



**FIFTH
WORLD CONGRESS
OF
HERPETOLOGY**

STELLENBOSCH

June 2005

ABSTRACTS AND PROGRAMME

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Foreword

This publication was compiled by the Local Organising Committee and represents a typical Congress programme and book of abstracts. As is the norm with publications of this nature, abstracts were edited only to conform to the relevant size and style, including some grammatical and typographical errors and not for their scientific content. No interpretations of abstract texts were performed. Also, the unavoidable choice of English as Congress language, has led to the necessity to edit some abstracts of those delegates whose native language is not English in order to conform to basic English literary requirements. It was not always possible to ascertain the sequence of surnames and first names of delegates, and we apologise if we had inadvertently transposed these – no disrespect was intended.

The Committee hopes that delegates to the Congress find this publication useful as official record of the Fifth World Congress of Herpetology.

Ernst Baard

Chair: Local Organising Committee

5th World Congress of Herpetology General Business Meeting

Secretary-General – Ulrich Joger
Secretary-General Elect – Walter Hödl
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Anslem de Silva – Sri Lanka
Richard Tinsley – UK
Boris Tuniev – Russia
Alberto Veloso M. – Chile
Elke Zimmermann – Germany
Mohammed Znari – Morocco
Annie Zuiderwijk – Netherlands

**Tuesday 21 June 17:30 at Jannasch
Hall, Conservatory of Music,
Stellenbosch University**

1. Opening of the meeting
2. Minutes of the last meeting
3. Report of the Secretary-General
4. Report of the Secretary-Elect: Next venue for the World Congress of Herpetology
5. Report of the Treasurer
6. Report of the Auditors
7. Report of the Congress Director
8. Elections:
 - 8.1 Executive Committee
 - 8.2 International Herpetological Committee
9. Future role of the International Herpetological Committee
10. Any other business

Note: All congress participants have the right to take part and vote in the meeting. A list of eligible candidates for the Committees will be distributed with this programme. Additional items for the agenda can be presented to the Secretary General until 24 hours before the business meeting.

Scientific Programme

Day 1: Monday 20 June	Venue 1 Conservatorium Ender Hall	Venue 2 Conservatorium Jannasch Hall	Venue 3 Conservatorium Fisner Hall	Venue 4 Lecture Hall 1028 Dept Soil Science	Venue 5 Conservatorium Classroom 1	Venue 6 Conservatorium Classroom 2
08:50	Announcements					
09:00-09:40	Plenary Lecture: Stuart S, Chanson J, Cox N and Young B Amphibians, Reptiles and the 2010 Biodiversity Target					
	SYMPOSIUM 1 Amphibian Declines Session Chair: Halliday	SYMPOSIUM 2 African Herpetological Diversity Session Chair: Joger	SYMPOSIUM 3 Sex determination and allocation in Reptiles Session Chair: Georges	Chelonian Biology Session Chair: Hofmeyr	Squamate Ecology & Behaviour Session Chair: Ford	Morphology Session Chair: Russell
09:50	Channing A Are there un-noticed amphibian declines in southern Africa?	Branch B Ancient lineages and modern landscapes	Sarre S, Georges A and Quin A Girls will be boys and boys will be girls: Investigating the TSD-GSD Continuum in Reptiles	Avery H and Spotila J Effects of resource availability on the reproduction and survivorship of the desert tortoise (<i>Gopherus agassizii</i>): implications for the life history and demography of desert reptiles	Mayes P and Thompson G The life of the semi-aquatic <i>Varanus mertensi</i> (Reptilia: Varanidae)	Hoyos J, Acosta A and Gomez F Sesamoid elements, foot and hand muscles: can we use them for phylogenetic hypotheses in frogs?
10:10	Karraker N Declines in Urodeles: non-existent or understudied?	Vences M Regional diversity and endemism of Madagascar amphibians and reptiles	Girondot M, Delmas V and Prévot-Julliard A-C Mechanistic biochemical and physiological models interplay to offer a new tool to understand temperature-dependent sex determination	Znari M and Nagy K Water, energy and food requirements in the Moorish tortoise, <i>Testudo graeca graeca</i> , in Western Morocco	Wotherspoon D Microhabitat selection and home range of the Jacky dragon, <i>Amphibolurus muricatus</i> in remnants of eastern suburbs <i>Banksia</i> scrub	Rocek Z Unusual features of the head anatomy in the discoglossid frog <i>Barbourula</i>
10:30	Boone M, Semlitsch R, Bridges C and James S Assessing the influence of multiple stressors on amphibian populations	Poynton J, Loader S and Clarke B Amphibian diversity in Eastern Tanzania	Robert K, Elf P, Thompson M and Fivizzani A Temperature-dependent sex determination in a viviparous lizard: What role do hormones play in sex determination?	Curtin A, Zug G, Avery H and Spotila J Bone growth patterns as indicators of life history parameters in desert tortoise (<i>Gopherus agassizii</i>) populations	Malisch A, Rotenberry J, Halama K and Allen M Developing and testing predictive niche models for five lizard species in southern California, USA	Lötters S, Baumgart A, Oberst M, Eisenbeis G, Viertel B and Veith M Larval morphology of reed frogs, <i>Hyperolius kivuensis</i> and <i>H. viridiflavus</i> , from western Kenya
10:50	Fellers G and Kleeman P The role of pesticides in amphibian declines in California, USA	Ogoanah S and Oboh I Amphibians of Delta State, Nigeria	Kuchling, G From theory to practice in temperature dependent sex determination: sex ratios in captive breeding and head starting projects of threatened chelonians in Madagascar, Mauritius and Malaysia	Hofmeyr M and Leuteritz T Extended reproductive seasons among southern African tortoises	Wassersug R, Bell S and McNeil J On the ecology of a snake at the northern limits of its range: <i>Thamnophis sauritus</i> in Nova Scotia, Canada	Sánchez-Villagra MR Winkler JD and Wurst L Evolution of autopodials in pleurodire turtles: developmental, phylogenetic and morphometric aspects
11:10*	Refreshments*	Refreshments*	Refreshments*	Refreshments*	Refreshments*	Refreshments*

Please note: refreshments will be served in THE FOYER OF THE MAIN VENUE

Day 1: Monday 20 June	Venue 1 Conservatorium Ender Hall	Venue 2 Conservatorium Jannasch Hall	Venue 3 Conservatorium Fismer Hall	Venue 4 Lecture Hall 1028 Dept Soil Science	Venue 5 Conservatorium Classroom 1	Venue 6 Conservatorium Classroom 2
11:40	Carey C, Voyles J, Dixon B and Livo L Hypotheses regarding how <i>Batrachochytrium dendrobatidis</i> causes amphibian deaths	Van der Meijden A, Vences M and Meyer A Molecular evidence for phylogenetic reassignment in some African Ranoid frogs	Nelson N, Pledger S, Thompson M, Keall S, and Daugherty C TSD in <i>Tuatara</i> : nesting ecology and global warming	Mwaya R and Msyani E Herbaceous composition and physical features of paths taken by pancake tortoise, <i>Malacochersust tornieri</i> , during inter-kopje displacement	Waters M, Meadows K and Moore M Radiotelemetry study of habitat use by queen snakes (<i>Regina septemvittata</i>) an extreme dietary specialist	Jamniczky H Turtles, Tomography, and Tree Topology: an integrative approach to primary homology assessment in Testudine braincase
12:00	Collins J Ranaviruses as emerging disease threats to amphibian populations	Rödel M-O and Ernst R West African amphibian diversity: much higher than predicted	Doody S, Guarino F and Georges A Testing for among-generation adjustment to offspring sex ratios: clinal variation in sex-determining attributes in the water dragon, <i>Physignathus lesuerii</i>	Ng P K A, O'Riordan R, Ramsay N and Chou L M Are red-eared sliders reproducing in Singapore?	Ford N and Lancaster D Both niche apportionment and dispersal influence snake assemblages in East Texas bottomlands	Klembara J The ontogeny of the posterior portion of the otocapital region of the neural endocranium in prehatching <i>Alligator mississippiensis</i>
12:20	Daszak P, Collins J and Longcore J Chytridiomycosis as an emerging disease threat to amphibian populations	Bauer A Phylogenetic and biogeographic patterns of gekkonid lizard diversity in sub-Saharan Africa	Roosenburg W and Allman P Latitudinal variation in sex ratio in a turtle with TSD	Ng P K A, O'Riordan R, Ramsay N and Chou L M Population and demography of the red-eared slider terrapin in Singapore	Barber T, Andreadis P and Gillingham J Ambush site selection in a generalist forager, the Western cottonmouth (<i>Agkistrodon piscivorus leucostoma</i>)	Thompson G and Withers PC Goanna shape: effects of size and phylogeny
12:40	Weldon C and Du Preez L Chytridiomycosis in Africa	Tilbury C, Tolley K, Matthee C and Branch W Dissecting the evolutionary relationships of the African chameleons – a review of the past, present, and a look at a proposed future	Schwartzkopf L and Way D Temperature dependent sex determination in the genus <i>Eulamprus</i> : a widespread character?	Guarino F, Georges A and White M Does security matter: ecology of an arid zone river turtle, <i>Emydura macquarii emmotti</i>	Phelps T Adders in the African landscape: Site fidelity and seasonal movement	Clemente C, Thompson G and Withers P Locomotion in Australian monitor lizards
13:00*	LUNCH*	LUNCH*	LUNCH*	LUNCH*	LUNCH*	LUNCH*
	Session Chair: Halliday	Session Chair: Branch	Session Chair: Wapstra	Session Chair: Reina	Session Chair: Mouton	Session Chair: Klembara
14:10	Relyea R The impact of pesticides on amphibian communities	Tolley K, Tilbury C, Branch B and Matthee C The Dwarfs of Africa: taxonomy, distribution and diversity of dwarf chameleons (<i>Bradypodion sensu lato</i>)	Georges A Symposium plenary: Sex determination and sex allocation: bridging the gap	Jensen K and Das I Ecology of freshwater turtles in Loagan Bunut, a peat swamp lake in Sarawak, Borneo	Reading C Ranging behaviour in the smooth snake, <i>Coronella austriaca</i> Laurenti	Hiller U and Werner Y Unicellular glands in gecko skin
14:30	Rowley J and Alford R Why does Chytridiomycosis drive some frog populations to extinction and not others? The effects of interspecific variation in host behaviour.	Kelly C The snake family Psammophiidae - systematics, phylogenetics and phylogeography of an African radiation		Reina R, Spotila J, Paladino F and Dunham A Climate change affects leatherback reproductive schedule and population viability	Znari M and El Mouden El Hassan Demography and population dynamics of a Bibron's agama population in Western Morocco	Russell A Integrative functional morphology of the gekkotan and polychrotid subdigital adhesive system

* Please note: lunch will be served in the SANLAM HALL AT THE LANGENHOVEN STUDENTS' CENTRE ACROSS THE ROAD FROM THE MAIN VENUE

