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# AHN

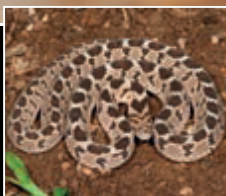
AFRICAN HERP NEWS



**Southern Rock Python**  
Predation by Carnivores



**Boomslang**  
Melanistic Coloration



**Montane Egg-eater**  
Diet and Distribution



**Mapacha Ridged Frog**  
Distribution

# HAA

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The HAA is dedicated to the study and conservation of African reptiles and amphibians. Membership is open to anyone with an interest in the African herpetofauna. Members receive the Association's journal, *African Journal of Herpetology* (which publishes review papers, research articles, and short communications – subject to peer review) and *African Herp News*, the Newsletter (which includes short communications, natural history notes, book reviews, bibliographies, husbandry hints, announcements and news items).

## NEWSLETTER

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Articles shall be considered for publication provided that they are original and have not been published elsewhere. Articles will be submitted for peer review at the Editor's discretion. Authors are requested to submit manuscripts by e-mail in MS Word '.doc' or '.docx' format.

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COVER PHOTOGRAPH: *Chondrodactylus angulifer*  
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HERPETOLOGICAL ASSOCIATION OF AFRICA

12<sup>TH</sup> CONFERENCE

**GOBABEB, NAMIBIA**

PLENARIES & GUEST SPEAKERS

**Primates and snakes:  
An 80 million year dialog?**

HARRY W. GREEN

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**Abstract.**— In this lecture I will describe evidence and uncertainties in an emerging theory that 1) As first constricting predators and, much later, venomous adversaries, snakes have significantly influenced the origin and subsequent radiation of primates, especially in terms of the neurobiology of vision and fear; 2) the origin of front-fanged venom injection radically changed the nature of snake encounters with their own predators, such that visually- and acoustically-oriented, cognitively sophisticated adversaries promoted the evolution of serpentine defensive displays and mimicry; 3) As visual, acoustic, cognitive, and *weapon-wielding adversaries*, primates have substantially affected snake evolution, including perhaps favoring origin of the only long-distance weaponry among all serpents. These long-term, bi-directional evolutionary relationships both challenge and potentially inspire efforts to appreciate and conserve snakes.

Key Words.— snakes, primates, venoms, predator-prey relationships, evolution

**Discovery of a new Tiger Snake  
in the central and northern Namib**

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**Abstract.**— Gobabeb was established because Dr Charles Koch was greatly impressed by the entomological biodiversity of the Namib. However, during summer evenings the chorus of different barking geckos is an indication of the herpetological diversity of this area. A while ago the discovery of a new Tiger Snake (*Telescopus finkeldeyi*) in the northern Namib in Angola led to intensive investigations of major herpetological collections. This showed that the new species was first encountered in Namibia while trying to decide on a site for this research station.

# Shifting Sands of Time History and future of Gobabeb

MARY SEELY

*Gobabeb Research and Training Centre & Desert Research Foundation of Namibia*

Ever since the University of California, Berkeley, and the Transvaal Museum, Pretoria, embarked on an expedition through the southern Namib and Kalahari, an interest was generated in the herpetology and the entomology of the area. Dr Charles Koch then continued expeditions through the Transvaal Museum that extended from the Olifants River in South Africa to well north of the Curoca River in Angola and all of Namibia in between.

As a result of these expeditions Dr Koch and the Transvaal Museum agreed to support a research centre in the Namib for which Gobabeb was thought to be an appropriate site. Wulf Haake and Bob Brain were two of the active herpetologists in the early days.

Through time the emphasis shifted from biodiversity to encompass geomorphology including sand dune dynamics, climate contributing to understanding of climate change and ongoing monitoring of the biota of the fog ecosystem.

With independence of Namibia the emphasis at Gobabeb shifted to education and training but all the time including the results of all types of research. Herpetology continues to be one of the focal points of this research and education at Gobabeb.

## Stable isotope ecology of Namib Desert lizards

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We used a stable isotope approach to examine the trophic niches of two species of sympatric, insectivorous lizards in the Namib Desert, the lacertid *Pedioplanis husabensis*, and the gekkonid *Rhoptropus bradfieldi*. We analyzed the carbon and nitrogen stable isotope ratios in plant tissues, available arthropod prey, and lizard tissues to map the movement of nutrients through plants, arthropods, and lizards, as well as to quantitatively estimate the size and position of *P. husabensis*'s and *R. bradfieldi*'s trophic niches. We found no to moderate levels of overlap in the trophic niches of these two lizard species and showed that the trophic niche of *P. husabensis* was 1.3 – 2.6 times larger, with a higher degree of trophic diversity among individual lizards, than that of *R. bradfieldi*. We concluded that these sympatric species are coupled to non-overlapping avenues of nutrient flows through the use of isotopically distinct arthropod resources, and that despite the very high available biomass of C3 plant-based nutrients, these two lizard species rely heavily on a food web based on C4/CAM-based plant resources.

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HERPETOLOGICAL ASSOCIATION OF AFRICA

12<sup>TH</sup> CONFERENCE  
**GOBABEB, NAMIBIA**  
ORAL PRESENTATIONS

**Are ambush-foraging and  
thermoregulation mutually exclusive?  
A test using Puff Adders  
(*Bitis arietans*)**

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**Abstract.**– Foraging mode has a pervasive impact on snake biology. For example, studies have related ambush foraging to snake morphology, anatomy, digestive physiology, metabolism, prey selection, spatial ecology and behaviour. However, few studies have considered the thermal implications of ambush foraging even though body temperature ( $T_b$ ) is known to have a profound impact on performance in snakes. Several of the characteristics associated with ambushing foraging, such as immobile concealment while foraging, would seem to be incompatible with thermoregulatory behaviour. I searched for evidence of thermoregulation in the Puff Adder (*Bitis arietans*), an extreme ambush forager, using standard telemetry and bio-logging techniques. I assessed thermal profiles of Puff Adder  $T_b$ , using Peterson *et al.* (1993)'s defined thermoregulatory patterns, to detect evidence of thermoregulation. I assessed thermoregulation in each of the three Puff Adder seasons: feeding (October to February), mating (March to May) and resting (June to September). Puff Adders showed clear evidence of thermoregulation and regularly attained target  $T_b$  (~32 °C) during the day, especially during the feeding and mating seasons. Gravid females thermoregulated more carefully, attaining target  $T_b$  more consistently than other individuals. Puff Adders can, potentially, make thermal choices at three different scales: firstly by choosing lie-ups with appropriate thermal characteristics, secondly, by moving short distances from ambush lie-ups to thermally-buffered microhabitats, and thirdly, by using minor adjustments of body position. My study suggests that Puff Adders thermoregulate at all three levels and generates testable hypotheses for future behavioural studies.

**Key Words.**– foraging ecology, thermoregulation, target body temperature

## Conservation strategies for KwaZulu-Natal's threatened anuran fauna

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**Abstract.**— KwaZulu-Natal hosts the highest frog diversity, and the second highest number of threatened frog species, in South Africa. Using the conservation research strategy developed for South Africa's threatened frogs as a guide, we have developed and implemented several conservation actions for the following species: the Kloof Frog, *Natalobatrachus bonebergi* (Pyxicephalidae), the Long-toed Tree Frog *Leptopelis xenodactylus* (Arthroleptidae) and Mistbelt Chirping Frog *Anhydrophryne ngongoniensis* (Pyxicephalidae), all Red Listed as Endangered. In accordance with Ezemvelo KZN Wildlife's norms and standards, surveillance and monitoring plans have been developed and are being tested for each of these species (as well as Pickersgill's Reed Frog, *Hyperolius pickersgilli*). For *N. bonebergi*, a method using egg-clump counts provides a means of assessing breeding success and gives an indication of abundance. KZN Wildlife Honorary Officers at Vernon Crookes Nature Reserve volunteered their time to test the monitoring plan between November 2013 and June 2014, resuming in August 2014. Call surveys are being used to monitor *L. xenodactylus* and *A. ngongoniensis*. In addition, distribution modelling has been conducted for each of these species to help guide surveys and assist in finding populations for monitoring and surveillance, assess threats and understand dispersal modes. A new project on *A. ngongoniensis* will commence in 2015, including implementation of recommended management practices and initiation of land-owner agreements to protect priority grassland habitat for this species. **Key Words.**— conservation research, threatened frogs, monitoring, distribution modelling, citizen science

## Phylogeny, taxonomy and biogeography of southern African leaf-toed geckos

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**Abstract.**— Leaf-toed geckos of mainland southern Africa were previously placed in the genera *Goggia*, *Afrogecko* and *Cryptactites*. Data from nuclear and mitochondrial genes, supported by morphology, reveal that *Afrogecko* is paraphyletic with respect to both *Cryptactites* and the Australian genus *Christinus* and that *A. swartbergensis* (Cape Fold Mountains) and *A. plumicaudus* (southern Angola) should be placed in monotypic genera — *Ramigecko* and *Kolekanos*, respectively. *Goggia*, endemic to

the Cape region of South Africa and adjacent parts of far southern Namibia, is only distantly related to this clade and is strongly supported as monophyletic. We estimated a multigene phylogeny for all species of *Goggia* in order to test for the presence of cryptic lineages and infer its biogeographic history. Patterns of relationship within *Goggia* support all species previously recognised on the grounds of morphology and allozymes, but additional taxa are also revealed. The large-bodied *G. microlepidota* is sister to a clade comprising all small bodied (*G. lineata* complex) forms. Within the *G. lineata* complex, the earliest divergence is between eastern and western sets of species and continued geographic isolation across the Cape Fold Mountains has played a major role in promoting speciation within the group. *Goggia lineata* itself is not monophyletic, and specimens from the Western Cape are assignable to a new species. In addition, a previously undescribed species is present in the Little Karoo. Additional deep genetic divergences, perhaps reflecting more cryptic species, are present within other currently recognized *Goggia* species.

