such data exist. We focused our sampling to ensure we obtained data from multiple species within a family, several families within and order, and several orders not previously investigated. Our work allows for a more comprehensive review of the mechanisms behind evaporative cooling across taxa and for modelling species' vulnerabilities to higher temperatures. Thus, our research will directly contribute to predicting these species' responses to rapid global warming.

4 Acquisition of a valuable asset – Establishing non-invasive hormone monitoring as an increasingly popular tool for research in South Africa.

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The endocrine system helps an organism to function properly by communicating and coordinating vital processes via hormones. However, very little is known about the endocrinology of the majority of mammals and even less is known for birds, reptiles, amphibians and invertebrates. Yet, hormone analyses are key for understanding basic physiological processes, such as reproductive function and responses to stressors. Hormones can be measured in various biological matrices, and the choice of which to use depends on a range of factors, including the type of information required, species differences in hormone metabolism and excretion, and the practicality of sample collection. For intractable or free-ranging wildlife species, non-invasive approaches based on especially faecal analyses offer tremendous advantages and are the preferred option in most situations.

Although widely useful for even a broader range of scientific disciplines, respective expertise and laboratory techniques for non-invasive hormone monitoring were not available in South Africa until twelve years ago. By depicting a number of key studies, this presentation will portray the onset, development, and current role of the Endocrine Research Laboratory, University of Pretoria, from a postdoctoral idea to a national and international well-recognised and highly recommended platform for wildlife and behavioural endocrinology research.

Theme 2: Biodiversity conservation and ecosystem resilience

5 Taphonomy of small mammal carcass.

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Caves are storehouses of information on natural resources and evolution and therefore many avenues of research can be pursued in caves. Research on cave taphonomy is especially important in South Africa because of its palaeontological wealth associated with caves. The aims of this study are to determine which species (hypogean or epigeal) play a role in the decomposition of a carcass within a cave, to identify the competition between hypogean (underground) and epigeal (above-ground)

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species and to determine the rate of decomposition within a cave. Three caves were used as study sites. The study involved the placing of rat carcasses in each of the caves, in each of the three cave zones (entrance zone, twilight zone and dark zone). This study included a variety of collection techniques including sand and pitfall traps. The invertebrates collected were brought back to the lab allowing larvae to grow to the adult stage for identification. Both hypogean and epigeal species were collected from various groups. Preliminary results suggest that epigeal and hypogean species were found on the carcasses indicating some amount of competition. The decomposition was much slower in caves than above ground.

6 The sale of exotic small mammal pets in South Africa.

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The sale of exotic small mammals is increasing and most of these mammals have become invasive through escape and release pathways. In South Africa, several species of small mammals are sold and kept as companion animals, and this poses an invasion threat. To evaluate the likelihood of exotic mammal invasions from the pet trade, it is important to investigate the degree of trade including the number of pet shops selling exotic mammals especially in terms of which species, the number of each species and the extent of trade in South Africa. We recorded a total of 108 pet shops in eight provinces, with Gauteng, Western Cape, and KwaZulu-Natal each having more than 15 pet shops. We found out that there were 13 different exotic small mammal species routinely sold in South Africa. Species of *Rattus*, *Phodopus*, *Cavia*, *Oryctolagus*, *Mastomys* and *Mus* being the most common mammalian species traded in the pet shops. Three traded species, *Rattus norvegicus*, *Mus musculus*, and *Oryctolagus cuniculus* are already declared invasive in South Africa and one native species, the multimammate mouse (*Mastomys natalensis*) was also sold. The popularity of these exotic mammals in the pet shops poses an invasion risk in South Africa.

7 Survey of herpetofauna diversity at the Botanical Garden of the campus of the Polytechnic Institute of Manica, Mozambique.

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The objective of this study was to evaluate the biodiversity of the herpetofauna. The species were captured through the combination of interception and fall traps and visual searches in microhabitats along transects. The searches were carried out by three people with 72 hours of sampling effort. Twenty-one individual anurans were sampled, distributed in four families and five genera and five species: *Phrynomantis bifasciatus* (4); *Amietophrynus guttural* (3); *Phrynobatrachus* spp (7); *Africalus fornasinii* (3) and *Kassina maculate* (4). *Phrynobatrachus bonebergi* of the family Phrynobatrachidae was the most abundant species. In the Reptilia class, 32 individuals were sampled in three families with the same number of genera and species found in amphibians: *Trachyleepis striata* (5 individuals); *Gerrhosaurus flavigularis* (8); *Cordylosaurus subtessellatus* (9); *Chamaeleo dilepis* (6) and *Mochlus sundevalli* (4). The species of *Cordylosaurus subtessellatus* of the family Gerrhosauridae was the most abundant species. The diversity of amphibians and reptiles was similar, with $H' = 1.55$ and $H' = 1.57$ respectively. These results will serve as a baseline to detect the effect of natural or anthropogenic changes of these taxonomic groups.

8 Involvement of the Musseia community in monitoring forest resources and wildlife in the Gilé National Reserve, Mozambique.

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Community involvement in the process of monitoring of forest resources and wildlife is a joint action amongst the population, State institutions and other social actors to improve the management system of natural resources and to formulate action strategies. This study was carried out in the community of Musseia in the Gilé National Reserve, with the purpose to understand the types of illegal activities and how this community is organized. Poaching (82%), with the use of traps, and the illegal exploitation of wood (59%) occurred in the total protection zone and was carried out by people of Asian origin with involvement of local communities from the districts of Ilé, Pebane, Gurué and Gilé in the Zambézia province. This community participates in the monitoring process through complaints to management committees of natural resources and the Forest Rangers community.