Day 1: Monday 20 June	Venue 1 Conservatorium Endler Hall	Venue 2 Conservatorium Jannasch Hall	Venue 3 Conservatorium Fismer Hall	Venue 4 Lecture Hall 1028 Dept Soil Science	Venue 5 Conservatorium Classroom 1	Venue 6 Conservatorium Classroom 2
14:50	Skelly D Parasite infection and amphibian limb deformities	Znari M, Ineich I and Dubois A Morphometric variation and relative growth in African lizards of <i>Agama</i> group: adaptive and evolutionary implications	Olsson M GSD and sex allocation in reptiles: an overlooked gold mine?	Avery H, Klein K, Spotila J and Bien W Ecology and population structure of sympatric turtle species inhabiting a highly urbanized freshwater ecosystem: a case study for determining effects of habitat fragmentation, modification, and isolation on a model reptilian community	Gerber G and Alberts A Effects of translocation and density the biology of the Turks and Caicos iguana, <i>Cyclura carinata</i>	Shacham B Tail injury linked to morphological asymmetry in a polymorphic snake
15:10	Refreshments	Refreshments	Refreshments	Refreshments	Refreshments	Refreshments
15:40	Kearney R and Fellers G Amphibian Research and Monitoring Initiative: an interdisciplinary approach to the study of amphibian populations in the United States	Nagy Z, Joger U, Vences M, Vidal N, Branch B, Pauwels O and Wink M The African colubroid radiation	Warner D An experimental test of the adaptive significance of temperature-dependent sex determination: an example using an Australian agamid lizard	Wallace B, Paladino F, Kilham S and Spotila J First field metabolic rates for marine turtles: climate and fisheries a one-two punch for Pacific leatherback turtles	Mouton le F, Flemming A, Effenberger E and Visagie L Spines versus speed in cordylid lizards: the armadillo lizard, <i>Cordylus cataphractus</i> , as an extreme	
16:00	Griffiths R and Gibson R Captive breeding of amphibians: conservation or cosmetic surgery?	Wüster W and Pook C Phylogeography of widespread African venomous snakes: is there a pattern?	Allsop D The evolutionary ecology of sex allocation in viviparous lizards		Radder R, Saidapur S and Shanbhag B Bigger boys at the top during breeding: influence of size, sex and reproductive phase on perching behaviour in the tropical rock lizard, <i>Psammophilus dorsalis</i>	
16:20	Halliday T Amphibian declines and extinctions: what can we expect in the next five years?	Bates M, Mouton le F and Swartz E Taxonomy of the <i>Pseudocordylus melanotus</i> complex	Wapstra E and Uller T Sex allocation in squamates: the past, present and future		Westhoff G, Tzschätzsch K and Bleckmann H Spitting behaviour in two species of spitting cobras	
16:40	Discussion	Rocha S, Carretero M and Harris J Diversity of reptiles in the Comoro islands: a phylogeographic analysis	Discussion			
17:00	Closure	Closure	Closure	Closure	Closure	Closure
17:30 – 19:00	World Congress of Herpetology Executive Committee meeting, Dept Botany and Zoology, Broom Lecture hall	Declining Amphibian Population Task Force business meeting, Dept Botany and Zoology, Seminar Room 2				

Day 2: Tuesday 21 June	Venue 1 Conservatorium Ender Hall	Venue 2 Conservatorium Jannasch Hall	Venue 3 Conservatorium Fismer Hall	Venue 4 Lecture Hall 1028 Dept Soil Science	Venue 5 Conservatorium Classroom 1	Venue 6 Conservatorium Classroom 2
08:50	Announcements					
09:00-09:40	Plenary Lecture: Vences, M The resurrection of oceanic dispersal: biogeography of the Madagascan herpetofauna in the molecular age					
	SYMPOSIUM 4 Techniques for studying the Ecology of Freshwater Turtles Session Chair: Vogt	SYMPOSIUM 5 Biology of <i>Xenopus</i> Session Chair: Tinsley	SYMPOSIUM 6 Lizard visual ecology and signalling Session Chair: Whiting	SYMPOSIUM 7 South American Anuran diversity Session Chair: Rocha	Thermal Biology Session Chair: Preest	Reptile Conservation and Variation Session Chair: Heatwole
09:50	Burden A, Griffiths R and Garcia G A comparison of four methods of estimating body condition in Malagasy freshwater turtles (<i>Pelusios castanoides</i> and <i>Pelomedusa subrufa</i>)	Tinsley R Species diversity of <i>Xenopus</i> : an update	Fleishman L Anoline lizard visual ecology: do habitat light spectra matter?	Sinsch U and Martino A The genus <i>Odontophrynus</i> (Anura: Leptodactylidae) in Argentina: distribution, taxonomy and phylogeny	C.R. Tracy, K.A. Christian, C.R. Tracy Using null models to evaluate thermoregulation in large reptiles	Alford R and Winter J Reptiles: the best indicators of environmental disturbance?
10:10	Van Wyk J, Strydom A and Leslie A Sexual dimorphism and seasonal reproduction in the South African fresh water turtle, <i>Pelomedusa subrufa</i> (Chelonia: Pelomedusidae)			Wollenberg K, Lotters S, Noonan V and Veith M Evolution of color and pattern polymorphism in the Dyeing Poison Frog, <i>Dendrobates tinctorius</i> (Amphibia: Dendrobatidae)	Schwarzkopf L and Way D Temperature dependent sex determination in the genus <i>Eulamprus</i> : a widespread character?	Thompson S and Thompson G Rehabilitation index for evaluating the success of rehabilitated disturbed areas using reptile assemblages as a bio-indicator
10:30	Refsnider J, Simons A and Linck M Habitat use and hibernaculum characterization of neonate Blanding's turtles: a multi-generational radio-telemetry study in Minnesota, USA	Evans B, Kelley D, Tinsley R and Cannatella D Phylogeny and duplicate gene evolution in African clawed frogs	Leal M To see or not to see: the effect of habitat light on the evolution of signal design and visual-system function in allopatric populations of the lizard <i>Anolis cristatellus</i>	Noonan B and Gaucher P Phylogeography and demography of Guianan harlequin toads (<i>Atelopus</i>): diversification within a refuge	McMaster M and Downs C Heating and cooling rates of leopard tortoises (<i>Geochelone pardalis</i>) under experimental and natural conditions	Reed R, Boback S and Montgomery C Ecology and conservation of endemic <i>Boa constrictor</i> in the Cayos Cochinos, Honduras
10:50	Kuchling G Assessment of reproductive cycles and nesting frequencies in freshwater turtle populations by ultrasound scanning and endoscopy	Tobias M, Evans B and Kelley D Evolution of vocal communication in the Xenopodinae	Stuart-Fox D, Moussalli A and Whiting M Natural selection on signal design in dwarf chameleons (<i>Bradypodion</i> spp.)	Rocha C, Hatano F, Vrcibradic D and Van Sluys M Frog species richness and composition in coastal Brazilian restinga habitats	Clusella Trullas S, Van Wyk J and Spotila J Are there differences in thermal balance, body temperature and activity between melanistic and non-melanistic species of Cordylid lizards in the Western Cape?	Nono Gonwouo L Cameroon chameleons with special reference to species of international pet trade
11:10	Refreshments	Refreshments	Refreshments	Refreshments	Refreshments	Refreshments

Day 2: Tuesday 21 June	Venue 1 Conservatorium Ender Hall	Venue 2 Conservatorium Jannasch Hall	Venue 3 Conservatorium Fismer Hall	Venue 4 Lecture Hall 1028 Dept Soil Science	Venue 5 Conservatorium Classroom 1	Venue 6 Conservatorium Classroom 2
11:40	Pearse D, Arndt A, Valenzuela N, Cantarelli V and Sites Jr J Metapopulation structure, nest-site fidelity, and conservation genetics of the Amazon river turtle <i>Podocnemis expansa</i> (Chelonia; Podocnemidae)	Villinger J and Waldman B MHC-based kin recognition in <i>Xenopus laevis</i> tadpoles	Ott M Lizards as a model to study mechanisms of visual evolution and development		Herczeg G, Kovács T, Gonda A, Török J, Korsós Z and Merilä J Basking lizards in the subarctic: thermoregulation of the common lizard (<i>Zootoca vivipara</i>) under environmental challenge	Zuiderwijk A, Smit G, Janssen I, Daemen B, and Groenvelde A Trends of reptile species in the Netherlands from long term monitoring
12:00	Anderson N, Pike D, Smith R and Seigel R Using multiple methods to manage capture bias: some cautions and considerations	Warren A, Caplen G and Tinsley R Behavioural biology of <i>Xenopus laevis</i> : implications for improved laboratory welfare	Thorpe R Testing the role of visual cues in speciation		Preest M Elevated corticosterone concentration affects thermoregulatory behavior and raises metabolic rate in the New Zealand common gecko, <i>Hoplodactylus maculatus</i>	Puky M, Farkas J and Toth M Amphibian and reptile road kills: importance, frequency, mitigation measures
12:20	Horne B Prolonged development in turtles: the role of embryonic diapause and embryonic aestivation	Van Wyk J, Hurter E, Pool E and Leslie A Seasonal variation in reproductive activity in natural <i>Xenopus laevis</i> populations in the Western Cape Province, South Africa	Whiting M, Stuart-Fox D and Stapley J Bright colours and UV signals in a lizard tournament			Halpern B, Major A, Péchy T and Kiss B Comparison of two isolated <i>Vipera ursinii moldavica</i> populations of the Romanian Danube-Delta
12:40	Roosenburg W All these data and what do we do now: analysis of mark-recapture data	Du Preez L, Everson G, Hecker M, Carr J, Giesy J, Kendall R, Smith E, Van der Kraak G and Solomon K Seasonal changes in testicular morphology in the African clawed frog, <i>Xenopus laevis</i> : a histometric analysis	Ikeuchi I Comparisons of social behaviours between diurnal and nocturnal geckos of Madagascar			Heatwole H Geographic variation in a far-flung archipelagic marine sea snake, <i>Laticauda colubrina</i>
13:00	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH
14:10 POSTER SESSION 1 (at lunch venue: SANLAM Hall, Langenhoven Students' Centre)						
15:10	Refreshments	Refreshments	Refreshments	Refreshments	Refreshments	Refreshments