Key Words.— *Goggia*, *Afrogecko*, *Kolekanos*, *Ramigekko*, molecular phylogenetics

## Reptile Diversity in southwest Angola

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**Abstract.**— Desert and succulent semi-arid scrublands extend along the Atlantic lowlands from Namaqualand to southwest Angola. Numerous studies have highlighted the unique herpetofauna associated with these hyper- and semi-arid habitats, from which forty new species have been described in the last 50 years. Along the southern border of Namibia the Richtersveld-Sperrgebiet region straddles the Orange River, and the rugged landscape and geological complexity of the region hosts a herpetological hotspot. Similar topographic diversity occurs along the northern border of Namibia, where the Kunene River separates the Kaokoveld and desert habitats of adjacent Angola. In recent years this northern region has become increasingly accessible, permitting study of the poorly-known herpetofauna. Recent discoveries in SW Angola (2009-2013) include the description of three new lizards, and the discovery of other novelties that await description. These findings are combined with collections from earlier explorations and now permit a preliminary summary of the herpetofauna of this poorly-known region of Angola. This is compared and contrasted with that of the Richtersveld-Namaqualand region.

Key Words.— Angola, reptiles, diversity

# A preliminary review of the western forms of the *Gerrhosaurus nigrolineatus* Hallowell species complex (Sauria: Gerrhosauridae) in Africa

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**Abstract.**— A recent molecular analysis indicated that *Gerrhosaurus* actually comprises three genera – *Gerrhosaurus*, *Broadleysaurus* and *Matobosaurus*. Within *Gerrhosaurus*, *G. bulsi* was the sister species to a clade containing *G. nigrolineatus*, *G. auritus* and *G. intermedius*. These four species, with the probable inclusion of *G. multilineatus* (not included in the molecular analysis), formed a closely-related ‘*G. nigrolineatus* species complex’ with a widespread distribution in Africa. West-Central African *G. nigrolineatus* were shown to be most closely related to *G. auritus* rather than to *G. nigrolineatus* from East and southern Africa; and the latter populations therefore represent a separate species for which the name *G. intermedius* is applicable. The results of this molecular analysis re-stimulated a morphology-based review of the *G. nigrolineatus* complex in western and south-western Africa initiated by the first author about 15 years ago. Although there is substantial overlap in scale counts, the various species can often be distinguished on the basis of their dorsal colour patterns, and *G. bulsi* also has a strongly armoured and spinose tail base. *Gerrhosaurus nigrolineatus* (Gabon, Congo, western D.R.C. and northern Angola) and *G. intermedius* (East and southern Africa, Angola and southern D.R.C.) differ with regard to colour pattern, degree of keeling on the soles of the feet, and numbers of longitudinal rows of dorsal scales. *Gerrhosaurus auritus* occurs mainly in Botswana and SW Zambia. Certainty on the status of *G. multilineatus* was particularly problematic as its vague description was based on a few subadults only, all of which were destroyed in a fire at the Museu Bocage in Lisbon in 1978. However, a recent examination of a large series of Angolan *Gerrhosaurus* at the American Museum of Natural History in New York by the second author provided insight into variation in tail spinosity and dorsal colour pattern, indicating that *G. bulsi* is in fact a junior synonym of *G. multilineatus* (Angola, Zambia and adjacent D.R.C.). We note that for widely distributed reptile taxa, unless detailed morphological analysis is conducted on museum material in the wake of molecular findings, zoogeography is rendered chaotic.

**Key Words.**— *Gerrhosaurus*, taxonomy, morphology, Africa



# Effects of predation risk, competition and climatic factors on the activity patterns of *Ouroborus cataphractus* and *Karusasaurus polyzonus* (Squamata: Cordylidae)

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**Abstract.**— Weather fluctuations have considerable impact on life-history traits in ectothermic organisms. For instance, favourable ambient temperatures can promote activity, while variation in precipitation can stimulate activity through its effects on food availability, especially in arid environments. Under certain conditions, however, inactivity might have a selective advantage over activity, as it increases survival by reducing exposure to predators and lessening intraspecific competition for shared food resources. Consequently, competitive and predatory pressures should influence the effect of abiotic factors on activity patterns in ectotherms. Using remote camera traps we recorded long-term activity patterns in the two closely related sympatric cordylid lizards *Karusasaurus polyzonus* and *Ouroborus cataphractus*. The former species is a solitary fast-moving lizard, while the latter is a heavily armoured lizard that permanently lives in groups. The significant interspecific difference in anti-predator morphology and social behaviour allowed us to unravel the effects of predation, competition and weather on the activity patterns of the two study species. Our results show that activity in *K. polyzonus* predominantly occurs during the dry season, when ambient temperatures are favourable enough to permit activity. Unsurprisingly, temperature was the best predictor of activity in this species. In contrast, a peak in activity during spring, coinciding with high food availability, was observed in *O. cataphractus*. Individuals are inactive during most of the dry season or restrict their activity to early morning and late-afternoon. High activity peaks, however, were observed after occasional summer rainfall. Contrary to *K. polyzonus*, none of the weather variables served as good predictors of activity. The selective inactivity displayed by *O. cataphractus* appears to be a survival strategy related to the high intraspecific food competition and increased predation risk experienced during the dry season.

**Key Words.**— activity time, climatic predictors, group-living behaviour, sit-and-wait foraging

# Digitizing Angolan and Namibian herpetological collections: Angolan collections in Portuguese natural history institutions

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**Abstract.**— Natural history collections are the main repository of biodiversity data. In recent years, initiatives such as GBIF and VertNet have made a great effort to digitize these data and make them available worldwide to researchers, conservationists, local and international authorities. Angola and Namibian collections are scattered across many museums in the world, and the majority are neither digitized nor georeferenced and thus not easily available to the scientific community. We recently initiated a project to digitize and georeference the Angolan and Namibian herpetological collections, and we present a first update on that work here. To date, we have digitized all the Angolan herpetological collections that exist in Portuguese natural history institutions. The majority of the Angolan herpetological collections, including the important Bocage type specimens, were lost in the fire that destroyed the collections of Museu Bocage, Lisbon in 1978. Today three Portuguese institutions still hold relevant Angolan collections: the Instituto de Investigação Científica Tropical (Lisboa), the Museu da Ciência (Coimbra), and the Museu de História Natural da Universidade do Porto (Porto). While these three collections are small, they hold collections from unique localities and some type specimens. We will present preliminary results and discuss the next states of this project.

**Key Words.**— Angola, georeferencing, biodiversity informatics, museum collections, Portugal

## Investigator Norm N. Clature solves the Maluti Mystery

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**Abstract.**— This tale has it all. Dead bodies, missing evidence, mistaken identities, blood smears, an odd scientist, and at least three different groups supporting opposing views. It seems that there have been many claimants to the senior position in the mountain village of Mont-aux-Sources, although some have been harshly dealt with, and others ignored. The offspring from different branches in the family tree

resemble each other, and DNA evidence shows that offspring from one family were fathered by males from another family. Sifting carefully through the babble, examining all the available evidence, and following the rules, Norm succeeds in solving a puzzle that dates back nearly a century.