9 Patterns of mammalian occupancy in a mixed land-use mosaic of the inland Southern Mistbelt forests of northern Eastern Cape, and southern KwaZulu-Natal, South Africa.

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The southern mistbelt forests of the Eastern Cape and southern KwaZulu-Natal, South Africa, are naturally fragmented but have been heavily logged in the past. Forest mammals are also hunted. Consequently, persistence of mammals in these disjunct forests is of concern. We investigated the effects of habitat transformation (fragmentation and other anthropogenic factors) on mammalian functional diversity in the fragmented southern mistbelt forests of the Eastern Cape (uMthatha area) and southern KwaZulu-Natal (Ingeli and Creighton areas). A minimum of 60 infrared motion detection camera traps were deployed at a time. We had 246 stations in the three southern mistbelt forest areas over 7161 days. Detection probability was low for all mammalian species, whereas occupancy varied. Blue duiker (*Philantomba monticola*) occurrence was low due to the impact of habitat transformation across the three different study sites. Mesocarnivore occurrence varied, however the large-spotted genet (*Genetta tigrina*) had a high occurrence in all areas. The proximity of human settlements to forest patches did not influence the occurrence of mammalian species recorded. Determining anthropogenic pressures on mammalian functional and taxonomic diversity change and whether losses in mammalian diversity are because of selective pressures is important to inform future management practices.

10 Monitoring and conserving South Africa's critically endangered hooded vultures.

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The hooded vulture, *Necrosyrtes monachus* (Temminck, 1823) has declined by > 80 % in the last 40 years and the species was reclassified recently as critically endangered. Although hooded vultures are widespread throughout Africa, they were studied poorly, until recently. We investigated the breeding success and productivity of hooded vultures in the Kruger-to-Canyons Biosphere Region, South Africa. Nests were located by ground searches along rivers in Mpumalanga and Limpopo Provinces, and nest checks were conducted at least three times during the breeding seasons as of 2015 to 2018. We report on hooded vulture breeding success and productivity, which was relatively poor in our study area. We also present a new record of inter-species nest competition, that of an Egyptian Goose attempting to breed in a nest that was occupied by a hooded vulture family. Our results can be used as a baseline for measuring the success of current and future conservation efforts.

Theme 3: Taxonomy, systematics and evolutionary biology

11 Is there adaptive differentiation among *Mastomys natalensis* occupying different habitats?

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There remains limited understanding of the evolutionary implications of human-driven land use, urbanization, and agriculture. Although evidence for rapid evolutionary change in anthropogenically modified habitats is growing, we don't know whether similar evolutionary response occur across what are very different anthropogenic habitats (e.g. urbanization vs agricultural). *Mastomys natalensis*, is a ubiquitous African rodent pest and a natural host for pathogens. Despite, its impact on human well-being there remains a lack of genomic resources necessary to understand the evolutionary implications of how human-driven land use and climate change influences the adaptation of *Mastomys*, and the potential socio-economic impacts of the species as a pest and pathogen host. To address these issues, we have sequenced a reference transcriptome that will allow for the study of exom adaptation in this ubiquitous species. We will be sampling *Mastomys* from replicate per-urban, sugarcane, maize and savanna habitat and will compare patterns of exom variation to determine whether localized, adaptive (directional selection for certain genes) and non-adaptive (genetic drift, reduce gene flow) convergent evolution is occurring across these different environments.

12 Evaluation of the nomenclatural status of the synonyms of *Enteromius anoplus* (Weber, 1987) (Teleostei, Cyprinidae).

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Enteromius anoplus, as currently described, is the most widely distributed freshwater fish in South Africa, with a range extending from the Cape Fold Ecoregion at the southern tip of the African continent, to the Limpopo River system which marks the northern-most distribution limit for the species. DNA-based studies have however revealed substantial genetic structuring within *E. anoplus*, raising the possibility that this species may harbour undocumented taxonomic diversity. *E. anoplus* was described based on specimens that were collected from the Gouritz river system. Three previously described species, *E. cernuus* from the Olifants-Doring river system, *E. oraniensis* from the Orange river system and *E. karkensis* from the uMngeni river system were put into synonymy with *E. anoplus*, but no adequate justification was provided for these decisions. These names have however been overlooked in all subsequent taxonomic accounts and catalogues of fishes of southern Africa, potentially obscuring biodiversity management and conservation prioritisation. The purpose of the present study is to integrate molecular and morphological data to examine the nomenclatural status of the names currently referred to as synonyms of *E. anoplus*. It presents a re-description of *E. anoplus* and revalidation of *E. oraniensis* and *E. karkensis*. The study is ongoing and results will be presented.

13 Four new species of the sac spider genus *Planochelas* Lyle and Haddad, 2009 (Araneae, Trachelidae) from central and southern Africa.