Day 2: Tuesday 21 June	Venue 1 Conservatorium Ender Hall	Venue 2 Conservatorium Jannasch Hall	Venue 3 Conservatorium Fismer Hall	Venue 4 Lecture Hall 1028 Dept Soil Science	Venue 5 Conservatorium Classroom 1	Venue 6 Conservatorium Classroom 2
	Session Chair: Horne	Session Chair: Wassersug	Session Chair: Fleischman	Invasion/Introduction/Technique Session Chair: Campbell	Ecotoxicology Session Chair: Bell Barbara	Reptile Conservation & Variation Session Chair: Puky
15:40	Vogt R Twenty five years of Temperature Dependant Sex Determination in turtles resulted in a revolution in conservation and management practices	Hecker M, Everson G, Murphy M, Carr J, Kendall R, Smith E, Van der Kraak G, Solomon K, Giesy J and Du Preez L Seasonal changes in plasma sex steroid concentrations and gonad growth in wild African clawed frogs, <i>Xenopus laevis</i>	Peters R Moving to be seen: signal design in an Australian agamid lizard <i>Amphibolurus muricatus</i>	Hoare J, Nelson N and Daugherty C Have introduced mammalian predators prompted behavioural changes in New Zealand lizards?	Bell, Barbara and Spotila J High incidence of deformity in oil exposed and unexposed turtles from the John Heinz National Wildlife Refuge, Pennsylvania, USA	Halpern B and Péchy T Complex program to save the Hungarian meadow vipers (<i>Vipera ursinii rakosiensis</i>) from extinction
16:00	Teillac P, Cadi A, Girondot M and Prévot-Julliard A-C Impacts and future of invasive <i>Trachemys scripta elegans</i> in France	Weldon C and Du Preez L The role of <i>Xenopus laevis</i> in pathogen dispersal	Baird T Does reproductive coloration function as a signal in female collared lizards?	Platenberg R and Valiulis J Impacts of introduced herpetofauna species on the northern U.S. Virgin Islands	Mann R, Serra E and Soares A Trophic transfer of cadmium in <i>Podarcis carbonelli</i> – a model lizard for ecotoxicology	Carretero M and Kaliontzopoulou A Size and shape variation between populations of the lizard <i>Psammotromus algerus</i>
16:20	Discussion	Jaksic F and Lobos G The ongoing invasion of African clawed frogs (<i>Xenopus laevis</i>) in Chile: current status	Hews D Laterality in animal signaling: proximate and evolutionary perspectives	Neilson K and Tocher M Barking up the right tree – the use of dogs for locating cryptic reptiles	Khan Z, Yasmeen G and Hamid S Effects of sandaphos (organophosphate) and β -cypermethrin on cholinesterase activity in the liver and kidney of the skittering frog	Kaliontzopoulou A, Carretero M, Harris DJ, Sa-Sousa P and Llorente G Patterns of morphological change of <i>Podarcis bocagei</i> and <i>P. carbonelli</i> in sympatry
16:40	Discussion	Discussion Led by Richard Wassersug	Discussion			
17:00	Closure	Closure	Closure	Closure	Closure	Closure
17:30 – 19:00		World Congress of Herpetology Annual General Meeting				

Day 3: Wednesday 22 June	Venue 1 Conservatorium Ender Hall	Venue 2 Conservatorium Jannasch Hall	Venue 3 Conservatorium Fismer Hall	Venue 4 Lecture Hall 1028 Dept Soil Science	Venue 5 Conservatorium Classroom 1	Venue 6 Conservatorium Classroom 2
08:50	Announcements					
09:00-09:40	Plenary Lecture: Claude Miaud & Olivier Marquis Are amphibians good biological indicators?					
	Amphibian and Reptile Communities Session Chair: Schwarzkopf	Communication/Behaviour Session Chair: Hödl	Osmoregulation, Physiology and Medicine Session Chair: Ford S	Chelonian Conservation Session Chair: Garcia	Palaeoherpetology Session Chair: Rocek	Amphibian Phylogeny and Taxonomy Session Chair: Lötters
09:50	Ernst R, Rödel M-O & Linsenmair K Amphibian communities on the cutting edge – analysing patterns and processes in altered tropical forests: studies from the Guiana Shield and West Africa	Waldman B and Macfie K Chemosignals in the archaic New Zealand frog <i>Leiopelma hamiltoni</i>	Tracy C, Christian K and Tracy C Ecological significance of body size and skin resistance to terrestriality in frogs	Santidrián Tomillo P, Spotila J and Paladino F Effects of conservation efforts on the leatherback turtle (<i>Dermochelys coriacea</i>) population nesting at Parque Nacional Marino Las Baulas, Costa Rica	Laurin M, Meunier F, Germain D, and Lemoine M A microanatomical and histological study of the paired fin skeleton of the Devonian sarcopterygian <i>Eusthenopteron</i> and the conquest of land by vertebrates	Arntzen J and Caccone G Molecular phylogeny of the salamandrid salamanders
10:10	Brodman B The effect of wetland cluster size and hydrology on the diversity and abundance of amphibian metapopulations during a 10-year study in the American Midwest	Byrne, P Strategic male calling effort in terrestrial toadlets	Cartledge V, McMaster K, Withers P and Thompson G Water balance in Australian desert frogs	García G, Kuchling G, Randriamahita, Griffiths R and Feistner A Population status of Madagascar side-necked turtle (<i>Erymnochelys madagascariensis</i>) at Ankarafantsika National Park, Madagascar	Havelková P Developmental origins of the sternal elements in Anura	Degani G, Pearlson O, Blaustein L, and Goldberg D Molecular DNA variation and mitochondrial sequence analysis of <i>Triturus v. vittatus</i> (Urodela) at different breeding place altitudes at its southern distribution limit
10:30	Exbrayat J-M Reproduction and viviparity in <i>Typhlonectes compressicauda</i> , Dumeril and Bibron, 1841 (Amphibia, Gymnophiona)	Amézquita A, Hödl W, Castellanos L, Lima A, Erdtmann L and Araújo M C Masking interference and the evolution of the acoustic communication system of the Amazonian poison frog <i>Epipedobates femoralis</i>	Ford S Kidney function in Western Australian agamid lizards	Hagerty B, Tracy R, Morafka D, McCoy E and Averill-Murray R Preserving the diversity of the desert tortoise (<i>Gopherus agassizii</i>): reassessing conservation units	Laurin, M., Soler-Gijón, R. The otic region of the Carboniferous temnospondyl <i>Iberospondylus schultzei</i> , the middle ear of temnospondyls, and the evolution of hearing in early tetrapods	Igawa T, Kurabayashi A, Nishioka M and Sumida M Phylogenetic relationship among Asian toads inferred from the nucleotide sequences of mitochondrial DNA genes
10:50	Valentine L and Schwartzkopf L Responses of reptile assemblages to seasonal management burning for weed control in tropical savannas of northern Australia	Hödl W, De Luna G, Amézquita A, Narins P, Hirschmann W and Grabul D Vocal sac motion: epiphenomenon or signal in anuran communication	Bunkers J, Hodges W, Garland Jr T and John-Alder H Effect of an anthropogenic disturbance on plasma corticosterone levels in the desert iguana, <i>Dipsosaurus dorsalis</i>	Tracy C, Averill-Murray R, Boorman W, Delehanty D, Heaton J, McCoy E, Morafka D, Nussear K, Hagerty B and Medica P Scientific assessment of the recovery plan for the Mojave desert tortoise	Rocek Z Developmental patterns of Mesozoic pipid frogs and problem of Pipidae-Palaeobatrachidae relationships	Veith M, Kosuch J, Rödel M-O and Lötters S Beauty and the beast – the evolution of sexual dichromatism in Afrotropical tree frogs
11:10	Refreshments	Refreshments	Refreshments	Refreshments	Refreshments	Refreshments

Day 3: Wednesday 22 June	Venue 1 Conservatorium Endler Hall	Venue 2 Conservatorium Jannasch Hall	Venue 3 Conservatorium Fismer Hall	Venue 4 Lecture Hall 1028 Dept Soil Science	Venue 5 Conservatorium Classroom 1	Venue 6 Conservatorium Classroom 2
11:40	Penner J, Kroiss J, Glos J and Rödel MO The influence of fragmentation and selective logging on reptile communities	Wassersug R, Roberts L, Gimian J, Hughes E, Saunders R, Devison D, Woodbury J and O'Reilly J The behavioural responses of amphibians and reptiles in microgravity	Blacker H, Tsopelas C, Orgeig S, Daniels C, Chatterton B Physiological and molecular characterisation of lymphangiogenesis in regenerating gecko tails	Heaton J and Cablk M (presented by Inman) The use of scent discriminating dogs to locate desert tortoises in the wild	Winkler J, Scheyer T, Aguilera O and Sánchez-Villagra M Palaeobiology and diversity of the turtle fauna from the Late Miocene Urumaco Formation in Venezuela	
12:00	Venz M and Eyre T Scales of influence:- responses of a reptile community in fragmented woodlands in southern Queensland, Australia	Kam Y-C and Chiu C-T Nest homing behaviour and maternal care of the Taiwanese tree frog, <i>Chirixalus eiffingeri</i> (Anura: Rhacophoridae)	Toriba M Vaccination against habu (<i>Trimeresurus flavoviridis</i>) venom carried out in Amami Islands, Japan for 33 years	Chan E-H and Kuchling G Sex ratios of river terrapins (<i>Batagur baska</i>) in the head-starting facilities of Malaysia	Van Dijk E Fossil footprints of a bipedal reptile from South Africa	
12:20	Masterson G, Maritz B and Alexander G Does grassland management negatively impact conservation of herpetofauna in South Africa?	Werner Y The multidimensionality of herpetology expressed in integrative teaching				
12:40	Ibrahim A The herpetology of the Suez Canal Zone: is the Suez Canal a bridge or barrier to herpetofauna?					
13:00	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH
14:00 – 15:30		WCH Executive Committee meeting				

Afternoon free

18:00 – Busses depart from main venue to Oude Libertas centre for Social Function

Day 4: Thursday 23 June	Venue 1 Conservatorium Ender Hall	Venue 2 Conservatorium Jannasch Hall	Venue 3 Conservatorium Fismer Hall	Venue 4 Lecture Hall 1028 Dept Soil Science	Venue 5 Conservatorium Classroom 1	Venue 6 Conservatorium Classroom 2
08:50	Announcements					
09:00-09:40	Plenary Lecture: Keogh S Diversification of Elapid snakes					
	SYMPOSIUM 8 Recent advances in the study of foraging modes Session Chair: Perry	SYMPOSIUM 9 Quantifying the ecology of burrowing herpetofauna Session Chair: Measey	Reptile Reproduction, Social Behaviour and Disease Session Chair: Bull	Workshop 1 African Amphibian Systematics Session Chair: Cannatella	Reptile Phylogeny and Taxonomy Session Chair: Lamb	Amphibian Conservation/Declines Session Chair: Crossland
09:50	Andreadis P Impatient ambushing by a semiaquatic snake	Malonza P and Measey J Life history and seasonality of a Kenyan caecilian	Kratchovil L and Frynta D Body size effect on egg size in eublepharid geckos (Squamata: Eublepharidae), lizards with invariant clutch size: negative allometry for egg size in ectotherms is not universal	Workshop on African Amphibian Systematics facilitated by David Cannatella	Melville J and Austin J Evolutionary ecology and molecular systematics of the Australian agamid lizards (Amphibolurinae)	Lemckert F and Mahony M Frog pond communities from southeastern Australia show stable community structures
10:10	Mori A and Toda M Two step decision making for ambushing by a Japanese pitviper, <i>Trimeresurus okinavensis</i>	Balestrin RL, Di-Bernardo M and Moreno AG Reproductive biology and diet of the semifossorial colubrid snake, <i>Atractus reticulatus</i> (Boulenger, 1885), in southern Brazil	Hoyer M, Bruins E, Verstappen F, Wolters M and Kik M The use of Tamoxifen to prevent egg production in a Burmese python, <i>Python molurus bivittatus</i>	Workshop on African Amphibian Systematics facilitated by David Cannatella	Donnellan S, Foster R, Hugall A, Hutchinson M, Lee M and Saint K Phylogeny, age and morphological evolution of the Australian agamid radiation	Crossland M and MacKenzie D Assessment of site occupancy modelling as a technique to monitor the threatened New Zealand frog <i>Leiopelma hochstetteri</i>
10:30	Ford N Can habitat modification affect the foraging methods of semi-aquatic snakes?	Stoelting R Microevolutionary implications of genetic variation in the São Tomé caecilian <i>Schistometopum thomense</i>	Groot T, Bruins E and Kuhn M Parthenogenesis in the Burmese python, <i>Python molurus bivittatus</i>	Workshop on African Amphibian Systematics facilitated by David Cannatella	Rastegar-Pouyani N A new form of <i>Trapelus</i> (Sauria: Agamidae) from southern Iran	García G, Griffiths R, Mayol J and Oliver J Bringing amphibians back from the brink: the Mallorcan midwife toad (<i>Alytes muletensis</i>) recovery programme
10:50	Wall M Specific dynamic action in an ambush-foraging snake analogue, Burton's legless lizard (<i>Lialis burtonis</i> , Pygopodidae)	Measey J Ecology, ecography and the size of caeciliid caecilians	Allman P and Roosenburg W Intraspecific variation in reproductive strategies of a wide ranging turtle	Workshop on African Amphibian Systematics facilitated by David Cannatella	Benavides E, McClellan D, Snell H and Sites Jr. J Inferring the history behind a recent divergence. Molecular phylogenetics of the lava lizard genus <i>Microlophus</i> (Squamata: Tropiduridae)	Foster J and Buckley J Returning the pool frog <i>Rana lessonae</i> to England: lessons for amphibian re-introduction policy and practice
11:10	Refreshments	Refreshments	Refreshments	Refreshments	Refreshments	Refreshments