Key Words.— taxonomy, Maluti River Frog, Phofung River Frog, Drakensberg, *Amietia*, *Strongylopus*

## Complex spatial genetic patterns and extensive secondary contact in the Spotted Sand Lizard (*Pedioplanis lineocellata*)

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**Abstract.**— The Spotted Sand Lizard, *Pedioplanis lineocellata*, is widespread across much of southern African found primarily in open habitats. Recent work uncovered four mitochondrial DNA clades which were previously unknown. The formation of these clades is thought to be linked to the Plio-Pleistocene glacial cycles. Furthermore, two of the most geographically widespread clades occur sympatrically in the Loeriesfontein region which has raised questions of possible hybridisation. To investigate gene flow between the latter two clades, samples were profiled at nine microsatellite markers and genetic patterns assessed using estimates of divergence and migration, and a discriminant analysis of principle components. While measures of genetic differentiation and the proportion of recent migrates at each population supports greater gene flow over a few 10s of kilometres and far less over 100s of kilometres, there was no isolation-by-distance pattern. This suggests that gene flow is influenced by barriers or environmental resistance to gene flow. Microsatellite genetic clusters did not match mitochondrial clades which was interpreted as evidence of recent gene flow between the two clades. Hybridisation at Loeriesfontein could not be detected because mitochondrial clades were not genetically distinct in terms of microsatellite loci investigated. Mitochondrial lineages may occur sympatrically at places other than Loeriesfontein but were not sampled by chance because of small sample sizes in the previous study. The regions of overlap between mitochondrial clades may be more extensive than previously thought. Further clarity regarding the formation of clusters awaits more comprehensive sampling.

Key Words.— *Pedioplanis lineocellata*, microsatellite, mitochondrial DNA, gene flow, isolation-by-distance, hybridisation

## The survival and dispersal of Cape *Xenopus* (Anura: Pipidae)

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**Abstract.**— The genus *Xenopus* (Anura: Pipidae) is a principally aquatic group of frogs occurring throughout sub-Saharan Africa. There are two species present in the south Western Cape; the widespread *Xenopus laevis* (Common Platanna) and the Endangered *X. gilli* (Cape Platanna). During the winter rains, *X. laevis* move into *X. gilli* sites where both species breed. This creates conditions for competition, hybridisation and direct predation. In this study we principally investigated the difference in survival between *X. laevis* and *X. gilli* during their shared winter occupancy and compare these to survival of an *X. gilli* population where *X. laevis* are removed (Cape of Good Hope Nature Reserve). In addition, we also investigated the difference in dispersal of these two species. Preliminary results indicate that *X. laevis* have higher survival than *X. gilli*, however there is no difference in the survival of the two *X. gilli* populations. We also show that *X. laevis* (Mean: 312 ± 89 m; Max: 439 m) have dispersed further than *X. gilli* (Mean: 241 ± 151 m; Max: 533 m), although the difference is not significant.

Key Words.— dispersal, interaction, survival, *Xenopus laevis*, *Xenopus gilli*

## Is dietary niche breadth linked to morphology and performance in sandveld lizards *Nucras* (Sauria: Lacertidae)?

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**Abstract.**— The functional characteristics of prey items (such as hardness and evasiveness) have been linked with cranial morphology and performance in vertebrates. In lizards particularly, species with more robust crania generally feed on harder prey items and possess a greater bite force, whereas those that prey on evasive prey typically have longer snouts. However, the link between dietary niche breadth, morphology, and performance has not been explicitly investigated in lizards. The southern African lacertid genus *Nucras* was used to investigate this link because the species exhibit differing niche breadth values and dietary compositions. A phylogeny for the genus was established using mitochondrial and nuclear markers, and morphological clusters were identified. Dietary data

of five *Nucras* species, as reported previously, were used in correlation analyses between cranial shape (quantified using geometric morphometrics) and dietary niche breadth, and the proportion of hard prey taken and bite force capacity. Dietary niche breadth and the proportion of hard prey eaten were significantly related to cranial shape, although not once phylogeny was accounted for using a phylogenetic generalized least squares regression. The proportion of evasive prey eaten was a significant predictor of forelimb length when phylogeny was taken into account. We conclude that, in *Nucras*, the percentage of evasive prey taken co-evolves with forelimb morphology, and dietary niche breadth co-evolves with cranial shape. However, although head width is correlated with the proportion of hard prey eaten, this appears to be the result of shared ancestry rather than adaptive evolution.

Key Words.— bite force, co-evolution, geometric morphometrics, phylogenetic generalized least squares regression, phylogeny, southern Africa, sprint speed

## Home on the range: Spatial interaction of two sympatric tortoises (*Psammobates oculifer* and *Stigmochelys pardalis*) in the thorn-bush savanna of central Namibia

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**Abstract.**— The opportunity to study the ecology of sympatric tortoise species is rare, nonetheless one place it is possible is southern Africa, home to more than one third of the world's 45 tortoise species. Due to its Africa-wide geographic distribution and large size, the Leopard Tortoise (*Stigmochelys pardalis*) has been relatively well-studied. However, its interaction and potential for competition with sympatric species is less understood. In the thorn-bush savanna near Windhoek, this species occurs sympatrically with the smaller Kalahari Tent Tortoise (*Psammobates oculifer*). We are studying the habitat (micro-climate and ecology), thermal ecology and movement patterns of translocated tortoises (seven *P. oculifer* and six *S. pardalis* discussed here). In this talk we present our preliminary findings on home range and core activity area within and between species. We use minimum convex polygon to delineate the extent of the home range and kernel density estimation to delineate the core activity area within the home range. We characterize differences in the spatial distribution of the core activity areas within and between species, and overlap as a possible indicator of competitive interaction. GPS loggers (30 min logging interval) have recently been attached to three *P. oculifer* and two *S. pardalis*. We will discuss in brief these new findings.

Key Words.— *Psammobates oculifer*, *Stigmochelys pardalis*, home range, GPS logger

## It's about time for sentinels: the tortoise in the coal mine

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**Abstract.**— Understanding patterns of conservation status within and among taxa, ecological guilds, life history strategies and trophic levels can inform important avenues for conservation, and the use of indicator or sentinel species. Although nearly half of all chelonian species are threatened with extinction, is it imprudent to consider chelonians as sentinels analogous to ‘the canary in the coal mine’. Chelonian biology, from behaviour and reproductive physiology (e.g., rates of vitellogenesis) to life histories and evolutionary rates, is starkly slow compared to that of the ‘canary’ or ‘hare’ (e.g., snowshoe hare and jackrabbit) sentinels. We can quickly detect the significant decline of canary sentinels to short-term, acute changes in the environment (e.g. an annual drought). However, chelonian physiology enables them to endure and survive such impacts. By the time we detect impacts on chelonians, the environment may be severely compromised (e.g., by plant invasions and altered fire regimes) and extremely expensive or impossible to recover. While the reproductive potential of canary sentinels enables their populations to recover quickly (e.g., for snowshoe hares, 250% to 3000% increases per year), the slow chelonian physiology and reproductive potential (ca. 2% to 10% per year) allows only extremely slow rates of population recovery. Consequently, enhancing chelonian reproduction is still a slow means to recover chelonian populations affected 20% to 98% by extended droughts and anthropogenic effects (e.g., fire, disease, plant invasions or introduced predators). Models indicate that enhancing adult survivorship, which naturally often exceeds 90% annually, may be effective towards population recovery. Also, we may be able to cost-effectively conserve individual diversity and affect population recovery by enhancing juvenile survivorship (typical annual rates ca. 50% to 80%) which has a large room for improvement, and can affect a large portion of populations. Canary and chelonian sentinels indicate considerably different conditions of the environment.

**Key Words.**— chelonian, rates, conservation, sentinel

## Adaptive simplification and the evolution of gecko locomotion

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**Abstract.**— Geckos are known for their remarkable ability to adhere to smooth and/or inclined surfaces using adhesive toe pads. As well as the multiple instances of the acquisition of adhesive capabilities, the secondary loss of the morphological modifications associated with adhesion has been reported for

several lineages. The *Pachydactylus* clade exhibits two unequivocal losses of the adhesive apparatus (*Chondrodactylus angulifer* and *Pachydactylus rangei*), and several cases of simplification (e.g., *Rhoptropus afer* and *Colopus wahlbergii*). This clade occupies both sandy and rocky habitats in southern Africa, and the secondary loss (or simplification) of adhesion appears linked to shifts in habitat use, from climbing to ground dwelling. Although the gain and loss of adhesion has been documented, little is known of the resulting functional consequences. Utilizing 14 species from the *Pachydactylus* clade and one outgroup (*Tarentola annularis*), we examined the morphometric changes associated with the reduction and loss of adhesion. We also explored the three-dimensional hindlimb kinematics of pad-bearing and secondarily padless/simplified taxa, using high speed videography, to determine the functional consequences of the simplification and loss of the adhesive apparatus. To examine morphology and kinematics in a phylogenetic framework, we developed trees based on existing sequences from four genes. We then used both Brownian motion and Ornstein–Uhlenbeck models of character evolution to compare changes in the evolutionarily rates and lability of locomotory traits in clades where adhesion is retained versus in clades where adhesion is reduced or lost. The rates of both morphological and kinematic evolution were elevated in the group with simplified/lost adhesive systems, suggesting that constraints placed on locomotion by the adhesive system were released. Supported by NSF IOS-1147043.