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The family Trachelidae (Arachnida: Araneae) is currently represented in the Afrotropical region by 60 species in 11 genera, namely *Afroseto* Lyle and Haddad, 2010; *Fuchiba* Haddad and Lyle, 2008; *Fuchibotulus* Lyle and Haddad, 2008; *Jocquestus* Lyle and Haddad, 2018; *Orthobula* Simon, 1897; *Patelloseto* Lyle and Haddad, 2010; *Planochelas* Lyle and Haddad, 2009; *Pochelas* Haddad and Lyle,

2008; *Spinotrachelas* Haddad, 2006; *Thysania* Simon, 1910; and *Trachelas* L. Koch, 1872. The recently described genus *Planochelas* Lyle and Haddad, 2009 is endemic to the Afrotropical region. Members of this genus are very small and arboreal. They are mainly collected by canopy fogging in tropical forest and savanna biomes. The recent taxonomic revisions of this genus include descriptions of more than four new species from West and Central Africa. Raising the total to nine species in the genus. In the current study, four new species of *Planochelas* are described, namely, *P. brevis* sp. n., *P. haddadi* sp. n., *P. jocque* sp. n. and *P. neethlingi* sp. n., from central and southern Africa, and an updated key to all the species in the genus is presented. Additionally, the known distribution range of *Planochelas* is extended to include southern Africa.

14 The study of free-living freshwater planktonic copepods collected from an ephemeral pool in Limpopo Province, South Africa.

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Certain species are adapted to survive dry periods in ephemeral pools. Such species are important as they form part of the zooplankton community in a temporary pool and play a vital role in aquatic habitats mainly because they are important in the food web. Unfortunately, such habitats have not received a lot of attention with the result that these species are not well documented. Part of the zooplankton consists of copepods. Currently there are only 34 copepod species, representing two orders, reported from freshwater habitats in South Africa. This study was conducted in a small ephemeral pool in the Limpopo Province. Qualitative sampling was done monthly from December 2014 until June 2015 using a plankton net and specimens were studied with the aid of a light microscope. Seven species were collected during the study which represents a high biodiversity of copepods from a single pool when compared with previous studies done in South Africa. The report of *Tropocyclops confinis* constitutes a new geographical record from South Africa while all other collected species are new records from the Limpopo Province.

15 A taxonomic study of free-living freshwater planktonic copepods from a temporary water body close to the University of Limpopo.

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Copepods are a diverse group of small crustaceans that successfully colonise almost all the available water habitats of the planet and as such play an important role in the food webs of aquatic habitats. In this respect, some are adapted to survive during dry periods in temporary pools. Globally, there are approximately 2 800 identified free-living species in freshwater bodies, and only 40 species have been reported from within South Africa. Currently, there are no records on the diversity of copepods that are occurring in the freshwater ecosystems of the Limpopo Province. Zooplankton were collected from a temporary pool along the R71 in the Limpopo Province, by sweeping through the water with a plankton net (100µm mesh size). Collected zooplankton were preserved in 70% ethanol and copepods were isolated and studied under stereo- and light microscopes, using the wooden slide technique. In order to identify the copepods, selected individuals were dissected, and morphological features drawn, using drawing tubes. Examined specimens were identified as members of the orders Cyclopoida and Calanoida. This study reports on the diversity of freshwater free-living copepods in Sandstoot pool, Limpopo Province.

16 A taxonomic revision of the border barb, *Amatolacypris trevelyani*: species delimitation, morphological diagnosis, and revised geographic distribution.

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The border barb *Amatolacypris trevelyani*, is a narrow range endemic minnow that is confined to the Buffalo and Keiskamma River systems, Eastern Cape. Recent studies identified evidence of genetic divergence between the two border barb populations. This study aimed to further determine the degree of genetic and morphological divergence between the Buffalo and Keiskamma river populations of A.

trevelyani and evaluate whether the Keiskamma lineage constitutes a distinct taxonomic entity. A total of 71 *cyt b* sequences spanning five genera, were used for phylogenetic analysis to determine the relationship of *Amatolacypris* to other southern African tetraploid cyprinids. Sequence data revealed that the Buffalo and Keiskamma lineages of *A. trevelyani* were genetically distinct, with 4.55-5.62% divergence between lineages and within lineage divergence values of 0.32% and 0.16-2.05% respectively. The level of divergence between these lineages is consistent with species-level genetic divergence values reported between other southern African tetraploid cyprinids. However, the morphological characters analysed showed a distinct overlap between these two lineages. Therefore, the morphometric and meristic characters used in the present study are taxonomically uninformative to distinguish these two lineages. Pending the ongoing evaluation of additional taxonomic characters, the two lineages should be managed as separate Molecular Operational Taxonomic Units to maintain their evolutionary potential by allowing the processes that generated current intraspecific diversity to continue into the future.

17 Ontogenetic and histological assessment of the limb bones of *Giraffa camelopardalis*.

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Giraffes have straighter and thicker walled limb bones than other artiodactyls. Limb bones of foetal giraffes increase in diameter and circumference faster than their body mass, whereas postnatally, except for the humerus and radius, the opposite occurs. The histological changes underlying the allometric growth and cross-sectional changes through ontogeny have not previously been assessed. Thus, the current study investigates the histology and microanatomy of giraffe limb bones through ontogeny. Mid-diaphyseal sections of humeri and femora of 14 individuals representing males, females, foetal, juveniles, subadults, and adults were sampled for histological analyses. Our results show that the foetus and juvenile individuals have round cross-sections, with small vacant medullary cavities. Their compacta consist of rapidly formed fibrolamellar bone tissue. Cross sections of older individuals are oval with cancellous bone surrounding the medullary cavity, and they have a large amount of fibrolamellar bone tissues towards the periphery, whilst nearer the endosteal region, dense Haversian bone tissues occur, and lamellar bone lines the medullary cavity. These observations indicate that after a rapid initial growth osteogenesis slows down. The results of this study will form the foundation to assess the biology of Pliocene fossil giraffids from Langebaanweg.

18 The parasite diversity of *Clarias gariepinus* and *Schilbe intermedius* from Tzaneen Dam in the Limpopo River System, Limpopo Province, South Africa.