Day 4: Thursday 23 June	Venue 1 Conservatorium Ender Hall	Venue 2 Conservatorium Jannasch Hall	Venue 3 Conservatorium Fismer Hall	Venue 4 Lecture Hall 1028 Dept Soil Science	Venue 5 Conservatorium Classroom 1	Venue 6 Conservatorium Classroom 2
11:40	Kerr G and Bull M Measuring movement and microhabitat in the field independent of an observer	Penman T, Lemckert F and Mahony M Conservation management of a threatened burrowing frog species	Girondot M, Georges J-Y, Rivalan P and Prévot-Julliard A-C North-Atlantic global climate influences the nesting behaviour of leatherback turtles in French Guiana	Workshop on African Amphibian Systematics facilitated by David Cannatella	Lamb T and Bauer A Footprints in the sand: independent reduction of subdigital lamellae in the Namib-Kalahari ground geckos	Elron E, Gasith A, Levi S and Gafny S Increased occupancy, a possible syndrome of a declining population: the case of the green toad in Israel
12:00	Bouskila A and Boochnik R The risk associated with foraging modes: a comparison between lacertid foragers	Inman R, Nusslear K, Heaton JS and Tracy, CR Assessing sampling availability in desert tortoises (<i>Gopherus agassizii</i>)	Bull M Social monogamy and parasite loads in the Australian sleepy lizard <i>Tiliqua rugosa</i>	Workshop on African Amphibian Systematics facilitated by David Cannatella	Pramuk J, De Queiroz K, Bezy R and Sites Jr. J Phylogenetic relationships within Xantusiidae: using trees to address evolutionary questions at multiple levels	Mahony M and Clulow J The inadequacy of standard conservation management approaches to the disappearances and declines of amphibians. A role for assisted reproductive technologies
12:20	Werner Y, Takahashi H, Yasukawa Y and Ota H Analysis of some factors affecting foraging behaviour of a nocturnal ground lizard, <i>Goniurosaurus kuroiwae kuroiwae</i>	Kupfer A, Nabhitabhata J and Himstedt W A review of the first long-term ecological study on a caecilian amphibian	Hibbits T and Whiting M Sexual selection in the common barking gecko (<i>Ptenopus garrulus</i>)	Workshop on African Amphibian Systematics facilitated by David Cannatella	Sinclair E, Pramuk J, Scholl R, Bezy R, Crandall K and Sites Jr. J Teasing apart the sexual history in <i>Lepidophyma</i>	Trudeau V, Gallant N, Croteau M, Duarte P, Wade M and Lean D Disruption of reproductive and thyroid endocrine systems in frogs by estrogenic pollutants and UV-B radiation: implications for population decline
12:40	Hawlena D, Bouskila A and Abramsky Foraging mode may indicate why growing-up lizards lose their infant costume of blue tail and striped body	Discussion	Henen B and Oftedal O Reproductive nutrition of female desert tortoises (<i>Gopherus agassizii</i>): the importance of dietary protein in spring and summer	Workshop on African Amphibian Systematics facilitated by David Cannatella	Pook C, Fry B, Lambert M, Favreau Y, Doljansky Y and Wüster W A phylogeny for <i>Dendroaspis</i> (Elapidae), according to mitochondrial DNA and toxin amino acid sequence data	Garner T, Walker S, Bosch J, Cunningham A and Fisher M The distribution of <i>Batrachochytrium dendrobatidis</i> in Europe
13:00	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH
14:10 POSTER SESSION 2 (at lunch venue: SANLAM Hall, Langenhoven Students' Centre)						
15:10	Refreshments	Refreshments	Refreshments	Refreshments	Refreshments	Refreshments

Day 4: Thursday 23 June	Venue 1 Conservatorium Ender Hall	Venue 2 Conservatorium Jannasch Hall	Venue 3 Conservatorium Fismer Hall	Venue 4 Lecture Hall 1028 Dept Soil Science	Venue 5 Conservatorium Classroom 1	Venue 6 Conservatorium Classroom 2
	Session Chair: Bouskila	Session Chair: O'Reilly	Session Chair: Henen	Session Chair: Cannatella	Session Chair:	Session Chair: Mahony
15:40	Miles Donald and Losos J Morphology, locomotor performance and foraging mode	Discussion	Sandmeier F, Tracy R, Hunter K and DuPre S Novel tools for assessing disease in the desert tortoise (<i>Gopherus agassizii</i>)	Workshop on African Amphibian Systematics facilitated by David Cannatella		
16:00	Brown T and Nagy K Lizard energetics and the sit-and-wait versus widely-foraging paradigm	Discussion	Buley K and Gibson R ShellShock	Workshop on African Amphibian Systematics facilitated by David Cannatella		
16:20	Perry G The problem of modality	Discussion		Workshop on African Amphibian Systematics facilitated by David Cannatella		
16:40	Discussion	Discussion		Workshop on African Amphibian Systematics facilitated by David Cannatella		
17:00	Closure	Closure	Closure	Closure	Closure	Closure

18:30: Busses depart from main venue for Moyo Restaurant at the Spier Wine Estate for Congress Banquet (bring a warm jacket, ladies, please do not wear high-heeled shoes and everybody, COME HUNGRY!)

Day 5: Friday 24 June	Venue 1 Conservatorium Ender Hall	Venue 2 Conservatorium Jannasch Hall	Venue 3 Conservatorium Fismer Hall	Venue 4 Lecture Hall 1028 Dept Soil Science	Venue 5 Conservatorium Classroom 1	Venue 6 Conservatorium Classroom 2
08:50	Announcements					
	SYMPOSIUM 10 Reptilian Viviparity Session Chair: Thompson	SYMPOSIUM 11 Caecilians: symposium in honour of Himstedt Session Chair: Wilkinson	Phylogeography and Genetics Session Chair: Turner	Biogeography/Regional Faunas Session Chair: Das	Amphibian Ecology and Life History Session Chair: Denoël	Workshop 2 CITES Workshop Session Chair: Weissgold
09:10	Blackburn D The reptilian model for evolution of viviparity: its potential and limitations	Wilkinson M Classification and phylogeny of caecilians (Amphibia: Gymnophiona)	Chiari Y and Meyer A Conservation genetics of Malagasy amphibians	Das I Herpetofauna of a forgotten mountain: Gunung Murud, Sarawak, northern Borneo	Sztatecsny M, Jehle R and Hödl W Multiple paternity in the common toad (<i>Bufo bufo</i>)	Weissgold B CITES: An overview of a treaty designed to protect species from overexploitation for international trade
09:30	Stewart J Variation in development of the yolk sac of squamate reptiles	Loader S Phylogenetic diversity of East African caecilians	Turner A and Channing A A closer look at the phylogeography of moss frogs	Van Devender R W, Abercrombie C and Moler P Herpetological surveys of Cat Tien National Park, Vietnam	Jehle R, Sztatecsny M, Whitlock A, Burke T and Hödl W Sequential mating and paternity in the common newt (<i>Triturus vulgaris</i>)	Van Dijk P-P CITES and the conservation of tortoises and freshwater turtles
09:50	Flemming A and Blackburn D Close contacts of the giant kind: on placental interfaces in matrotrophic lizards	Venu G and Venkatachalaiah G Cytotaxonomy of Indian caecilians	Gamble T Delimiting species using multiple molecular datasets: an example in the genus <i>Acris</i>	Bragadeeswaran S Marine herpetofaunal diversity along Tamil Nadu, South East Coast of India.	Hettyey A and Roberts D Sperm traits of the quacking frog, <i>Crinia georgiana</i> : within and among population variation in a species with a high risk of sperm competition	Martens H CITES: Conservation issues of the live herp trade
10:10	Murphy C, Adams S and Thompson M The plasma membrane transformation as key to the evolution of viviparity	Müller H Caecilian skull development revisited	Zhang H, Zhou K and Zhang G Mitochondrial DNA divergence in Chinese populations of black spotted frog (<i>Pelophylax nigromaculata</i>): implication for late Pliocene vicariance	Dixson M and Carr J Structure of the herpetofauna of two wildlife management areas in Ouachita Parish, Louisiana, USA	Norris K and Hosie C More than one way to lay an egg: oviposition behaviour of the European newts, <i>Triturus vulgaris</i> and <i>T. cristatus</i> , on a range of substrates	Baard E CITES legislation and herpetological conservation in South Africa – a hindrance or practical conservation tool?
10:30	Refreshments	Refreshments	Refreshments	Refreshments	Refreshments	Refreshments