Key Words.— gecko, Namibia, *Pachydactylus*, locomotion, biomechanics

## Tortoise (Testudines: Testudinidae) radiation in southern Africa from the Oligocene to present

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**Abstract.**— Ten of the 16 extant tortoise genera are endemic to the African Region. Southern Africa has exceptionally high testudinid diversity with five genera and 14 species, but the diversity at the generic and species level may be even greater than is reflected by the current taxonomy. The aim of this study was to clarify evolutionary relationships among, and the diversity of, testudinids in southern Africa. We used three mitochondrial (16S, 12S and ND4) and two nuclear (prolactin and R35X) DNA loci in conjunction with fossil data to produce a dated phylogeny, and examined cladogenic events in context of palaeoclimatic shifts and landscape heterogeneity. Using Kinixys and the Malagasy genera, *Pyxis* and *Astrochelys*, as outgroups, the southern African tortoises form a well-supported clade and our phylogeny comprises of two major lineages. The earliest divergence contains two species, *Homopus femoralis*

and *Homopus areolatus*, whereas the second lineage is more diverse and consists of two clades. Clade one comprises *Chersina angulata* and the remaining *Homopus* species; *H. boulengeri*, *H. signatus* and *H. solus*. Clade two includes *Stigmochelys pardalis* and all *Psammobates* species and subspecies. As *Homopus* is shown to be paraphyletic, we propose to resurrect *Chersobius*, which increases to six the number of testudinid genera in the subcontinent. Substantial genetic differentiation within terminal branches points towards radiation events from the Late Miocene onwards, as well as the presence of several cryptic lineages. For example, *Psammobates tentorius* consists of four terminal branches, indicating greater diversity than represented by the currently recognized three subspecies. We propose that the development of east-west and north-south aridity gradients, the onset of rainfall seasonality and changes in landscape heterogeneity were important drivers in the diversification of southern African testudinids throughout the Miocene and Pliocene.

Key Words.— *Chersina*, *Chersobius*, dated phylogeny, *Homopus*, Miocene, Palaeoclimate, *Psammobates*, *Stigmochelys*

## Geographic variation in body size and diet among elapid snakes

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**Abstract.**— Snakes represent one of the most remarkable radiations of any vertebrate group. Because they have evolved a number of unique morphological, physiological and behavioural adaptations for prey capture, diet is thought to have played a significant role in this radiation. We assessed the variation in the diets of the elapid snakes, one of the most speciose and widespread snake lineages. We collected information about the consumption of ten prey classes for 303 species (approximately 86% of all species). Hierarchical cluster analysis revealed five major dietary groups characterised respectively by: (A) terrestrial vertebrates especially endotherms; (B) terrestrial vertebrates especially ectotherms; (C) fish or invertebrates; (D) broad representation of most prey classes; and (E) squamates especially snakes. Body size varied significantly among species of the different dietary groups: species representing diet A were much larger, and species representing diet B were much smaller, than those representing diets C, D, and E. Similarly, variation in body size, as measured by coefficient of variation emphasised the remarkable Australasian radiation, with Afrotropical species also exhibiting high diversity in body sizes. Dietary groups were not equally distributed among zoogeographic regions. Afrotropical elapids had the largest mean body size and were significantly larger than the Australasian and Neotropical radiations. Our work demonstrates the extent of variation in morphology and ecology of elapids globally, and provides the natural historical context for understanding diversification and biogeography of this medically important group. Our future analyses will make use of this extensive database to test the impact of dietary trait shifts in a phylogenetic context.

Key Words.— radiation, diet, Elapidae, biogeography



## Does climate change drive extinction risk in Namibian lizards (Lacertidae)?

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**Abstract.**— Reptiles are supposed to be relatively invulnerable to the ongoing rapid anthropogenic climate change as they are able to actively regulate their body temperature ( $T_b$ ) through behaviour, tolerate high  $T_b$  and resist water loss. However, recent studies have shown that lizards and snakes seem to be more at risk than previously expected. In Mexico, increased local extinction probability in lizards correlated with the magnitude of warming during the reproductive period, questioning the assumption of climate invulnerability. We tested the hypothesis that different lizard species of the family Lacertidae are vulnerable to rises in maximum temperatures in Namibia, especially in the Namib and the Kalahari. We predicted that inhabiting different habitats with different microhabitat temperatures and different preferred  $T_b$  within different distribution ranges would result in differences in local extinction probability. As opposed to other studies our model integrates past and present distributions verified by museum collections and ground-truthed, a quantifiable physiological parameter (preferred body temperature  $T_{pref}$ ) and available operative temperatures in correlation to air temperatures. Data was collected for 17 species (*Meroles anchietae*, *M. cuneirostris*, *M. suborbitalis*, *M. ctenodactylus*, *M. reticulatus*, *M. micropholidotus*, *M. knoxii*, *Pedioplanis namaquensis*, *P. laticeps*, *P. lineocellata*, *P. breviceps*, *P. rubens*, *P. undata*, *P. inornata*, *P. gaerdesi*, *P. husabensis* and *Heliobolus lugubris*). Our first results seem to indicate that populations of at least one of the tested species were extirpated (both predicted by the model and verified) in the hottest area of its distribution range due to increased maximum temperatures during the reproductive season since the mid-1970s. Furthermore, different extents in future extinction risk are predicted under consideration of the currently accepted climate change scenarios. It seems that Namibian Lacertidae under current conditions already live at their thermal maximum.

Key Words.— climate change, preferred body temperature, lacertidae, Southern Africa, extinction risk

## Treatment of snakebite in domestic animals

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**Abstract.**— I have practised as a veterinarian with farm and companion animals since the 1970s, gaining experience mainly in the Hartbeespoortdam area of North West Province, South Africa, Namibia (North and South), Natal (Coastal and Midlands) and the Highveld region of Gauteng. My interest in reptiles and amphibians involves mainly those indigenous to southern Africa. In all incidents of snakebite, an

attempt is made to identify the species of snake responsible. Over time our practice has developed a protocol to deal with cases involving dogs – we deliver practical, effective treatment at as low a cost as possible. Patients are admitted to hospital as soon as possible and assessed. Serious cases are given full-scale treatment. For moderate cases, treatment is adapted to needs and progress of the case. Mild cases receive palliative treatment and observation of progress. Companion dogs form the majority of snakebite cases. Domestic cats are rarely bitten by venomous snakes. I have not yet come across a proven snakebite involving any type of farm animal. Polyvalent antivenom (SA Vaccine Producers) is the essential mainstay of treatment for serious and moderately severe envenomation. Intravenous fluid therapy, respiratory support, painkillers and anti-inflammatories are ancillary treatment. The primary species of snake involved in my personal experience are, in order of importance, Puff Adder (*Bitis arietans*), Bushveld Cobra (*Naja annulifera*), Mocambique Spitting Cobra (*Naja mossambica*; venom in eyes a very common problem), Night Adder (*Causus rhombeatus*) and Rinkhals (*Hemachatus haemachatus*).

Key Words.— veterinarian, dogs, cats, polyvalent antivenom, envenomation

## **Phylogenetic relationships in the *Pachydactylus capensis* species complex (Sauria: Gekkonidae) of southern Africa**

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**Abstract.**— The *Pachydactylus capensis* species complex (*P. capensis*, *P. affinis*, *P. vansoni*, *P. tigrinis*, *P. oshaughnessyi*) has an extensive distribution in southern Africa. We aim to test species/population boundaries within the *P. capensis* species complex using large samples. Preliminary analysis based on sequence data from 16S rRNA indicated three major clades corresponding with *P. capensis*, *P. vansoni* and *P. affinis*. Within *P. capensis*, there were two major groups, whereas in *P. affinis* there were two major groups with as many as four species. Although *P. capensis* is considered a terrestrial species, some specimens have been collected in rocky, mountainous habitat. Other molecular markers will also be employed to construct the phylogeny, and to determine genetic boundaries across the range of the species complex taking habitat and ecology into consideration. Findings will be used to update the taxonomy of the group in an evolutionary context as the existence of cryptic lineages is suspected.

Key Words.— reptiles, Thick-toed Gecko, phylogenetics, genetic diversity, morphology

## A summary of snakebite in Zululand

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**Abstract.**— With its favourable climate, much of Zululand has an abundance of snakes. Snakebites are regularly reported with the majority occurring in the warm, wet months from December to April. Over 1200 victims are hospitalised annually in the Zululand, Uthungulu and Umkhanyakhude districts with approximately two thirds of victims showing signs of envenomation. While most snakebite victims got to the hospital within six hours, some were admitted more than 16 hours after the bite. 10% of the victims were treated with antivenom. Over 95% of victims experienced classic cytotoxic envenomation with excessive pain, swelling and in many cases, subsequent tissue damage. The average stay in hospital was three days. The early administration of polyvalent antivenom was highly effective in reducing the area of necrosis and fatalities were rare. Over 40% of victims experienced some level of allergy to the antivenom with 20-40% of those victims going into anaphylactic shock. A bivalent antivenom for *Naja mossaambica* and *Bitis arietans*, and one that does not cause such a high percentage of allergic reaction is needed.