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The importance of fish parasites is usually seen from their negative influence on the health of fish and any resultant economic loss they may cause. They also have adverse consequences to other animals that serve as hosts in the life cycles including man. Furthermore, the usefulness of parasites has been shown by contribution to studies on their use as biological tags and for host identification, improvement of genetic stock. To gain more knowledge on the diversity of parasites in/on fish, two fish species were collected with the aid of gill nets. Of the 54 host specimens collected at Tzaneen Dam during high-flow and low-flow, 22 were *Clarias gariepinus* and 32 were *Schilbe Intermedius*. The host specimens were examined for ecto- and endoparasites metazoan parasites, with the aid of a stereomicroscope. Parasites were fixed and preserved according to standard methods. A total of 11 metazoan parasite species (3 monogeneans, 2 digeneans, 2 nematodes, 1 cestode, 2 copepods and 1 branchiura) were found. The current results will help the management with bio-assessment and bio-monitoring as parasites can be used as indicators to environmental degradation and pollution.

Theme 4: Behavioural ecology

19 A comparison of camera-trapping and scat surveys as methods to study latrine use in carnivores.

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Latrines play a significant role in olfactory communication in carnivores. Therefore, determining patterns of latrine use can shed light on species biology and behaviour. We compared camera-trapping and scat surveying and evaluated whether both methods are able to generate similar information on annual patterns of latrine use by two sympatric genet species (*Genetta genetta* and *G. tigrina*). We monitored and visited 39 latrines monthly over a period of 12 months at the Great Fish River Reserve, Eastern Cape, South Africa. We found little difference between both methods in terms of providing valuable data on latrine use (latrine visited or not) and intensity of use (number of genet visits/scats), with two peaks of defecation observed in June (mating) and September (birth of first litter), respectively. However, although cameras were not active throughout the monitoring period due to a wide range of technical issues, information provided was overall more detailed with this method. We conclude that it is possible to collect useful data on latrine use on a low budget using scat surveys. When access to research funds is not an issue, camera trapping will provide more exhaustive information, including records of marking behaviours performed by the focal species during latrine visits.

20 Nesting success of the African Broadbill in the Limpopo Province.

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The African Broadbill is listed as Vulnerable in the latest South African Red Data Book. The reasons for the species decline include a range of factors, but habitat destruction through rural and urban expansion appears to be the main reason. Although the breeding success of the population in north-eastern Limpopo Province is reportedly low, the reasons for this is largely unknown. We studied the nesting success of the species at Roodewal Forest in the Soutpansberg over four seasons. The daily survival rate of African Broadbill nests using Mayfield's Estimator was similar to other avian species at Roodewal. Predation was the major cause of nest failure, with a wide range of nest predators recorded preying on nests. Primates were the main predators responsible for 56% of nest losses, but birds also featured prominently as nest predators. We will present the results of this study, including a comparison with other species nesting at Roodewal, and discuss possible mitigating measures.

21 Sugar preference of invasive Common Mynas *Sturnus tristis*.

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Nectarivorous and frugivorous birds have been found to select their diet according to sugar type and concentration. Consequently, many studies of sugar preference have been conducted on various avian species. Common Mynas, *Sturnus tristis*, are considered amongst the 100 worst invasive species worldwide and damage fruit crops in some countries. However, their sugar preferences have never been studied. Therefore, we investigated the effect of sugar type and concentration on sugar preference and assimilation efficiency in Common Mynas ($n = 7$). Birds were given pairwise choice tests of sugars (fructose, sucrose and glucose) of 5 g/ml to test sugar preference. Common Mynas showed preference for glucose. To determine at which concentrations they prefer glucose, they were offered three different concentrations of glucose (5, 10 and 25%) and showed distinct preference for the 10% concentration of glucose. The birds maintained body mass in the respective experimental trials thus showed sufficient

energy intake. Common Mynas failed to digest and absorb sucrose, but fructose and glucose were digested and assimilated efficiently for all concentrations. Results of this study showed that Common Mynas prefer glucose at ~ 10% concentration.

22 Effects of land-use on the spatio-temporal ecology of two mongoose species in KwaZulu-Natal, South Africa.

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The spatial ecology of the Herpestidae family remains relatively poorly studied across southern Africa. Small carnivore species, like mongoose, can provide models of how mesocarnivores persist with anthropogenic land-use change. We are investigating how this land-use change affects aspects of the ecology, especially spatial habitat and temporal use and movements of two co-inhabiting mongoose species (water: *Atilax paludinosus*, large grey: *Herpestes ichneumon*). Individuals of these two species were trapped, collared and tracked using Global Positioning System (GPS)-Ultra high frequency (UHF) transmitters to study their activity, home range size and habitat use across a land-use gradient from the fragmented natural and farmland mosaic of the KwaZulu-Natal Midlands to urban areas of the greater eThekweni Durban Metropolitan Open Space System (D'MOSS). Home ranges and habitat use showed great individual variation. This highlights how the behavioural plasticity and generalist nature of these species contributes to their persistence in anthropogenically transformed landscapes.

23 Variation in echolocation call intensities and detection distances of bat assemblages across an environmental gradient.