Day 5: Friday 24 June	Venue 1 Conservatorium Ender Hall	Venue 2 Conservatorium Jannasch Hall	Venue 3 Conservatorium Fismer Hall	Venue 4 Lecture Hall 1028 Dept Soil Science	Venue 5 Conservatorium Classroom 1	Venue 6 Conservatorium Classroom 2
11:00	Andrews R and Parker S PO ₂ in utero and the transition to viviparity in sceloporine lizards	Møbjerg N New insights in caecilian mesonephric nephron design	Sano N, Kurabayashi A, Mikami N, Fujii T, Yonekawa H and Sumida M Complete nucleotide sequence of the mitochondrial DNA of <i>Rhacophorus schlegelii</i> (family Rhacophoridae) and structural features of rhacophorid mtDNAs	Kovac S and Carr J Herpetofauna and microhabitat associations at Buckhorn and Sicily Island Hills Wildlife Management Areas in northeast Louisiana, USA	Denoël M, Whiteman H and Wissinger S Are cannibalistic morphs of the tiger salamander obligatory cannibals?	Jenkins H, Webb and Fergusson R (presenting on behalf of Jenkins) CITES and crocodylian conservation: perceived or real relationship?
11:20	Thomson M, Herbert J, Murphy C and Thompson M <i>HoxA10</i> in the viviparous lizard <i>Eulamprus tympanum</i> and the oviparous lizard <i>Lampropholis guichenoti</i>	Du Preez L and Wilkinson M The first record of a polystomatid monogenean from a caecilian host	Goricki S and Trontelj P Genetic differentiation of the European cave salamander <i>Proteus anguinus</i> (Proteidae)	Cook S Historical and ecological determinants of species richness in the lizard fauna of Australia's wet tropics	Chadwick E, Slater F and Ormerod S Phenological change in coexisting populations of <i>Triturus</i> : inter- and intra-specific differences in response	Discussion
11:40	Jones S, Swain R and Atkins N Flexibility in the timing of parturition: the key to viviparity in lizards?	Jared C and Antoniazzi M A contribution to the natural history of <i>Siphonops annulatus</i> (Amphibia, Gymnophiona, Caeciliidae)	Batista V, Carretero M and Harris J Genetic structure of <i>T. mauritanica</i> populations across the Mediterranean basin	Sharrad R, Sacchi M and Clay R The survival of reptiles in the Mount Lofty Ranges, South Australia	Yetman C Endeavours into the ecology of giant bullfrogs – some preliminary results	Discussion
12:00	Herbert J, Lindsay L, Thompson M and Murphy C Calcium transport across the uterine epithelium of pregnant lizards	Himstedt W Sensory ecology in caecilians	Harris J, Perera A, Vasconcelos R, Brown R, Carretero M and Pérez-Mellado V Morphology, mtDNA and subspecies in <i>Lacerta perspicillata</i>	Wegmann M, Veith M, Linsenmair KE and Rödel M-O Biogeography of West African amphibians – spatial prediction based on satellite derived data	Bell Ben and Pledger S Population stability, high survival and striking longevity in the terrestrial Maud Island frog <i>Leiopelma pakeka</i> in New Zealand	Discussion
12:20: POSTER SESSION 3 (at lunch venue: SANLAM Hall, Langenhoven Students' Centre)						
13:00	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH

Day 5: Friday 24 June	Venue 1 Conservatorium Ender Hall	Venue 2 Conservatorium Jannasch Hall	Venue 3 Conservatorium Fismer Hall	Venue 4 Lecture Hall 1028 Dept Soil Science	Venue 5 Conservatorium Classroom 1	Venue 6 Conservatorium Classroom 2
	Session Chair: Stewart	Session Chair: Gower	Session Chair: Arntzen	Session Chair:	Session Chair: Yetman	Session Chair:
14:10	Shine R Did embryonic responses to incubation conditions drive the evolution of reptilian reproductive modes?	Mohun S Caecilian eyes: a morphological and molecular perspective	Terrassa B, Brown R, Castro J, Giménez P, Hoskisson P, Pérez-Mellado V, Hernández-Estevéz J, Picornell A and Ramon M Genetic diversity of <i>Podarcis lilfordi</i> in the Balearic islands		Woodhead C, Vences M, Vieites D and Griffiths R Feeding ecology of <i>Mantella aurantiaca</i> at Andasibe, Madagascar	
14:30	Lourdais O, DeNardo D and Heulin B Does gravity influence maternal thermoregulation in an oviparous reptile?	Kupfer A Reproductive biology of caecilians (Amphibia: Gymnophiona): past, present & future	Brown R, Hoskisson P, Welton J and Báez M Secondary contact of <i>Gallotia galloti</i> lineages within an island		Van Dijk E and Koeslag A Anura as prey of the spotted eagle owl in the Western Cape, South Africa	
14:50	Calderón Espinosa ML, Méndez de la Cruz FR and Andrews R Egg retention in the <i>Sceloporus spinosus</i> group (Sauria: Iguanidae): evaluating the cold climate model for the evolution of viviparity	Gower D Conservation biology of caecilians (Amphibia: Gymnophiona)	Arntzen J W and Sá Sousa P Morphological and genetic differentiation of lizards (<i>Podarcis bocagei</i> and <i>P. hispanica</i>) over the Ria de Arosa archipelago, NW Spain, under vicariance and occasional dispersal			
15:10	Refreshments	Refreshments	Refreshments	Refreshments	Refreshments	Refreshments
15:40	Ramírez-Pinilla M, de Pérez G, Stashenko E and Carreño F Placental transfer of nutrients during gestation and ultrastructure of the placentae in <i>Mabuya mabouya</i>		Rastegar Pouyani E, Joger U and Wink M Phylogeography of the <i>Eremias persica</i> complex of the Iranian plateau			
16:00	Atkins N Deferral of parturition: a flexible strategy for optimising offspring fitness in viviparous skinks		Ursenbacher S Genetic structure in remnant populations of adder (<i>Vipera berus</i>)			
16:20	Chiaravigho M Reproductive trade-off in female of Argentine <i>Boa constrictor</i> (Boidea)		Sagvik J, Uller T and Olsson M Outbreeding depression – a problem in amphibian conservation?			
16:40	Adams SM, Biazik JM, Murphy CR and Thompson MB A new placental morphotype: The cyto-epitheliochorial placenta of the skink <i>Pseudemoia entrecasteauxii</i>					
17:00	Formal closure of the Fifth World Congress of Herpetology by Secretary-General					

Poster Schedule

SESSION	POSTER	PRESENTING AUTHOR	TITLE
Session 1	Poster 1	Adeba, Patrick Joel	The Influence of Forest Fragmentation on Community Composition of Leaf Litter Amphibians in Tai and Lamto
Session 1	Poster 2	Aranyavalai, Varanya	Taxonomic Re-evaluation of the Two Subspecies of <i>Leiolepis belliana</i> (Hardwicke & Gray, 1827)
Session 1	Poster 3	Atkins, Natalia	Using GPS to establish HR to assess SS and RS
Session 1	Poster 4	Attmarsson, Erik	Captive husbandry and breeding of a laboratory collection of the inland taipan, <i>Oxyuranus microlepidotus</i> , with a record of three consecutive clutches.
Session 1	Poster 5	Bergallo, Helena	Snake richness, abundance and mass in two areas of an Atlantic Rainforest area (Ilha do Cardoso, Brazil)
Session 1	Poster 6	Carr, John	The Herpetofauna of Upper Niger National Park, Guinea
Session 1	Poster 7	Exbrayat, Jean-Marie	First observations about the embryonic development of the pituitary in <i>Typhlonectes compressicauda</i> , (Amphibia, Gymnophiona)
Session 1	Poster 8	Exbrayat, Jean-Marie	The spleen in adult <i>Typhlonectes</i> (Amphibia, Gymnophiona)
Session 1	Poster 9	Hopkins, Samantha	Microhabitat Preference of Tadpoles in a temporary pond in the Western Cape, South Africa
Session 1	Poster 10	Hosie, Margot	Testicular structure and spermatogenesis of <i>Trachylepis varia</i> (Family Scincidae)
Session 1	Poster 11	Kam, Yeong-Choy	Effectiveness of amphibian monitoring techniques in a Taiwanese subtropical forest
Session 1	Poster 12	Kok, Phillipe	Preliminary investigations of the herpetological species richness and community structure
Session 1	Poster 13	Kratochvil, Lukas	Egg shape and size allometry in geckos (Squamata: Gekkota), lizards with contrasting eggshell structure
Session 1	Poster 14	Lemckert, Francis	Plantations do not perform well as habitat for herps
Session 1	Poster 15	Manzano, Adriana	Forelimbs musculature and associated tissues in turtles
Session 1	Poster 16	Maritz, Bryan	The effect of pitfall size and type of funnel trap on trap success
Session 1	Poster 17	Marques Lima dos Santos, Rodrigo	Banding patterns and chromosomal evolution in five neotropical species of Telidae, Squamata).
Session 1	Poster 18	McKay, Jeanne	The Declining Amphibian Populations Task Force (DAPTF): achievements and future directions
Session 1	Poster 19	Moretti, Renata	Spawning sites of the side-necked turtles <i>Peltecephalus dumerilianus</i> (Schweigger, 1812), <i>Podocnemis erythrocephala</i> (Spix, 1824) and <i>Podocnemis expansa</i> (Schweigger, 1812) (Testudinata, Podocnemididae) on the Trombetas River's basin, State of Pará, Brazil
Session 1	Poster 20	Nuneza, Olga	Participatory Assessment of Amphibian Fauna in Malindang Range, Philippines
Session 1	Poster 21	Rastegar-Pouyani, Nasrullah	Lizard Fauna of Southern Zagros Mountains, Iran
Session 1	Poster 22	Rastegar-Pouyani, Nasrullah	Systematics and Biogeography of Lizards of Kermansha Province, Western Iran
Session 1	Poster 23	Da Rocha, Carlos Frederico	Niche differences among sympatric lizards in a sand dune habitat of Southeastern Brazil (Jurubatiba, Rio de
Session 1	Poster 24	Da Rocha, Carlos Frederico	Frog species richness and composition in coastal Brazilian restinga habitats

Session 1	Poster 25	Rodrigues, Miguel Trefaut	Molecular phylogeny and origin of parthenogenesis in lizards of the genus <i>Leposoma</i> (Squamata, Gymnophthalmidae)
Session 1	Poster 26	Rodrigues, Miguel Trefaut	A new genus and species of microteiid lizard from the Atlantic Forests of the state of Bahia, Brazil, with a new generic name for <i>Colobosaura mentalis</i> , and a discussion of relationships among the Herodactylini (Squamata, Gymnophthalmidae)
Session 1	Poster 27	Shimada, Tomohiko	Taxonomy of <i>Meristogenys</i> from a stream in Borneo
Session 1	Poster 28	Slater, Fred	Three Decades of Decline in Wales: A Retrospective View
Session 1	Poster 29	Söderman, Fredrik	Life history characteristics and population trends of the common frog <i>Rana temporaria</i> in Malla nature reserve, northern Finland
Session 1	Poster 30	Trudeau, Vance	Differential sensitivity of anuran species to the toxic effects of malathion and methylmercury
Session 1	Poster 31	Van Sluys, Monique	Frog community from the floor leaf litter from an Atlantic Rainforest area from southeastern Brazil
Session 1	Poster 32	Westhoff, Guido	Response characteristics of infrared sensitive multiunits in the Tectum opticum of <i>Crotalus atrox</i>
Session 1	Poster 33	Dawood, Abeda	Genetic variability between populations of the critically endangered frog <i>Microbatrachella capensis</i>
Session 1	Poster 34	Zimkus, Breda M.	Preliminary phylogeny of <i>Phrynobatrachus</i> (Anura: Petropedetidae) inferred from mitochondrial 12S and 16S rRNA sequences
Session 1	Poster 35	Amaro-Ghilardi, R	A new diploid number for the Neotropical genus <i>Leptodactylus</i> (Amphibia, Anura, Leptodactylidae)
Session 2	Poster 1	Antoniazzi, Marta Maria	Morphological characterization of the infralabial glands of "goo eater" snakes (Colubridae: Dipsadinae)
Session 2	Poster 2	Barribaeau, Seth	The Role of the MHC in Disease Resistance in <i>Xenopus laevis</i> Tadpoles
Session 2	Poster 3	Benavides, Edgar	Small-scale phylogeography of Galapagos Lava Lizards (Genus <i>Microlophus</i>): Patterns of Colonization and Demographic History
Session 2	Poster 4	Borczyk, Bartosz	Sexual dimorphism in body size and tail length in the European Grass Snake
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ORAL PRESENTATION ABSTRACTS