**Key Words.**— Snakes, snakebite, Zululand, cytotoxic envenomation, *Bitis arietans*, *Naja mossaambica*, antivenom, anaphylaxis

## Dietary diversity of African vipers (Squamata: Viperidae): recent adaptation or historical contingency?

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**Abstract.**— Morphology and behaviour related to trophic interactions inform investigations of ecological diversification because those traits structure communities, thereby playing key roles in the origin and maintenance of biodiversity. While novel trophic adaptations (particularly macrophagy and evolution of venoms) have been inferred as driving snake diversification, few studies have explicitly examined trophically-related traits in a detailed phylogenetic context to assess their role in the diversification of advanced snakes. We examine diet type for 160 species of vipers to reconstruct dietary characteristics of ancestral vipers at phylogenetically and biogeographically informative nodes, with a special emphasis on African lineages. We test whether dietary traits of modern vipers show evidence of recent adaptation or whether such traits are better explained by ancient historical contingencies. Ancestral state reconstruction unambiguously showed that the ancestor of all vipers, of viperines, and of crotalines consumed both ectothermic and endothermic prey, probably with an ontogenetic shift between them, respectively. African

vipers show little variation in this trait, with only *Causus* showing a conserved shift towards consuming ectothermic prey exclusively, and apparently no species shifting to a strictly endothermic diet. Body size varied significantly between species that consume different dietary groups: species that consume only ectotherms were significantly smaller, and species that consume only endotherms were significantly larger than species that consume both groups of prey items. Diet type showed little phylogenetic signal suggesting local adaptation. We were unable to assign invertebrate-consumption unambiguously to any key ancestral nodes, but the trait is highly conserved within clades in which it has evolved. Our results extend earlier work by showing that the biology of modern vipers often reflects combinations of both recent local adaptation and ancient adaptive shifts.

Key Words.—ancestral state reconstruction, phylogeny, diet, body size

## Geographic distribution of amphibians and reptiles of Angola

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**Abstract.**—Angola is one of the larger countries in Africa and, due to its great geographical and climatic variety, presents a diversity of biomes and habitats, representing an important puzzle piece for understanding biogeographic patterns across sub-Saharan Africa. Angola is one of few biodiverse countries in Africa that remains seriously lacking in surveys of vertebrate diversity. This lack of knowledge has several historical causes, but the 27-year civil war greatly hindered research and contributed to this delay. Data regarding the occurrence and geographical distribution of amphibians and reptiles in Angola are currently scattered across natural history institutions in Africa, Europe and North America, and in a diversity of books and scientific papers. Currently, there is no available distribution database or atlas. These data are not easily accessible or properly formatted to use in distributional, niche-modeling, or biodiversity survey studies, thus limiting hindering future studies and conservation actions. Considering the threats faced by amphibians and reptiles worldwide and consequently the need for an update overview of the diversity and distribution of amphibians and reptiles in Angola, we compiled a database with all the available published bibliographical data on amphibian and reptile occurrences in Angola, updated the taxonomy and nomenclature for every citation and mapped the species occurrences in the country. A total of 110 amphibian and 307 reptile taxa were confirmed for Angola, while the presence of some other taxa is considered doubtful. Our results also show that the knowledge on the distribution of amphibians and reptiles in the country is not homogeneous, and for several areas such as Cuando-Cubango Province in the southeast Angola,

there is an almost complete absence of data. This work, together with current projects on digitizing museum collections and new fieldwork, constitutes an initial contribution for a future Atlas and Red List on the Angolan herpetofauna and contributes to the general knowledge of the biogeography of south-western Africa.

Key Words.— Angola, distribution, biodiversity informatics, historical records

## Evolutionary and palaeoenvironmental implications of fossil frog assemblages from the South African west and south coasts

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**Abstract.**— Frog bones have been recovered from a number of South African west and south coast archaeological and palaeontological sites dating to the early Pliocene, Pleistocene and Holocene. The oldest site presented in this study is the early Pliocene (5.1 Mya) west coast fossil site of Langebaanweg (32° 57' 23.8" S; 18° 06' 58.2" E) which contains a rich and diverse anuran fauna recovered from the two main fossil-bearing members, the Muishondfontein Pelletal Phosphate Member (MPPM) and the Langeberg Quarzose Sand Member (LQSM). The former represents river channel deposits, and the latter, more terrestrial, purportedly floodplain, deposits. Differences in the frog communities from these members reflect the different depositional environments, and provide new palaeoenvironmental information for 5.1 Mya, when the west coast supported a rich and diverse anuran community. The majority of frog families identified at Langebaanweg contain high numbers of endemic species today and contributes to our understanding of the evolution and origin of the high degree of endemism of south-western Cape frogs. The morphology of fossil *Breviceps* and *Xenopus* taxa from Langebaanweg, as well as other Pleistocene and Holocene sites, are compared with each other, and to modern taxa, in order to assess morphological change over time.

Key Words.— Langebaanweg, palaeoenvironment, *Breviceps*, *Xenopus*

## Assessing the threats against the Cape Platanna

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**Abstract.**— More publications exist on the conservation of the Cape Platanna, *Xenopus gilli*, than any other African amphibian, yet its status continues to decline. Threats against this species are said to include habitat alteration, genetic introgression, as well as predation and competition from the native congener *X. laevis*. Despite severe habitat alteration on the Cape flats, a reserve network has the potential to harbour populations. A study of the genetics of this species in the 1990s concluded that genetic introgression was minimal. Is it a legitimate claim that an endemic and sympatric congener is a conservation threat? Is there any evidence for competition or predation? In this study, we review what has been published on the threats to *X. gilli* and present some preliminary results from our ongoing studies. We suggest that careful management of populations can have a tangible effect on the conservation of this IUCN Endangered species, and that its future is in fact reliant on this.

Key Words.— African clawed frogs, conservation, hybridisation, predation, threats, wetlands

## Chemical crypsis in the ambushing *Bitis arietans* (Squamata: Viperidae)

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**Abstract.**— Ambush foragers use a hunting strategy which places them at risk of predation by both visual and olfactory-oriented predators. Resulting selective pressures have driven the evolution of impressive visual crypsis in many ambushing species, and may have led to the development of chemical crypsis. However, unlike visual crypsis, chemical crypsis is difficult to demonstrate or quantify. Field observations of Puff Adders (*Bitis arietans*) going undetected by mongooses and dogs, both of which are scent-orientated predators, lead us to investigate chemical crypsis in this ambushing species. We trained four scent-matching dogs of different breeds to test whether a canid predator could detect *B. arietans* using olfaction. We also tested for chemical crypsis in *B. arietans*' sloughed skin and in five species of active-foraging snakes. Due to differences in the modality of foraging, active foragers are predicted to have easily detectable scents due to reduced selective pressures acting on a "moving target". Dogs unambiguously indicated all active-foraging species and the sloughed skin of *B. arietans*, but

failed to correctly indicate Puff Adder scent, confirming that *B. arietans* employs chemical crypsis. The dogs' ability to detect *B. arietans* sloughed skin fits with field observations, where Puff Adders relocate to a new lie-up immediately after shedding. This is the first demonstration of chemical crypsis anti-predatory behaviour, though the phenomenon may be widespread among ambushers, especially those that are at high risk of predation. Our study provides additional evidence for the existence of an ongoing chemically-mediated arms race between predator and prey species.

Key Words.— olfactory camouflage, selective evolution, Puff Adder

## Assessing the effects of changing climate on distributions of the endemic amphibian fauna of the Cape Floristic Region

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**Abstract.**— Climatic changes have had profound impacts on the distribution of species throughout time. In response to these climatic shifts, species have shifted ranges, adapted genetically or became extinct. Using Species Distribution Models (SDMs) on current distribution data, we assess the impacts of climatic changes on the distribution of a community of 37 amphibian species endemic to the Cape Floristic Region (CFR); a region that is proposed to have experienced relatively stable climates throughout the Quaternary, thus leading to current exceptional levels of endemism across taxa. We used paleo-climate models for 21 Kya (Last Glacial Maximum: LGM) and 6 Kya (Holocene Glacial Minimum: HGM) to reconstruct hypothetical historical distributions and future climate models to construct hypothetical future distributions for the year 2080. We found that CFR amphibian community has lost suitable climate space since the LGM and this trend is expected to continue under future climate scenarios. In addition, the rate at which the CFR amphibian community is expected to shift in keeping with predicted climatic changes, as well as the rate of climate space loss far exceeds historical background rates.