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Call intensity is an ecologically crucial parameter, as it determines the extent of the bats' perceptual space and, specifically, prey detection distance. Intensity of signals is subject to atmospheric attenuation as it propagates through the physical environment in a habitat and this limits the effective range of bats prey detection. The study aimed to investigate climate change effects, via changes in temperature and humidity on call intensities and detection ranges of bat assemblages in five biomes across South Africa. We used the state-of-the-art multiple microphone array system to record echolocation calls to measure intensities. Temperature, relative humidity, air pressure, were recorded using a portable weather station while recording echolocation calls. To determine the size range of prey for each biome, light traps were used to catch insects at the same time while recording bat calls. With measured intensities (as source levels) at different temperature and humidity, and range of insect sizes, the detection distances for the prey was calculated. Preliminary results for bat call intensities and detection ranges in fynbos biome ($R=0.784$, $P=0.0001$) and desert biome ($R=0.4802$, $P=0.0001$) reveal a significant difference. Thus, detection distances vary across different habitats in accordance with different prevailing environmental conditions.

Theme 5: Human dimensions of wildlife

24 A peculiar case of an exclusively African bird in ancient Egypt. **K. Braulińska¹**

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Ancient Egyptians imported African animals, which is scarcely evidenced in zooarchaeology, however pronounced in iconography. The most prominent depiction comes from the Temple of Queen Hatshepsut at Deir el-Bahari, where the present author, a zoo-Egyptologist, works on the animal decoration of the walls. The so-called Punt Portico presents animals in their indigenous African environment, subsequently led towards the boats of the Queen's expedition, and ultimately presented in Egypt. The author's work has revealed the only hitherto discovered pharaonic example of an arguably

African bird, which may be identified as a Secretary bird (*Sagittarius serpentarius*) or African Harrier-hawk (*Polyboroides typus*). Both species, extant in South Africa, presumably were unknown to pharaonic Egypt, which could have caused the zoological faults in the representation. Particularly in the case of such discrepancies, ethology must support the identification. Animal behavior is still neglected in archaeology and Egyptology. Combining the zoological facts with some ancient Egyptian phenomena and habits may shed light on the depicted behavior of an animal, as well as on the human motivation to choose and “import” the species. The complexity of the aforementioned birds’ case is hoped to be decreased after the contact with the professional zoological environment in Africa.

25

Aspects of the ecology of the Western Cattle Egret *Bubulcus ibis* and various heron species on farmlands and in urban areas of KwaZulu-Natal.

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Although the expansion of cities has been shown globally to have negative impacts on wildlife, some species persist often becoming “urban exploiters”. We are investigating aspects of the ecology of the Western Cattle Egret (*Bubulcus ibis*) and various heron species on farmlands and in urban areas of KwaZulu-Natal Province, South Africa, to determine the effects of anthropogenic changing land-use on these species. The positions of all roost and nesting sites along a land-use gradient will be identified and monitored monthly. We are using citizen science data to determine their habitat use and feeding ecology. Preliminary results show the importance of urban wetland habitats for Western Cattle Egret and various heron species persistence in these areas.

26

Human induced threats to a nonhuman primate of “Least Concern” (*Otolemur crassicaudatus*, *Primates: Galagidae*) in northern South Africa.

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The population distribution and demography of continental Africa’s strepsirrhine primates are poorly known. We present data on human induced threats to the thick-tailed galago, *Otolemur crassicaudatus*, in the western Soutpansberg Mountain region of northern South Africa, Limpopo Province. This species is rated as “least concern” and with a population trend of “stable” by the International Union for Conservation of Nature (IUCN). However, our data indicate that there are a number of human-induced threats, despite this species often being viewed as ubiquitous. Threats include: individuals being killed by motor vehicles, domestic dogs (sometimes due to local cultural practices), and electrocution from movement along power lines. Across these categories, we have recorded 16 *Otolemur* human-related deaths since 2014 in our study area (road kills $n = 8$; electrocutions $n = 2$; dog kills $n = 6$). We argue herein that these data very likely represent a small portion of the actual human impact on this species. We therefore suggest *Otolemur crassicaudatus*, which has received limited attention compared to other strepsirrhines (e.g. Madagascar’s lemurs) and better-known primate taxa, such as, African apes, should more accurately be listed as a “data deficient” species by IUCN, rather than least concern. New surveys are clearly required to assess this species’ current distribution, demography and taxonomy.

27 Diet of caracal (*Caracal caracal*) on lethal and non-lethal control farms in the Karoo.

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Caracals (*Caracal caracal*) are widespread, elusive predators in southern Africa. In the Karoo region, they are thought to be one of the biggest contributors to livestock losses and as a result, pastoralists make use of lethal and non-lethal control mechanisms. Previously, no studies have focused on the effect of these predator control mechanisms on the ecology of caracals. For this study, 136 scats have been analysed from a lethal and non-lethal control farm as well as a control site in the area. A total of 30 prey items from 13 categories have been recorded. The most commonly consumed items across the three sites were vegetation, hares, rock hyraxes, invertebrates, small rodents and wild ungulates. The ANOVA yielded a non-significant *p*-value, indicating no difference between the items consumed on the three sites. Dietary niche breadth was higher on the lethal control farm compared to the non-lethal and control sites, indicating more generalist behaviour in that site. Livestock were only consumed on the lethal control farm and contributed less than 3% of the total biomass consumed, thereby suggesting that caracals do not favour livestock over wild prey.

28 Factors influencing the spatial distribution of African elephant *Loxodonta africana* mortalities in a hunting area of the African Savanna.