A new placental morphotype: the cyto-epitheliochorial placenta of the skink *Pseudemoia entrecasteauxii*

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The placentae of viviparous amniotes can be categorized as epithelio-chorial, endothelio-chorial or hemo-chorial. In the latter two, the uterine epithelium is breached and embryonic tissues embed to varying degrees in the underlying stroma. In the epitheliochorial mode of placentation, the uterine epithelium remains intact, at least to the extent that it is not breached, and it continues to form an unbroken layer that is the usual histological condition of epithelium. All three types of placentation occur in mammals, but only the epitheliochorial type has been described in squamates so far. We used scanning and transmission electron microscopy to describe uterine tissue of the viviparous lizard *Pseudemoia entrecasteauxii*. The paraplacental region of the chorioallantoic placenta shows a distinct variation of epitheliochorial placentation; the cytoplasm becomes extremely attenuated for extended distances over maternal blood vessels and the epithelial nuclei become displaced to occupy only the portion of the epithelial cell that lies alongside the invaginated maternal blood vessels. Displacement of the nuclei and organelles reduces the uterine cell layer to an attenuated cytoplasmic extension that overlies the endothelial layer of the uterine capillary. Thinning of the uterine epithelium becomes more extensive as pregnancy progresses and the uterine capillaries expand, resulting in the maternal-fetal barrier being reduced to as little a 0.5µm thick extension of uterine epithelial cytoplasm, suggesting optimal gas exchange is facilitated by these modifications. We have suggested calling this form of placentation the "cyto-epitheliochorial" placental type. As a similar placental morphotype has been described in a eutherian mammal, the American mole, *Scalopus aquaticus*, our concept of "cyto-epitheliochorial" placentation may have applicability across placental amniotes.

Reptiles: the best indicators of environmental disturbance?

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The diversity and richness of vertebrate assemblages are often used as indicators of environmental quality. Using a single class of terrestrial vertebrates can cause problems because the classes vary in vagility,

environmental sensitivity, and detectability. We compared the responses of amphibians, reptiles, birds, and mammals to disturbance by sampling in undisturbed and revegetated areas at an open-cut bauxite mine near Weipa, Queensland, Australia. The native vegetation in the area is open woodland dominated by *Eucalyptus tetrodonta*, with mesic forest along watercourses. The vegetation of revegetated sites was highly variable in composition. We sampled 75 plots, including 15 with native vegetation and 60 revegetated sites aged from 3 to 22 years. These were stratified by age class, and by distances from mesic habitat and native woodland. We carried out repeated surveys to characterise the vertebrate assemblage in all seasons, using a variety of techniques. Birds recolonised very quickly following disturbance, and the composition of the bird assemblage at each revegetated site was affected most strongly by the composition of the dominant vegetation. The mammal fauna showed little pattern with respect to time since disturbance or distance to native habitat. The amphibian fauna re-established quickly following disturbance, and appeared insensitive to the composition of the dominant vegetation. Amphibians were affected most strongly by distance to mesic habitats and native woodland. The clearest effects of disturbance were evident in the composition of the reptile assemblage at each site. Reptile richness remained low on average for at least 22 years following revegetation, and was negatively related to distance from native habitats, and thus potential sources of colonists. Our results suggest that monitoring the reptile assemblage in this system would provide the most sensitive indicator of recovery following severe disturbance.

Intraspecific variation in reproductive strategies of a wide ranging turtle

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Understanding the importance of intraspecific phenotypic differentiation among wide ranging populations remains at the core of life history research. Phenotypic variation in life history traits such as offspring size, growth, and survivorship is the target of studies attempting to understand the coevolution of these traits. Species with a wide geographic range have long been used for these studies because adaptation to local environmental conditions is expected. We collected diamondback terrapin, *Malaclemys terrapin*, eggs from multiple sites within its range to quantify variation in egg size and the amount of stored energy reserves provided within the eggs. Females in southern populations produce significantly larger eggs than females in northern populations. The larger eggs contain a larger yolk and have more lipid stores. Eggs from three populations were incubated at

three temperatures to compare the thermal influence of lipid utilization and development rates among the populations. There is an interaction effect between the source population and incubation temperature indicating the influence temperature has on development rates is population specific and will vary among populations of a single species. We will also present information on hatchling growth and energetics, including lipid utilization and metabolic rates, to suggest intra-specific variation in egg size is driven by the energetic demands of hatchlings and not by a simple demographic tradeoff as currently believed.

The evolutionary ecology of sex allocation in viviparous lizards

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Previous work on *Eulamprus tympanum* (the southern water skink) suggests that offspring sex is determined by temperature. The existence of TSD in live-bearers is novel, and its phylogenetic spread and the associated socio-ecological correlates offer a potential new niche for the study of sex determination and sex allocation. However, whilst the reports of TSD in viviparous species are enticing, we must ensure that we proceed with attention to biological reality – as for an observed trait to be evolutionary meaningful, it must operate within the bounds of the animal's natural environment. In the present study I revisit reports of TSD in *E. tympanum*, framing the study in a natural context of variation in the time available for pregnant females to bask. Further, I extend the experiment to test for a potential interaction between the effects of temperature and the operational sex ratio that a pregnant female experiences. The overall aim being to test the hypothesis that pregnant females are able to facultatively select the sex of their offspring in response to imbalances in the OSR, using TSD as the mechanism of sex ratio adjustment. In addition, I investigate the sex determining mechanism and potential for facultative sex allocation in the sister species to *E. tympanum*, the yellow bellied water skink, *Eulamprus heatwoeli*. Any differences between these two species in their mechanism of sex determination, or their ability to facultatively allocate sex, offers great potential for deepening our understanding of the selective forces shaping the evolution of these fundamental traits.

Impatient ambushing by a semiaquatic snake

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Many supraspecific clades (e.g. Linnean families) exhibit evolutionary conservatism in foraging mode. Taxa that deviate from the behavior typical of their

lineage are thus of considerable evolutionary interest. Among snakes, viperids embody the passive extreme on the foraging mode spectrum. I have been using nightvision devices (sensitive to near-infrared light) to record the movements of a semiaquatic, North American viperid, the Cottonmouth (*Agkistrodon piscivorus*). Cottonmouths appear to employ a more active foraging style than confamilials. Cottonmouths do hunt from ambush, either in a coiled or an extended posture. However, while ambush site tenancy for many viperids is measured in days, cottonmouths are noticeably less patient. In nocturnal observations of 2-8 h, cottonmouths occupied 1-5 ambush sites (mean 1.8 sites, n=28); 43% of the snakes occupied 2+ sites. Another behavior consistent with frequent site changes is the scent marking of noteworthy ambush sites. Cottonmouths rub their head on emergent objects after encounters with prey. I also have some limited observations to suggest that cottonmouths may occasionally employ active search. Habitat seems to provide the best explanation for the impatient ambushing of cottonmouths, as water is an energetically efficient, low friction medium for locomotion. Foraging mode theory will be enriched by (1) closer scrutiny of those taxa that do not fit the profile of the extremes, and (2) lengthier observations (via technological prostheses and old-fashioned persistence) of foraging individuals.

PO₂ in utero and the transition to viviparity in sceloporine lizards

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The evolution of reptilian viviparity from oviparity putatively requires transitional stages of increasingly longer periods of embryonic development in utero, that is, longer periods of egg retention by the gravid female. Studies on sceloporine lizards demonstrate that embryonic responses to egg retention that is extended beyond the time of normal oviposition range from developmental arrest to normal development. The present study was designed to test the hypothesis that O₂ availability is the proximate factor that determines the rate and degree of development when eggs are retained in utero. Eggs of *Urosaurus ornatus*, *Sceloporus undulatus*, *Sceloporus virgatus*, and *Sceloporus scalaris* were incubated under simulated in utero conditions at pO₂s of 5.3, 7.9, 13.8, 18.5 kPa for 10 days starting at the time of normal oviposition. These data were used to establish a standard curve for the relationship between oxygen concentration and the amount of development. Information on embryos that were retained by females was used to establish the actual amount of development in utero during the same time period. Results indicate that pO₂ in utero is directly related to the amount of development that occurs in eggs that are retained beyond the time of normal oviposition, ie., pO₂ increased in the order of *U.*

ornatus, *S. undulatus*, *S. virgatus*, and *S. scalaris*. Development during extended egg retention in utero of these species is arrested, arrested, retarded, and normal, respectively. These observations indicate that selection for extended egg retention is associated with incremental increases in the availability of oxygen to embryos.

Using multiple methods to manage capture bias: some cautions and considerations

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It is known that certain methods may capture a sex, age class, or species particularly efficiently. In order to reduce the effects of these biases, researchers often employ multiple techniques. However, the portion of a population (e.g., sex, size) that a suite of methods captures has rarely been evaluated, especially between sites. We compared how three methods (hand captures, traps, and road-searching) captured gopher tortoises (*Gopherus polyphemus*) both within and between sites in Mississippi and Florida, USA. The type of method employed significantly influenced age class, sex and size of tortoises captured. More importantly, the biases of some methods (e.g., hand captures, road cruising) were not consistent between sites. Our data suggest that researchers may not be able to predict how a given method will perform (in terms of its biases) when used at a new study site. We present a novel way to interpret variation in capture efficiencies both within and between sites. Furthermore, we propose that studies could benefit by making three considerations. First, prior to any study, a suite of methods which meet the assumptions of the multiple methods paradigm should be chosen. After gathering preliminary data, researchers could evaluate their methods using our bias matrix and select those methods which minimize bias. Lastly, authors of comparative studies of demography and life history could test for bias both within and among their study sites and report results appropriately.

Molecular phylogeny of the salamandrid salamanders

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We sequenced 800 bp of the cytochrome-b mitochondrial gene of 12 *Triturus* and 25 other salamander species together representing all 14 nominal genera of salamandrid salamanders. Data were analysed with a Bayesian method of inference,

with and without published sequence data incorporated. Basal groups are subsequently i) the monospecific genus *Salamandrina*, ii) a clade of 'true' salamanders (*Chioglossa*, *Mertensiella* and *Salamandra*), iii) a *Pleurodeles-Tylotriton* clade and iv) the American *Taricha* and *Notophthalmus* clade. In the remainder, *Triturus* species are placed in three or more groups, in line with the earliest classification by Bolkay (1928) who recognized species groups characterized by small-, medium- and large- body size. The genus is, however, not monophyletic. For example, *Euproctus asper* is sister to the *T. cristatus* - *T. marmoratus* group (A) and the Oriental *Cynops* - *Pachytriton* - *Paramesotriton* clade is sister to *T. alpestris* (B). These groups, together with *Neurergus* and *T. vittatus* from the Near East and the *Corsica-Sardinian Euproctus* are sister to the clade of small-bodied *Triturus* species (i.e., *T. boscai*, *T. helveticus*, *T. italicus*, *T. montandoni* and *T. vulgaris*) (C). Molecular clock estimates on the basis of four palaeogeographic calibration points indicate that the lineages A-C are 20-33 MY old.