Key Words.— climate change, Cape Floristic Region, amphibian community, species distribution models, rate of change

# The Gerrhosauridae-Cordylidae divergence: Effects of going on a diet

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**Abstract.**– The squamate suborder Scinciformata is comprised of four families: skinks (Scincidae), night lizards (Xantusiidae), plated lizards (Gerrhosauridae), and girdled lizards (Cordylidae). The Scincidae occupies the basal position in the scinciform phylogenetic tree, with the Xantusiidae being sister to the two most recently diverged families, the Gerrhosauridae and Cordylidae. In this paper, we use a simple parsimony approach to reconstruct ancestral states for the Scinciformata. Our preferred hypothesis is that the Gerrhosauridae/Cordylidae divergence was accompanied by transitions from a terrestrial lifestyle to a rock-dwelling one, from a widely foraging mode to a sit-and-wait one, from heavy armour to light armour, as well as the loss of lingual prehension and the evolution of exposed generation glands. We demonstrate that the inclusion of a clumped food source such as black flies in the diet of the most recent common ancestor of extant cordylids would have forced the ancestor to become an agile, rock-dwelling sit-and-wait forager that used jaw prehension to secure prey and that heavily relied on high levels of visual and chemical communication in the dense aggregations that would have formed at food hotspots. In extant platysaurinids, aerial predation pressure apparently continuously reinforces light armour and agility, which in turn reinforce dorso-ventral flattening of the body to compensate for the lack of armour. It was only after the evolution of viviparity, that the system was compromised. The prolonged gestation period and increased clutch size of the viviparous cordylinids, would have seriously compromised agility and dorso-ventral flattening in females, forcing individuals to stay closer to their rock shelters during activity and to shelter in wider crevices. This would have resulted in increased terrestrial predation pressure and an increased need for armour.

**Key Words.**– ancestral state reconstruction, black flies, Platysaurinae, viviparity, Cordylinae



# Semi-comparative phylogeographic analysis of two widely distributed squamate sister-species (*Agama atra* and *A. anchietae*) reveals unrecognized cryptic species and incongruent genetic and biogeographic patterns

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**Abstract.**— African lizards in the genus *Agama* are speciose and have a pan-continental distribution, making them an ideal model for investigating bio- and phylogeographic patterns. Many species have large geographic distributions that span numerous biogeographic barriers. Species with such distributions, when analyzed at finer scales, may reveal that some are, in fact, complexes of cryptic species, particularly those with strict ecological requirements. Two rupicolous lizard species, the Southern Rock Agama (*Agama atra*) and Anchieta's Agama (*A. anchietae*), are widely distributed (mostly allopatrically) across much of southern Africa. Using expanded geographic sampling, as well as both nuclear and organellar (i.e., mtDNA) genetic data, we asked: 1) is there evidence of unrecognized cryptic diversity within these taxa; 2) are the distributions of the recovered clades shaped by proposed bio-/phylogeographic barriers (e.g., Knersvlakte plain, Orange & Kunene rivers, Great Escarpment etc.); and 3) are the recovered mtDNA clades congruent to those recovered by the nuclear data? We found substantial mtDNA sub-structure within both species, suggesting that each is a complex of cryptic species. Proposed phylogeographic barriers demarcate some clades, however the results vary. Furthermore, the nuclear data are incongruent with respect to the recovered mtDNA clades in *A. atra*, instead suggesting one large panmictic population. We discuss possibilities for this incongruence, as well as why the results differ for *A. anchietae*, and how these species-specific patterns can provide insight into the processes governing speciation in southern Africa.

Key Words.— nuclear DNA, mitochondrial DNA, evolution, speciation, Africa

## Identifying priority conservation areas for the Sungazer (*Smaug giganteus*) using ecological niche models

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**Abstract.**— The Sungazer (*Smaug giganteus*) is a Threatened South African cordylid species, with an Area of Occupancy just over 1000 km<sup>2</sup>. The species faces increasingly severe threats to its habitat from burgeoning human populations that require more space for agriculture, residential areas, dams and mines. As a result, 44% of the Extent of Occurrence has been irreversibly transformed, with a rate of habitat decline of 1.5% per year. In the light of these risks, conservation measures to protect habitat across the distribution of the species must be considered. However, the species occurs patchily across its distribution and an unguided approach to conserving habitat is likely to be unsuccessful for the long-term conservation of the species. We constructed ecological niche models to detect areas of optimal Sungazer habitat and associated high population density, based on 536 locality records, and 24 environmental GIS layers. The model resolved five zones of optimal habitat. These zones have a total area of 812 km<sup>2</sup> and are spread across the distribution, with sites situated in the west (Welkom), north centre (Vrede, Edenville), south east (Harrismith) and north east (Volksrust). We estimated that these areas would support between 7 000 and 11 000 individuals. This is four to five times the mean minimum viable population (MVP) for vertebrate species. Ideally, a network of protected areas that cover the priority areas and link them through corridors would serve as the best approach to conserving the species. This would ensure that relatively large populations could persist within a network of linked optimal habitat patches.

Key Words.— nuclear DNA, mitochondrial DNA, evolution, speciation, Africa

## Cryptic frog diversity may indicate overlooked biodiversity hotspots in West Africa

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**Abstract.**— West African's biological diversity is under severe pressure. With dramatic speed, natural ecosystems, forests and savannas are exploited (e.g., logging, mining) and converted into agricultural systems (e.g., cotton fields, rubber and oil palm plantations). The troubling state of the region's biological richness may be in future additionally challenged by changing climatic conditions. In contrast we are

still far from comprehensively knowing the region's species richness. Despite intensive research activities during the last 20 years, this knowledge gap still exists for the anuran fauna of the Upper Guinean forests. During the last years we detected unexpected rates of cryptic diversity in various non-related frog genera. In this talk we present the geographic pattern of this cryptic diversity, interpret this pattern based on presumed previous forest fluctuations and discuss how our results might be used to detect overlooked areas of exceptional biological richness in other taxa.

Key Words.— biodiversity hotspot, habitat conversion, forest refugia, Upper Guinea forests

## Are South Africa's amphibians slipping through the conservation cracks?

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**Abstract.**— Amphibians have one of the highest rates of extinction globally. While the threat-levels of species, as defined by the IUCN, are based on many criteria, sometimes little attention is given to how the distributions of species relate to protected areas or areas of land transformation. Data collected during the South African Frog Atlas Project (Minter *et al.* 2004) allowed us to analyse the distribution data for South African amphibians in terms of land-cover characteristics, with a focus on formally designated conservation areas. Using a ranking system based on Extent of Occurrence, Area of Occupancy and the portion of the distribution within conservation areas, we identified 15 species of amphibians in South Africa that are of conservation concern in this respect. The four species of highest concern were *Heleophryne orientalis*, *H. regis*, *Breviceps fuscus* and *Amietophrynus pardalis* as only small portions of their distributions lie within the formally designated conservation network of South Africa. These species face habitat loss over a large proportion of their distribution, and yet they are currently classified as Least Concern. This suggests that species of conservation concern may be overlooked by the IUCN conservation assessment process. These flagged species should thus undergo further studies to reassess their conservation status. Our results indicate that there is a need to look more closely at the conservation network within South Africa and assess whether it can be altered to sufficiently conserve all of South Africa's amphibians.

Key Words.— IUCN conservation assessment, conservation network, South African Frog Atlas

## Microornamentation on snake scales

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**Abstract.**— The microscopic structures (microornamentation) on the surface of snake scales may have a variety of functions. For example, Spinner *et al.* (2013) showed that the microornamentation on the black scales of the West African Gaboon Adder created a velvet appearance, aided in dirt-repellence,

and potentially functioned in improving the snake's thermoregulation and camouflage. We surveyed 10 species of snakes for the presence of microornamentation using light microscopy. We detected microornamentation in three species, *Bitis schneideri* (Namaqua Dwarf Adder), *B. arietans* (Puff Adder) and *Hemachatus haemachatus* (Rinkhals). We then used scanning electron microscopy (SEM) to quantify the morphometrics of microornamentation for the latter two species. We found etched parallel grooves at three levels of organisation (approximately 30  $\mu\text{m}$ , 5  $\mu\text{m}$ , and 0.4  $\mu\text{m}$ ) on *H. haemachatus*. For *B. arietans*, we detected significant differences in the height of microornamentation between black (40  $\mu\text{m}$ ) and pale (17  $\mu\text{m}$ ) scale regions, but no differences in the density on each region. These results suggest that the colour of *B. arietans* scales is primarily a product of the pigment in the micro-ornaments. We suggest that microornamentation creates optical effects on the scales of both *H. haemachatus* and *B. arietans*, and improves thermoregulation in *H. haemachatus* and camouflage in *B. arietans*.