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The study seeks to understand factors influencing the spatial distribution of natural elephant mortalities in a hunting area using species distribution models. We used ensemble modelling to understand factors influencing the spatial distribution of natural elephant mortalities in Chewore Safari Area. The model was calibrated using presence only data for locations of natural elephant mortalities which were identified during the period 2000 - 2007. We also used covariates which includes distance from major water sources (DW), distance from protected area boundary (DPB), temperature, normalised difference vegetation index (NDVI) and elevation. Results showed that Classification Tree (CTA), Maximum Entropy (MaxEnt), Random Forest (RF) and Gradient Boosting Machine (GBM) performed better (TSS > 0.7) when modelling the distribution of natural elephant mortalities. Modelling with ensemble species distribution performed well (TSS = 0.78, ROC = 90). The contribution of individual covariates to the model were as follows: DW= 42.3%, DPB= 13.7%, temperature = 21.7%, elevation =13.5%, NDVI = 8.8%). The results show that distance from water was the key factor influencing distribution of natural elephant mortalities. It was found that the majority of elephants die close to major water sources, which suggests the need to evaluate changes in elephant's gastric and blood chemical composition before and after drinking water.

29 Illegal activities that influence the conservation of forest and wildlife resources in the Gilé National Reserve, Mozambique.

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This work results from a survey conducted at the National Gilé Reserve (RNG), which is located between the districts of Pebane and Gilé Zambézia Province, Mozambique. The study analysed illegal activities that are committed in RNG. The survey data were based on semi-structured interviews, informal conversations and direct observations on the ground where 75 individuals aged 18–75 years were interviewed. The results showed that illegal logging (44.0%), followed by poaching (28.0%), shifting agriculture (16.0%) and illegal fishing (12.0%) were the illegal activities committed in RNG and its buffer zone. In addition, the practical causes of these illegal activities included lack of benefits from

the Reserve (45.33% of respondents), poverty (12% of respondents) and unemployment (42.67% of respondents).

30 Effects of habitat-patch size and patch isolation on the diversity of forest birds in five forests in the urban mosaic of Durban, South Africa.

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Loss of habitat area and structural heterogeneity through anthropogenic fragmentation pose a threat to the survival of wildlife. We described the effects of forest fragmentation via measures of patch size and isolation on the taxonomic richness and functional richness of forest birds in five forest Protected Areas within Durban, South Africa. We quantified the avian taxonomic, guild and functional richness and measured at each survey patch. We measured the influence of patch size, isolation distance, patch shape and habitat configuration (i.e. habitat amount on each diversity measure through a series of General Linear Models). We conducted 137 fixed-radius point-count surveys across 41 distinct forest patches during the austral breeding season. The explanatory variables in the top models had a significant effect on all avian diversity measures but habitat amount did not. The amount of habitat surrounding a patch was not significant for measures of bird diversity but based on the Akaike's weight it was important for avian specialist species. Isolation distance did not have a significant effect on the measures of bird diversity. These results show the importance of large forest patches for the conservation of forest birds and maintaining ecosystem functioning and services of forests in increasingly urbanising landscapes.

31 Respect thy neighbour: Human, black mamba and Mozambique spitting cobra interaction in the city of Durban, KwaZulu-Natal Province, South Africa.

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Anthropogenic land-use change especially urbanisation, generally affects biodiversity negatively. However, some species can persist in urban areas. The black mamba (*Dendroaspis polylepis*) and the Mozambique spitting cobra (*Naja mossambica*) are two snake species capable of living in urban landscapes. However, this likely leads to increased human-snake conflict. We are investigating aspects of the ecology, behaviour and gene flow patterns of black mambas and spitting cobras in the city of Durban, KwaZulu-Natal Province, South Africa. Since 2016 we have been retrieving, examining and recording both species presence within the city. Geographical location, body length and sex of each snake caught are recorded and tail tips obtained for genetic analyses, before their release. To date tail tips have been collected from 100 black mamba and 65 Mozambique spitting cobras from different locations throughout the city. Only three individuals have been recaptured. Most times both snake species are found in urban areas close to remnant natural forest. Experiences and attitudes of people from all sectors of Durban towards these snakes are being assessed and education awareness conducted to determine if human -snake conflict can be further mitigated.

32 Habitat use, population size estimation and assessment of factors affecting an urban exploiter, the tree agama: *Acanthocercus atricollis atricollis* (Squamata: Agamidae).

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Continued anthropogenic land-use change, especially urbanisation, has extensively impacted natural environments. Urbanisation has caused major alterations to ecosystems, generally resulting in decreased biodiversity. However, some species thrive in urban environments by making use of available opportunities and resources. The tree agama (Squamata: Agamidae), *Acanthocercus atricollis*, has reported population increases in urban areas, specifically in the KwaZulu-Natal Province, South Africa. We investigated aspects of their ecology (habitat use, microhabitat preferences,

population size) and behaviour to determine what factors influence their persistence within urban environments. Our study was conducted at two sites in Pietermaritzburg; an urban area (Azalea Gardens Retirement Village) and a periurban semi-green area (Maritzburg Golf Course). Agamas were marked with beads to identify individuals. Basking and shading patterns changed with season and time of day. We found that an increase in food availability, decreased predators and competition, and sufficient basking opportunities, promoted their population increase in the urban area, and that the tree agama is an urban exploiter.

Theme 6: Invasion biology

33 Controlling the Louisiana red swamp crayfish, *Procambarus clarkii* (Crustacea, Decapoda) populations in the Free State Province using various eradication methods.