Morphological and genetic differentiation of lizards (*Podarcis bocagei* and *P. hispanica*) over the Ria de Arosa archipelago, NW Spain, under vicariance and occasional dispersal

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We studied 13 island and several mainland populations of *Podarcis*-lizards in the Ria de Arosa in NW Spain by the joint analysis of morphological and genetic data (14 morphometric characters, 12 meristic characters, eight variable enzyme loci and DNA sequence data for a 300 bp stretch of the cytochrome-b gene). Molecular methods perform well for *P. bocagei* versus *P. hispanica* species identification. Locally both species have parapatric ranges over the inner and outer islands of the Ria, respectively. Island lizards are larger than their mainland counterparts, with a contrasting pattern shown for relative head-chest length and relative hindlimb size. The number of supraocular scales is higher on islands than in the mainland. Two individuals carried *hispanica* mitochondrial DNA in a *bocagei* nuclear background. We conclude that dispersal and hybridisation events are rare and form insufficient a homogenizing force to prevent the morphological and genetic diversification of island populations. Morphological change in the archipelago has occurred over up to 14,000 yr of population isolation, following the inundation of the Ria river valley by a rising sea-level.

Deferral of parturition: a flexible strategy for optimising offspring fitness in viviparous skinks

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In most squamates viviparity is, in effect, prolonged egg retention, with relatively simple placental arrangements and embryonic nutrition is supplied through yolk. Nevertheless, in many squamates viviparity involves a diverse range of placental arrangements and a complete spectrum of embryonic nutritional modes. Obviously placentotrophy must confer advantages that overcome the costs of producing and maintaining complex placentae, and presumably these advantages relate to ecological circumstances where lecithotrophy has limitations. Utilising species in my model genus, *Niveoscincus*, there is strong evidence that placentotrophy first evolved as a facultative mechanism enabling mothers to supplement an adequate yolk supply, and to provide flexibility in the timing of parturition. The basis of my comparative study is the primarily lecithotrophic *N. metallicus* which has limited capacity to delay parturition under adverse conditions. The southern snow skink, *N. microlepidotus*, while also primarily lecithotrophic, exploits the option of deferred parturition even further. In this species, embryos are fully developed in autumn but remain in utero over winter with birth occurring in mid-spring. I have shown that a trade-off exists between offspring fitness and survival in this species by experimentally delivering embryos in autumn. This species also has the ability to defer birth for an additional four weeks, when experimentally placed under cold conditions at the time of natural births. The spotted snow skink, *N. ocellatus* represents the alternative evolutionary avenue and exhibits significant placentotrophy. I investigated the ability of this species to defer parturition when experimentally placed in cold conditions for differing lengths of time at the end of gestation, and the resultant consequences for offspring quality and survivorship. With the shift to a more obligate placentotrophic component, there has been a reduction in the capacity for facultative placentotrophy and therefore reduced flexibility in the timing of parturition.

Ecology and population structure of sympatric turtle species inhabiting a highly urbanized freshwater ecosystem: a case study for determining effects of habitat fragmentation, modification, and isolation on a model reptilian community

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Habitat loss, degradation, and fragmentation are considered major factors in the global decline of aquatic and semi-aquatic reptiles. Wetlands that

provide opportunities for foraging, predator avoidance, nesting, and other essential activities of semi-aquatic reptiles have declined precipitously in the United States over the last 200 years. We conducted a comparative study of five sympatric aquatic turtle species inhabiting twelve aquatic wetlands at the Philadelphia International Airport (Philadelphia, Pennsylvania, USA), to determine whether populations of turtle species respond differentially to habitat changes caused by urbanization. We assessed each wetland for severity of habitat modification, fragmentation, and isolation. We marked, measured, and recaptured >1,500 individual threatened red-bellied turtles (*Pseudemys rubriventris*), painted turtles (*Chrysemys picta*), snapping turtles (*Chelydra serpentina*), musk turtles (*Sternotherus odoratus*) and invasive red-eared slider turtles (*Trachemys scripta*) inhabiting twelve wetlands on and adjacent to the Philadelphia International Airport, to determine how urbanization and wetland modifications affect turtle populations and communities. Populations of red-bellied turtles inhabiting wetlands <0.5 km apart from adjacent wetlands achieved higher densities, and had more size classes represented, than populations occupying more isolated wetlands. More isolated wetlands (>0.5 km apart) had either 1) highly biased populations of red-bellied turtles in favor of adult size classes, or 2) had no red-bellied turtles. In contrast, populations of painted turtles and snapping turtles were ubiquitous throughout the system of Airport wetlands, achieved relatively high densities, and had more size/age classes represented, compared to populations of red-bellied turtles. Populations of non-native red-eared slider turtles occurred predominantly outside of protected Airport grounds, where the surrounding human population had free access to wetlands. Populations of red-eared slider turtles were composed of a high proportion of juvenile-sized individuals, suggesting that non-native turtles had relatively high rates of nest success, or, more likely, high rates of introduction to the ecosystem from anthropogenic sources (i.e., captive releases). Musk turtles were relatively rare or absent from sampled wetlands. Nesting sites were generally extremely spatially limited, and were often restricted by fences or adverse habitat modification, which presumably had negative effects on hatchling success for all turtle species. Surveys of nesting areas revealed high rates of predation along edges of designated wetlands (e.g., along fencelines, roads, runways, etc.). Our comparative study of sympatric turtle species at the Philadelphia International Airport provides a case study and model for understanding the complex effects of urbanization on semi-aquatic reptiles at the individual, population, and community levels.

Effects of resource availability on the reproduction and survivorship of the desert tortoise (*Gopherus agassizii*): implications for the life history and demography of desert reptiles

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Conservation and management efforts for recovering declining reptiles are encumbered because of the inability to connect environmental variation to demographic rates in wild populations. Although it is generally assumed that desert tortoise (*Gopherus agassizii*) populations fluctuate as a result of spatial and temporal variations in environmental factors, it is not known how environmental variations affect demographic parameters for this and many other reptilian species. Accurate data on birth rates, recruitment rates, death rates, and growth rates in response to environmental variations are not available for the desert tortoise. Our study of the reproductive ecology and survivorship of the desert tortoise in the Mojave Desert, California, has helped to elucidate the relationships between environmental fluctuations and demographic processes in this model desert reptile. We report demographic findings from two study sites in the Mojave Desert where we closely monitored reproduction and survivorship in radio-tagged individuals. At one study site (Ivanpah Valley, Mojave National Preserve, California), rainfall varied three- to four-fold within the valley along a 10 km-long elevation gradient ranging from 850 m to 1150 m. At lower elevation sites, annual rainfall was lower and mean clutch size of female tortoises was 3.8 eggs clutch⁻¹, whereas at higher elevation sites, mean clutch size was 4.9 eggs clutch⁻¹. Mean clutch frequency at the lower elevation sites was 1.3, compared to 1.5 at the higher elevation sites. Adult female survivorship during 1997 to 2000 was 77.8% at the lower elevation sites, compared to 100% at the higher elevation sites. At another study site to the west (Fort Irwin Reference Site [FIRS], near Barstow, California), low fecundity rates of 3.2 eggs clutch⁻¹, and a mean clutch frequency of 0.9 occurred in the same year. Adult female survivorship at FIRS was 90.5% from May 2000 to November 2001. Nesting success was very low at both Ivanpah and FIRS study sites due to high predation rates and nest flooding. Episodes of high adult mortality have also been studied at the Ivanpah study site over the last 15 years. These episodes of high mortality occurred during relatively long (e.g., 1.5 yr) intervals of low rainfall. Because the sex ratio of dead adult tortoises found during these episodes was greatly biased toward females, we hypothesized that the relatively high investments of energy, nitrogen and water that are made to produce eggs in the nesting season prior to drought made reproductive females especially susceptible to mortality during subsequent intervals of drought.

CITES legislation and herpetological conservation in South Africa – a hindrance or practical conservation tool?

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The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) came into force on 1 July 1975 and has a membership of more than 150 countries. These countries act by regulating and monitoring the commercial international trade in an agreed list of species whose survival in the wild may be threatened by unregulated trade and/or over-exploitation. In South Africa, the national Department of Environmental Affairs and Tourism is the implementing agent of CITES and acts as the communication channel between the CITES Secretariat and the country. Each of the nine provinces or states has the delegated responsibility for the implementation of the Convention in their respective provinces. There are currently 58 South African reptile species listed by CITES and include all terrestrial tortoises, sea turtles, and the marsh terrapin, the Nile crocodile, all members of the girdled and crag lizard genera *Cordylus* and *Pseudocordylus* respectively, the African rock python, all members of the dwarf chameleon genus *Bradypodion*, as well as the flap-necked and Namaqua chameleons, the Namaqua day gecko, and the rock and water monitors, genus *Varanus*. No South African frogs are listed by CITES. South African tortoises, girdled lizards and dwarf chameleons appear to be sought-after items on the international herpetological pet market, but very little, if any, evidence exists to corroborate this. One could argue that this is a result of strict enforcement of conservation policies and legislation including CITES, since in general, South African conservation authorities have not supported the commercial exploitation of herpetofauna from the wild. In this presentation, the current situation and trends regarding new policies and legislation will be addressed, backed up with CITES export and import statistics and a conclusion drawn as to whether CITES is a hindrance or a useful conservation tool in South Africa.

Does reproductive coloration function as a signal in female collared lizards?

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Female-specific reproductive coloration is widespread among lizards, prompting several hypotheses to explain potential signaling functions. I tested four of these hypotheses in free-ranging collared lizards, *Crotaphytus collaris*. Female markings did not appear to function for advertisement to same-sex competitors because they were rarely displayed during female-

female interactions, and markings developed well before peak aggression among females. The number of displays given to courting males by females that had, and had not yet developed markings did not differ suggesting that markings do not function as a sex-recognition signal. Females developed pigmentation while they matured their first clutches, and markings were maintained throughout the development and oviposition of second and third clutches. Male courtship with females having markings was longer and involved more displays, suggesting that development of coloration stimulates male courtship when females are receptive. To test this hypothesis experimentally, I established nine pairs of females that had not yet developed markings and were matched for size, age, and reproductive stage. One female in each pair was painted with orange markings and the other with light brown to match the natural background coloration of female *C. collaris*, and to mask natural markings when they developed. Males began courting orange-painted females within 2h, and orange females were courted over five times more frequently than brown females. The difference in courtship frequency did not appear to result from males avoiding brown females because the average male-female distance in the two treatment groups was not different. Together results support the hypothesis that reproductive coloration in *C. collaris* females signals courtship receptivity rather than rejection to males.

Reproductive biology and diet of the semifossorial colubrid snake, *Atractus reticulatus* (Boulenger, 1885), in southern Brazil

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Atractus reticulatus is a small, semifossorial snake that occurs from Paraguay to Uruguay. This study was based on the analyses of 135 specimens from southern Brazil, preserved in collections, and on field observations. The snout-vent length (SVL) of mature females was significantly larger than that of mature males, and the tail length (TL) of mature males was significantly longer than of mature females. Males may reach sexual maturity in eight to 10 months (SVL c. 198 mm) and females in 11 to 12 months (SVL c. 242 mm). The reproductive period begins in late August, with clutches from November to January, and recruitment from January to March. Fecundity is low: the number of vitellogenic follicles varied from 2 to 6, and the number of eggs from 1 to 3. The eggs are large, elongated, and the clutches are heavy, corresponding to approximately 27% of the parental female weight. Fecundity reduction and egg elongation appears to be one answer to the semifossorial way of life, as specimens need to move inside galleries and under rocks. *Atractus reticulatus* feeds exclusively on annelids. Thirty two stomachs (25.4%) contained 52 items, being 44 (84.6%) oligochaetes (75.0% of them of the family Megascolecidae), four (7.7%) Hirudinea, and four

(7.7%) unidentified annelids. Among 20 individuals captured with some content in the gut, 17 (85.0%) were captured by night or in the first hours of the morning, indicating foraging activity in these periods. About 83% of ingested prey was epigeic indicating that this species forages mainly at the soil surface. Prior to swallowing, the annelids were usually oriented and ingested from the anterior portion of the body (86.4%, n = 32), possibly as worms taken from behind may autotomise and hence escape from the snake.