Key Words.— structural colour, pigment, light microscopy, scanning electron microscopy

## Phylogenetics and biogeography of the northern *Cordylus*

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**Abstract.**— The genus *Cordylus* is made up of 21 species of small, mostly-rupicolous lizards, divided into two geographically distinct lineages. One lineage is restricted to the southern and western areas of South Africa and Lesotho, and the other extends from eastern South Africa northwards to Angola and Ethiopia. While the southern clade is well-studied and has been the focus of several recent phylogenetic analyses, the evolutionary relationships of the eastern clade are less well known. This study uses a well-sampled, multi-locus phylogeny of eastern *Cordylus* as a foundation for a range of biogeographic and systematic analyses, identifying hidden diversity within the Tanzanian and Angolan *Cordylus*, and uncovering a number of clear biogeographic patterns, including strong evidence of a single exodus from southern Africa during the late Miocene.

Key Words.— girdled lizards, species delimitation, historical biogeography, systematics

## Progress in protecting Pickersgill's Reed Frog *Hyperolius pickersgilli* (Anura: Hyperoliidae) in KwaZulu-Natal

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**Abstract.**– Pickersgill's Reed Frog, *Hyperolius pickersgilli* (Anura: Hyperoliidae) was uplisted from Endangered to Critically Endangered in the previous Red List assessment for South African frogs (2010). The species is known only from a limited number of sites along the KwaZulu-Natal coastline. Recommendations regarding conservation research and action for the species were outlined in the conservation research strategy developed as a result of the assessment. The species received the highest conservation priority ranking in terms of requiring more knowledge on threats and basic biology, identification of management units, implementation of monitoring, obtaining population estimates and initiating stakeholder agreements to protect habitat. Through the joint efforts of the Endangered Wildlife Trust, Ezemvelo KZN Wildlife and North-West University, we have succeeded in initiating and implementing the following conservation actions for *H. pickersgilli*: 1) ongoing surveys have revealed new localities and helped to understand threats; 2) a Biodiversity Management Plan for Species (BMP-S) has been developed and finalised for approval by the Minister of the Department of Environmental Affairs (DEA), with the input of 14 stakeholders; 3) a monitoring protocol has been developed and tested; 4) using this monitoring method population abundance estimates have been obtained for selected sites; 5) sites have been prioritised and rehabilitation work on these has commenced through funding from the DEA; 6) collaborations with *ex situ* organisations, that have resulted in a better understanding of the breeding biology, and; 7) improved capacity, education and public awareness, resulting in various research and citizen science projects as well as local employment.

**Key Words.**– Biodiversity Management Plan, conservation research, monitoring, abundance estimates, habitat management

# Little frogs and big surprises: phylogenetics of the widespread species *Arthroleptis wahlbergii*

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**Abstract.**— The amphibian *Arthroleptis wahlbergii*, as currently defined, is broadly distributed along the eastern margin of South Africa, primarily associated with forest fragments within the savanna and grassland biomes. It is the southernmost species in this genus and, along with three *Leptopelis* species represents the southern extent for the African family Arthroleptidae. Many animal taxa that inhabit forests in this region have been shown to exhibit strong phylogenetic structure, often at the species level. For example, dwarf chameleons (*Bradypodion*) and velvet worms (*Peripatopsis*), from the naturally fragmented forests of KwaZulu-Natal and the Eastern Cape regions where *A. wahlbergii* occurs, are thought to have diversified and fragmented in connection with fragmentation of forests since the early to mid-Miocene, and multiple cryptic species have been uncovered. Given that forest dynamics may be a strong force for allopatric speciation in the region and that *A. wahlbergii* contains populations that differ phenotypically, we investigated *A. wahlbergii* in a phylogenetic context using one mitochondrial and one nuclear marker (16S, RAG-1). Thirty-seven individuals from 11 forest patches were included in a maximum likelihood analysis. Eight strongly supported clades were recovered, at least three of which show levels of divergence similar to that found between other amphibian species. These clades reflect the major forest types in the area (Afrotentative, Scarp, Coastal forest) to a limited extent, but geographical proximity of subpopulations is a stronger predictor of relatedness than current forest type classification, with additional population level structure within each forest type associated with individual forest fragments. These results largely mirror that found for *Bradypodion* by suggesting that fragmentation of forest habitat, as well as forest type, has profoundly affected forest specialists, and is a major driver of divergence between species and populations.

**Key Words.**— amphibians, *Arthroleptis wahlbergii*, Afrotentative forest, biogeography, phylogenetics

## ***Arthroleptella*: What we know now and what we still need to investigate (Anura: Pyxicephalidae)**

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**Abstract.**— A review is provided on the current state of knowledge on endemic South African genus *Arthroleptella* (moss frogs). Existing gaps in our knowledge are identified for future research to resolve. Included in the review is a brief overview of the systematic placement of the genus and its likely origin as inferred from DNA-based phylogenies; the mode of speciation and possible causes including identification of barriers to gene flow, the current number of species in the genus, the variation of advertisement calls across genetic clades and space, and the threats to the continued existence of the various *Arthroleptella* species.

**Key Words.**— phylogeny, speciation, vicariance, advertisement calls

## **Environmental citizenship in citizen science: A case study of a volunteer conservation group, from Noordhoek, South Africa**

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**Abstract.**— The Endangered Western Leopard Toad (*Amietophrynus pantherinus*) is endemic to the winter-rainfall parts of the Western Cape, areas which are also favoured for human settlement. Residents in the Noordhoek area witnessed many toads being killed on roads during their annual migration to breeding ponds. Concerned citizens mobilised a volunteer group to mitigate this threat to the species. My research interest lies in the analysis of the learning dynamics presented in citizen science groups, the enabling and constraining factors shaping citizen science practices and how participation in citizen science nurtures environmental citizenship. I have chosen a case study approach to explore the practices of the Toad NUTS (Noordhoek Unpaid Toad Savers) group. The evidence showed that the Toad NUTS group is a community of practice where learning occurs by legitimate peripheral participation and is deepened through an apprenticeship style of learning interaction with more experienced volunteers. Four interconnected components of learning were identified: practice, meaning, identity and community. There are various shaping arrangements of cultural-discursive, material-economic and social-political configurations which not only influence Toad NUTS practices, but require that volunteers learn to navigate these arrangements and develop relational expertise in order to implement conservation strategies successfully. Volunteers with a pre-existing sense of environmental citizenship are more likely to join a citizen science group.

However these virtues are also strengthened and others are gained with ongoing participation in citizen science practices. This study showed that citizen science presents opportunities to develop the core science and applied mathematics knowledge and skills of volunteers. If facilitated sensitively, citizen science can make a meaningful contribution to the field in which they operate, in this instance, in conservation, while also nurturing the governmentality of the volunteers with regard to the species and the environment.

Key Words.— Western Leopard Toad, citizen science, volunteers, learning, environmental citizenship, practices, conservation strategies, governmentality

## **Exploring the invasion of *Amietophrynus gutturalis* (Anura: Bufonidae): a multidisciplinary approach**

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**Abstract.**— The Guttural Toad, *Amietophrynus gutturalis* (Power, 1927), is a generalist and synanthropic species naturally distributed in central and southern Africa. Due to its adaptable habits, it has become invasive in Cape Town, where it was introduced from KwaZulu-Natal at the end of 1990s, probably as eggs or tadpoles with a consignment of aquatic plants. Despite an ongoing, sustained eradication campaign which started in 2010, the invaded range is currently expanding. Moreover, in the last twenty years the same species shows a range expansion along the western stretch of the Orange River, probably because of anthropogenic landscape transformation. We aim to predict the potential spread of *A. gutturalis* in the Cape Town area and estimate the efficacy of the current eradication program utilizing individual based model. Moreover, we aim to investigate the extent of change of the phenotype since introduction in the novel environment context of Cape Town, in order to identify possible adaptive responses during invasion. To achieve this, we will compare the invasive population with the native one in KwaZulu-Natal, by considering energetic reserves, life-history traits and physiology. We will use this comparison to quantify the extent to which species-specific physiological constraints could limit the future spread of an invasive species. Finally we intend studying the Guttural Toad's invasive spread along the Orange River and assess the extent, due to spatial disequilibrium dynamics, the phenotype of the individuals at the invasion front diverges from that of long-established populations.

Key Words.— Guttural Toad, invasive spread, local adaptation, phenotypic plasticity, spatial disequilibrium dynamics



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**Thermal ecology of two sympatric tortoise species (*Psammobates oculifer* and *Stigmochelys pardalis*) in the Thorn-Bush Savanna of central Namibia.**

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**Abstract.**— This study investigated the thermal behaviour of two sympatric tortoise species, *Stigmochelys pardalis* (previously known as *Geochelone pardalis*) and *Psammobates oculifer*. In addition, the study is part of larger international study that aims to predict the possible impact of rapid global warming on tortoise adaptation and survival. The study is currently being conducted in the semi-arid savanna of Windhoek at the Hohewarte farm, in Namibia. To assess the thermal behavior of these two species, transmitters and temperature loggers were attached to tortoises for continuous long-term monitoring of individuals. Data were collected from December 2013 (and is currently ongoing) to measure the seasonal and daily difference in the activity patterns and thermal ecology of these tortoises. Preliminary results suggest that tortoises are most active during morning and afternoon hours, and although more active during the wet season, there is a surprising amount of dry-season activity. During the winter months, *P. oculifer* is more active than *S. pardalis*. The use of burrows over pallets appears to increase during the summer months, likely for protection from higher temperatures. Nonetheless, temperature data-loggers recorded external carapace temperatures as high as 50 °C, although not for extended periods of time. Conversely, winter temperatures regularly dipped below freezing (as recorded by our adjacent weather station) for up to several hours at night, and tortoise temperature data loggers closely tracked these ambient conditions, dropping below freezing for short periods. We have found one small *P. oculifer* on more than one occasion completely buried by as much as 4 cm of dirt below the surface.