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Procambarus clarkii is rated amongst the worst and widespread aquatic invasive alien fish species of the Astacidea family. *Procambarus clarkii* is responsible for great modifications in invaded environments, from outcompeting native species to altering food web composition and habitat structure causing irreparable ecological and economic damages. Its recent discovery in the Free State Province is a major cause for concern. In an attempt to eradicate *P. clarkii*, collapsible and minnow traps baited with fresh fish heads or dog food were used in addition to scooping the shoreline and hand searching in burrows. Catch per unit effort (CPUE) was 0.78 ± 0.19 ind./trap/night and 0.14 ± 0.04 ind./trap/night for fish heads and dog food, respectively. Minnow traps with fish heads had a CPUE of 1.2 ± 0.57 . Two *P. clarkii* were collected by scooping and 12 retrieved from burrows. Standard traps with fish heads should be considered as the appropriate method for intensively trapping *P. clarkii*. The action of trapping should also be supplemented by the active searches, scooping and possibly the introduction of a native predator to suppress the *P. clarkii* population.

34 Effects of indigenous southern African ungulates on seed dispersal and germination of the alien invasive lantana *Lantana camara* and bugweed *Solanum mauritianum*: a pilot study.

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Alien invasive plants negatively affect biodiversity, flourishing once established, and maintained by disturbance and seed dispersal. Avian seed dispersal is extensively documented, however terrestrial mammalian seed dispersal is relatively understudied. Here, we determined the effects of indigenous southern African ungulates on seed germination of the alien invasive lantana (*Lantana camara*) and bugweed (*Solanum mauritianum*). The objectives were: (1) to determine the community of potential ungulate seed vectors, and (2) to determine the effects of ungulate gut passage on germination success of bugweed. Using camera traps, field assessments of fruit consumption were conducted for five consecutive days at a time, followed by the collection of faecal samples from the vicinity of bugweed. The seeds were harvested for germination trials in a greenhouse with controlled temperature at the University of KwaZulu-Natal, Pietermaritzburg. We found that various ungulate species forage on the fruits of lantana and bugweed. There was greater seed germination for bugweed seeds that had passed through the gut of ungulates than those that were manually de-pulped or seeds in whole fruits. Ungulates form part of the long-distance dispersal network responsible for the spread these alien invasive plants. Further research pertaining to animal tracking may determine the magnitude of alien invasive plant dispersal.

Theme 7: Aquatic ecology and management

35 Real-time remote water quality, flow and ecological response monitoring of *Labeobarbus natalensis* in the uMngeni catchment using the FISHTRAC programme as a potential tool for resource managers.

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Anthropogenic factors are affecting riverine ecosystems globally. The uMngeni River in KwaZulu-Natal Province, South Africa, is a high use and economically important river with various dams established to support two major cities (Pietermaritzburg and Durban). We investigated the behavioural response of a potential indicator species as a means of measuring the ecological response of the ecosystem to water quantity and quality changes. We characterised the behaviour of yellowfish (*Labeobarbus natalensis*) within the uMngeni River using radio-telemetry (FISHTRAC) and concurrently measured water quantity and quality using water quality probes (probes). These probes are linked to the FISHTRAC programme through a Data Management System (DMS) and recorded pressure (converted to discharge), water temperature and conductivity. Probes were placed in the same reach as tracked *L. natelensis*, so that all variables (probes and tagged fish) can be recorded simultaneously onto the DMS. The preliminary results show that the use of fish movement in combination with the water quality data can be set at various limits to alert to potential water quality issues, acting as an early warning system for water resource managers.

36 Microplastic ingestion by selected filter feeders along the south-east coastline of South Africa.

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Microplastics have been identified as a key ecological threat in aquatic systems as these particles are routinely ingested by marine organisms, particularly filter feeders, which subsequently impact on their fitness. At present there are no studies on the ingestion of these particles by filter feeders along the southern African coastline. Study examined the seasonal and spatial variability in the ingestion of microplastics by four species of filter feeders: the mussels *Perna perna* and *Mytilus galloprovincialis* and the barnacles *Octomeris angulosa* and *Tetraclita serrata*, at two sites along the south-eastern coastline of South Africa. Sampling was conducted at Kenton-on-Sea, Eastern Cape, and Wilderness, Western Cape in July 2017 (winter) and January 2018 (summer). The ingestion of microplastics was determined using the acid digestion technique. Microplastic loads ranged from 2.57 ± 1.73 to 33.62 ± 19.74 microplastics.g⁻¹ *wwt* and demonstrated no significant species, spatial or temporal patterns. ($p > .05$ in all cases). Similarly, there were no significant spatial or temporal patterns in the size of the microplastics (range 1-16µm) ingested by the filter feeders. The absence of statistically significant differences in ingestion of microplastics by the filter feeders points to a ubiquity in the availability of microplastics within the water column in time and space within the region of study.

37 The status, distribution and abundance of South African freshwater fishes: A prelude to predicting the impacts of climate change on selected South African freshwater fish.

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Freshwater fishes face several anthropogenic threats that have resulted in a global decline in both their abundance and diversity; a trend that is starting to be observed in South Africa. One of the main threats to South Africa's freshwater fishes is climate change. Hence, understanding how freshwater fishes will be impacted under future climate change scenarios is pivotal if we are to implement adequate

conservation and management strategies to limit the number of species extinctions in these ecosystems. Considering this, we have begun investigating the impact of climate change on freshwater fishes within South Africa. Using Google Scholar and Web of Science, as well as records from the South African Institute for Aquatic Biodiversity (SAIAB), we set out to consolidate historic freshwater fish data, to better understand exactly where each species currently occurs. These data will then be incorporated into a single, publicly accessible database, which will serve as a baseline to aid in the development and fine-tuning of predicative species distribution models for select ecologically and commercially important species within the country. Ultimately a model of this ilk will be critical to truly understand the impact of climate change on all South Africa's freshwater fishes.