**Key Words.**— sympatric, *Psammobates oculifer*, *Stigmochelys pardalis*, thermal biology

## Harnessing the power of social media: hashtags as a tool to synthesise reptile natural history

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**Abstract.**— Despite growing interest in the behaviour and ecology of reptiles in Africa, our understanding of the natural history of many species remains speculative. However, advancement of digital photography and social media provides a powerful tool to remedy this situation as photographs of interesting and often novel observations of reptile behaviours are regularly posted on major social media platforms such as Facebook and Twitter. We propose the use of a series of standardised hashtag social media metadata tags, linking posts to specific themes, and making those themes searchable and collatable. We propose the use of four hashtags to categorise major classes of observation. Observations of reptiles with prey items should be designated by #WildReptileFeeding; observations of reptiles being killed or preyed upon should be designated by #WildReptilePredation; observations of copulating, courting, male-male combat, birthing, or egg-laying should be designated by #WildReptileMating; while agonistic interactions between individuals of different species should be designated by #AgonisticReptile. Preliminary results suggest significant potential to discover novel species interactions (both trophic and agonistic), as well as broad-scale spatial and temporal activity patterns exhibited by free-ranging reptiles. The value of our proposal is thus dependent on community buy-in and active use and tracking of the proposed hashtags.

Key Words.— natural history, citizen science, predation, reproduction, feeding

## Comparative phylogeography of three rock dwelling lizard species (*Agama atra*, *Karusasaurus polyzonus*, & *Chondrodactylus* *bibronii*) provides insight into the speciation process in southern Africa

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**Abstract.**— Geology, geography and changing climate have all played a role in shaping the distribution of organisms in southern Africa, particularly for species spanning the arid/semi-arid Karoo Biome.

Using comparative phylogeography, we explored patterns within three sympatric yet distantly related, rock-dwelling lizard species: the Southern Rock Agama, *Agama atra*; Bibron's Gecko, *Chondrodactylus bibronii*; and the Karoo Girdled Lizard, *Karusasaurus polyzonus*. All three taxa are saxicolous, greatly utilizing the geologically complex, ancient, rock formations found throughout the subcontinent; yet differ in period of daily activity, social structure, and microhabitat use (although *C. bibronii* has been observed inhabiting the same rock cracks with either *K. polyzonus* or *A. atra*). In many regards *C. bibronii* could be considered a 'rock generalist,' often living in rocky habitat unsuitable for either *A. atra* or *K. polyzonus*. This habitat 'leniency' could potentially erase significant, informative genetic signal as it would allow for better individual dispersal throughout its range. In light of this, we hypothesized that there would be a degree of shared evolutionary history across the subcontinent between the three, particularly at recognized barriers to gene flow for other rock-dwelling organisms (e.g., the Knersvlakte plain) due to shared distribution and gross ecological requirements. Employing genetic data we asked: 1) what is the structure of 'populations' within a species, and what are the geographic boundaries of those groupings; 2) are these clusters/populations isolated (or conversely, is gene flow ongoing between them), and for how long; and 3) how have climatic shifts affected species/population distributions? The species-specific patterns provide insight into the processes of speciation governing the arid zones of the southern hemisphere.

Key Words.— squamate, evolution, Cordylidae, Agamidae, Gekkonidae

## The movement ecology and habitat use of the Cape Dwarf Chameleon

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**Abstract.**— This project focussed on the Cape Dwarf Chameleon (*Bradypodion pumilum*), a Western Cape endemic, found primarily in transformed and degraded habitats. Using micro radio-transmitters, we documented habitat-use and the area utilized by this species using data from five individuals radio-tracked in 2014 and six individuals in 2010 at the Noordhoek Wetlands, Cape Town. The area utilized and daily displacement were examined for differences between sexes. Additionally, chameleon perch diameters were compared to diameters of randomly sampled vegetation transects to test whether chameleons select specific branches or use all available sizes. To test whether chameleons prefer to be higher at night (more exposed) and lower (more concealed) during the day, the height above ground and vegetation cover was documented and compared between day and night. Perch height and vegetation cover were also compared between sexes to investigate differences in risk taking. The area utilized and perch cover for radio-tracked chameleons were not significantly different between the sexes. However,

males perched higher in the vegetation than females and may have had a greater daily displacement and perch diameter (the data were inconclusive). Lastly, we found that chameleon vegetation use varied between day and night, but not between early morning, midday and late afternoon (e.g., chameleons perched in higher, less dense vegetation at night than during the day). This study reveals how the Cape Dwarf Chameleon utilises the environment, and provides insight into the potential for dispersal of the species across the transformed, fragmented landscape.

Key Words.— Chamaeleonidae; conservation; habitat fragmentation; dispersal; habitat selection; radio-telemetry

## **Seed dispersal by tortoises (*Psammobates oculifer*) and the effect of their gut passage on seed germination**

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**Abstract.**— Tortoises play a vital role in the ecosystem. Some frugivorous tortoises play an important role in seed dispersal. They can disperse seeds away from the parent plant to areas favourable for establishments through gut passage. Tortoises subject seeds to less severe digestive processes in their gut. The longer period the seeds stay in the gut, the further they can be dispersed depending on the distance travelled by the tortoise away from the parent plant. The study was carried out to investigate the plant species dispersed by the Serrated Tortoise (*Psammobates oculifer*) in the wild, the effect of gut passage on the germination rate of seeds eaten by the tortoises (tomato seeds) and the retention time of the ingested seeds. The tortoises used in the study were captured in the non-protected areas of Botswana and were kept at the animals' outdoor enclosure at Botswana College of Agriculture (BCA), where experiments were conducted. Faeces defecated during transportation from the bush to BCA were collected and analysed for the presence of seeds which were later identified at the herbarium. At BCA, the tortoises were maintained on indigenous vegetation and supplemented on various fruits and vegetables known to be eaten by tortoises. The gut passed seeds, the seeds extracted directly from fruits as well as the whole fruit were planted at the end of the experiment and number of germinated seeds recorded daily. The food retention time was calculated by subtracting the time in which the colourful beads appeared in the faeces from the time at which the feeds mixed with beads were offered. The serrated tortoises were found to disperse seeds of *Grewia* species in the wild. Gut passage was found to significantly enhance germination rate of tomatoes while food retention time ranged from three to seven days. This study demonstrates the importance of the tortoises in the ecosystem.

Key Words.— food retention, gut passage, seed dispersal, tortoises

# The invasive Guttural Toad, *Amietophrynus gutturalis* (Anura: Bufonidae) of Cape Town, South Africa: Where do they come from?

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**Abstract.**— Invasive species and the effect they have on the natural biota are cause for great concern. The mega-diverse Fynbos region of the Western Cape, South Africa plays host to three exotic and potentially invasive amphibian species. A recent introduction of Guttural Toad, *Amietophrynus gutturalis*, egg-clutches, tadpoles or male and female adults were somehow introduced to the Constantia region of Cape Town. As this region plays host to many of the endangered Western Leopard Toad, *Amietophrynus pantherinus*, breeding sites, the expanding population of *A. gutturalis* may be problematic. In order to adequately manage and understand this invasive species it is important to isolate the origin of the population; determine if single or multiple introductions have occurred; provide an estimate on how many individuals were released; and compare the invasive populations' genetic variation to that of populations across their natural range. Twenty four samples from the invasive population and 45 samples from across the species natural range were sequenced. A resulting total of 121 genetic sequences derived from ND2 and 16S genetic markers were aligned in Sequencher 5.2.4 and all sequencing errors were checked against the chromatogram. These genetic data will be used to produce a fine scale phylogeny and haplotype network across the range of the natural population in order to examine population structure. Using haplotype networks and  $F_{st}$  as an estimator of genetic distance from both natural and invasive populations we identify the origin of the invasive population and assess the genetic diversity of both populations in order to assess the invasive species genetic potential.

Key Words.— invasive species, Cape Town, mtDNA, ND2, 16S, Bufonidae



Photo: Bill Branch

Gobabeb, Namibia



Photograph by Unknown

Sand storm at Gobabeb



Photo: Bill Branch

Ed Stanley and the balance of nature.



Photo: Edward Stanley

Ed's close-up of *Meroles anchietae*.