38

Ecological implications of the use of noxious arts on artisanal fisheries in the Albufeira de Chicamba Real Reservoir in Manica, Mozambique.

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The ecological implications of using noxious arts in practice of small-scale fishing were studied at Albufeira de Chicamba Real reservoir in Manica, Mozambique. We sought to identify the locations of landing and discard sites of the fish, the means and techniques used by fishermen and to examine the ecological implications of these practices. In order to reach the objectives, bibliographical research and field research data were used. Sixty-seven percent of the respondents landed and discarded fish on the riverbanks, whereas 33% did so in the middle of the river. Respondents used predominantly line fishing (54%) followed by traditional traps (21%), gill nets (16%) and mosquito nets (9%) to catch fish. These techniques led to a 42% removal of vegetation from the river berms, a 16% decrease in fishes of the Mozambique Tilapia species, a 16% increase in fish waste associated with the inappropriate disposal of fish and 26% of the destruction of fish breeding sites. The study recommends effective monitoring of fishing techniques and illegal fishing, as well as intensification of the sensitization of local communities in the use of sustainable techniques.

39

Stereological analysis of the effects of Trenbolone Acetate on gametogenesis in the ovaries of the fish, *Oreochromis mossambicus*.

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The increase in endocrine disrupting chemicals (EDCs) in the aquatic environment is of concern globally. Sources of EDCs include pharmaceuticals, personal care products and organic sewage. EDCs like trenbolone acetate (TBA) may cause masculinisation in fish. This includes the development of incipient dorsal pads in female which are histologically similar to those of males. The aim of this study was to qualitatively and quantitatively describe the histological changes in fish ovaries exposed to TBA. Adult *Oreochromis mossambicus* fish were exposed to two different concentrations (14.5 µg/L and 16.0µg/L) of TBA for 96 hours. The volume of the gonads was determined using weight displacement technique. Histological analysis was done using a light microscope to determine if there were any histological alterations due to exposure. Stereological analysis which entails the determination of the volume densities using the point count method was done. Histopathological alterations due to the exposure of fish to TBA included the disintegration of the vitellogenic theca layer, liquefaction of vitellogenic oocytes, fatty degeneration and atretic oocytes. Furthermore, an increase in melanomacrophage centres (MMCs) was observed in ovaries exposed to TBA. The stereological study showed that vitellogenic oocytes are the most abundant in ovaries of mature adult *O. mossambicus* female fish.

40 River connectivity and fish migrations a missing link in Water Resource Management in South Africa.

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In South Africa, the progressive water resource management legislation has resulted in new protection efforts to sustain water resources. The National Water act advocates the implementation of Resource Directed Measures (RDM) that include the determination of ecological requirements that are addressed in a trade-off process to establish suitable protection measures for water resources. In South Africa, the importance of river connectivity management and associated fish migrations are unknown and have not adequately been investigated. The Kruger National Park in South Africa is a world-renowned conservation area that has five major rivers flowing in an easterly direction through the park from high resource use areas upstream of the park. Although the Ecological Reserve for these protection prioritised ecosystems have been established and gazetted, the desired wellbeing of the systems has not been achieved. This has partly been attributed to river connectivity loss and disruptions of fish migrations. To mitigate these omissions, the role of river connectivity and associated ecosystem processes has been proposed to be integrated into an adaptive, use and protection trade-off processes for RDM. This has resulted in new water resource protection requirements for these resources that have major consequences to resources availability for use.

41 FishBOL-SA: DNA-barcoding of South-African linefishes.

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South African linefishes represent an important natural resource for the country, but overexploitation is posing a threat to both the stocks and the communities relying on them. To ensure the sustainable use of this natural resource, management policies need to be improved and implemented. Good knowledge of species biodiversity is a prerequisite to any management policy/actions. Traditional taxonomy alone has shown some limits. The use of DNA barcoding can help to address the issue of rapid and reliable species identification, but it is critical to rely on a reference database built using the national collection. This may be accomplished following an integrated approach generating high-quality molecular data for a collection of voucher specimens identified by taxonomic experts. Using both the BOLD database and the sequencing of new specimens, we assembled such a reference database for 139 of the most common South African linefish species. This increased the number of reference DNA barcodes and identified the targets for future barcoding projects identified. From the new database, we can also recognise possible misidentifications and cryptic species and highlight areas for more research regarding sequence quality. The present work opens new perspectives on the study of linefish biodiversity around South Africa and has implications on the management of this resource.

42 Bloodworm used as bait: identification and genetic structure.

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Bloodworms are polychaete worms that are frequently harvested to use as bait by fishermen in South Africa. These worms have been identified as 'any species of the genus *Arenicola*' although only one species of this genus has been described locally, and species of a second genus, *Abarenicola*, may potentially be used as bait. Limited research has been conducted to support the daily bag limit of five worms per permit-holder. This study aimed to determine which species are collected as bloodworm bait and to investigate their population structures to determine whether populations are isolated and potentially vulnerable to local extinction. Bloodworm were collected from seven sites in the Western

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Cape and one site in the Eastern Cape. *Arenicola loveni* was collected at all sites, while *Abarenicola gilchristi* was collected at only one site in the Western Cape. Using the COI gene, Bayesian Inference and haplotype network analyses of *A. loveni* indicated that the western and southern populations were isolated from each other. Furthermore, from among a total of 29 haplotypes produced, 23 were private, indicating little gene flow among populations. This provides strong evidence to suggest that individual populations may be vulnerable to local extinction if over-exploited.