Ambush site selection in a generalist forager, the Western cottonmouth (*Agkistrodon piscivorus leucostoma*)

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Ambush site selection in the western cottonmouth (*Agkistrodon piscivorus leucostoma*) plays an important role in foraging success. Fieldwork conducted in Hardin Co. Tennessee characterized the factors affecting ambush site selection in this generalist forager. The study also analyzed the importance of prey availability in site selection. Various habitat features were recorded at the ambush sites as well as at four distinct sites at a distance of 2 meters from the ambush sites. These random sites were determined using the four compass points and were used as potential sites that were not selected by the snakes. Recorded habitat features included aquatic versus terrestrial habitat, cover, water depth, grass density, distance to/from shore, water flow, distance from wood structure (with >2 cm diameter) and aquatic support. For each captured snake, sex, total and tail length, as well as weight was determined. To estimate prey availability, frog density surveys were conducted for three nights. Researchers walked the 800 meter stream system recording number of frogs seen, flushed, and heard within 2 meters of the stream. Ambush site selection in *A. p. leucostoma* was determined to be non-random. Habitat factors such as water depth and cover were shown to be significant in site selection whereas distance from wood structure and aquatic versus terrestrial habitat were shown to be randomly selected. Prey density was shown to have a 98% correlation with site selection using the Pearson Correlation Coefficient. Since foraging success is determined by prey capture, it would seem logical that site selection is strongly influenced by location and density of prey. Ambush site selection in the generalist forager, *A. p. leucostoma*, is non-random and strongly influenced by prey location as well as habitat features such as cover, which may aid in camouflage from potential predators.

Taxonomy of the *Pseudocordylus melanotus* complex (Sauria: Cordylidae)

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The taxonomic status of crag lizards referable to the *Pseudocordylus melanotus* complex of South Africa, Lesotho and Swaziland remains confused. Until recently three subspecies of *P. melanotus* were recognized, namely *melanotus*, *subviridis* and *transvaalensis*. The other two taxa in the complex are *P. langi* and *P. spinosus*, both of which have, in the past, been confused with *P. m. subviridis*. An attempt was made to resolve the taxonomy of this complex using both morphology and allozymes. A total of 532 specimens were examined for 80 scale characters each, while allozyme electrophoresis was conducted on samples from 13 localities representing all known taxa (except *P. spinosus*) and including apparently isolated populations. The allozyme analysis confirmed the species status of *transvaalensis*, *melanotus*, *subviridis* and *langi*. There was a fixed allelic difference between sympatric *subviridis* and *langi*, as well as parapatric *subviridis* and *melanotus*. Two populations from the northern part of the range of *melanotus* also represent separate lineages. An isolated population of *subviridis* in the Amatole Mountains and a population from southern Lesotho differ from other *subviridis*. However, an isolated population of *melanotus* in northern KwaZulu-Natal was inseparable from *transvaalensis* using allozymes, although the two taxa are easily separated morphologically. All five currently recognized taxa are distinguished using scale characters. There are also differences in head scalation between the three allopatric sub-populations of *P. transvaalensis*. Over most of their geographical ranges, including areas of parapatry, *melanotus* and *subviridis* are distinguishable by differences in the frontonasal (divided in *melanotus*, entire in *subviridis*) and arrangement of enlarged lateral temporals (in two rows horizontally in *melanotus*, a single row in *subviridis*). In northern populations of *melanotus* the frontonasal is usually entire, as in *subviridis*, but the temporals remain typically *melanotus*.

Genetic structure of *T. mauritanica* populations across the Mediterranean basin

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The Moorish gecko, *Tarentola mauritanica*, is well distributed throughout North Africa from the Mediterranean to the Sahara and also in the Iberian Peninsula, the southern coast of France, Italy and has isolated populations in Greece, Israel and many Mediterranean islands. Mitochondrial DNA (12S rRNA and 16S rRNA) sequences were analysed and revealed that *T. mauritanica* might be a species

complex, with at least eight genetically distinct lineages, and paraphyletic with respect to *Tarentola angustimentalis* from the Canary Islands. A single mitochondrial DNA haplotype was found in Portugal, Spain, Italy, Tunisia, Menorca, Crete and Madeira, raising the possibility that *T. mauritanica* might be introduced across Europe. Since the majority of variation within this species is in North Africa, it was suggested that the introduction was probably from Tunisian populations to Europe. However an extended analysis found a new genetically distinct lineage found so far only in Spain, which seems to indicate that not all the European populations result of an anthropogenic introduction.

Phylogenetic and biogeographic patterns of gekkonid lizard diversity in sub-Saharan Africa

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Gekkonid lizards constitute an important component of reptile diversity in sub-Saharan Africa. Distinctive endemic gecko faunas characterize Southern, Eastern, Equatorial, and West Africa and relatively few taxa link adjacent regions. Diversity is greatest in Southern Africa, which is characterized by high levels of both specific and generic endemism. The largest and most diverse radiation of Southern African geckos is the *Pachydactylus* group, which consists of more than 60 species, most of which are highly substrate specific and confined to small regions of endemism. Eastern Africa, particularly the more arid regions of the Horn of Africa, supports high specific diversity of geckos, but generic endemism is low. Mesic portions of West and Equatorial Africa have relatively low gecko diversity and localized specific endemism is uncommon, although recent discoveries suggest that this may be an artefact of under collecting and a lack of adequate systematic study. Relationships among African gekkonid genera remain poorly known, but the largely rupicolous *Pachydactylus* radiation of southern Africa is allied to North African/Mediterranean taxa (*Tarentola*), while a number of Southern and Eastern African genera are likely invaders of the continent from Madagascar. The gecko faunas of West and Northeastern Africa are dominated by species of *Hemidactylus*, representing endemic radiations of a nearly cosmopolitan group with other major centres in Southwest Asia and India. Among the most enigmatic geckos are *Urocotyledon* (East and West Africa) and *Cnemaspis* (chiefly Equatorial Africa), with putative sister taxa in the Seychelles and tropical Asia, respectively. Specific level phylogenetic patterns for a variety of groups suggest that the current diversity of sub-Saharan African geckos is largely a product of geologically and climatically-mediated cladogenetic events that occurred throughout the Tertiary.

High incidence of deformity in oil exposed and unexposed turtles from the John Heinz National Wildlife Refuge, Pennsylvania, USA

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In February of 2000, an underground pipeline spilled approximately 750,000 liters of oil into a man-made lake in the John Heinz National Wildlife Refuge in Philadelphia, Pennsylvania, USA. Twenty turtles surfaced covered with oil. Other turtles were confined to the spill area by a fence for several months. We collected and incubated eggs yearly from 2000-2003 from control and oil exposed snapping turtles (*Chelydra serpentina*) and painted turtles (*Chrysemys picta*). We rated severity of embryonic deformities as minor, moderate or lethal. In 2000 percent occurrence of each type of deformity (such as deformed tail) was always higher for snapping turtle embryos from oil-exposed mothers than from unexposed mothers. Percent occurrence of each type of deformity in 2002 was in most cases still much higher among snapping turtle embryos from oil exposed mothers than among those from unexposed mothers. Tail and shell abnormalities were the most common deformities in both oiled and control groups both years. Sample sizes of control and oil exposed painted turtles were small. Percent occurrence of each type of deformity in painted turtle embryos from oil exposed and control females varied with no clear pattern like that seen in snapping turtles. Shell abnormalities and dwarfism were the most common deformities among painted turtle embryos. Percent deformity rate was greater in painted turtles than snapping turtles, regardless of maternal oil exposure or lack thereof. Our results indicate that although the oil spill did not kill snapping turtles it affected development of embryos from contaminated mothers. Effects continued 2 years post spill. Caution must be applied because although turtles appear to be resistant to immediate toxic effects of oil contamination, they suffer physiological damage that has lasting effects on reproductive success.

Population stability, high survival and striking longevity in the terrestrial Maud Island frog *Leiopelma pakeka* in New Zealand

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Leiopelma pakeka (family Leiopelmatidae) is a threatened and archaic K-selected species surviving in remnant coastal forest on Maud Island, New Zealand. On two study plots approx. 150 m apart, frogs have been individually marked with toe clips since 1976, providing nearly three decades of population data. In contrast to Archey's frog *Leiopelma archeyi* that has recently declined on the North Island, the Maud Island frog has remained relatively stable in numbers over

1983-2004, even increasing slightly. Annual survival estimates for frogs on the two plots have been high, especially in apparent males (mean 0.96) compared with females (mean 0.91). In a pioneer population of 100 frogs transferred to a restored site on Maud Island, mean survival after initial settlement was even higher (0.97). This high survival of *L. pakeka* has led to striking longevity - one female in the source population surviving for at least 34 years, while many other frogs have survived for over 25 years. We investigated the impact of toe clipping, finding evidence of short-term capture-shyness after individuals were first marked. The number of toes removed has little influence on return rate once the effect of time of first capture is removed. This long-term research has contributed directly to the conservation management of this frog through monitoring its population trends and through evaluating the success of a trial translocation.

Inferring the history behind a recent divergence: Molecular phylogenetics of the lava lizard genus *Microlophus* (Squamata: Tropiduridae)

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The genus *Microlophus* (Dumeril and Bibron, 1837) consists of a moderately sized group of tropidurine lizards endemic to South America. Monophyly of *Microlophus* is supported by the presence of hemipenes with apical disks (Frost, 1992). The genus is composed of 22 species distributed along the Pacific coastal desert of southern Ecuador, Peru and Chile, and in the Galapagos Archipelago, 960 km E of mainland Ecuador. Two geographic groups approximately correspond with two taxonomic assemblages: the peruvianus (mainland) and the occipitalis (insular and mainland) groups. Previously published hypotheses based on allozymes and mitochondrial gene sequences have suggested that the Galapagos radiation originated from two separate colonization events, but possible mainland ancestors and source regions are poorly resolved. In this communication we present results of several tree-based phylogeny reconstruction methods based on multiple nuclear gene regions that are informative at several divergence levels within the genus. We retrieve a strong signal for the two-colonization hypothesis, and the source region of origin appears to be from a single, regional ancestor. We also hypothesize mainland areas of in situ speciation, as well as regions of recent population expansions. Further, we estimate divergence dates for clades on the mainland and in Galapagos based on algorithms that allow rate heterogeneity among genes and among lineages.

The reptilian model for evolution of viviparity: its potential and limitations

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Phylogenetic analyses of reproductive diversity reveal that viviparity has originated and evolved by very different historical trajectories in mammals and reptiles. In squamates, viviparity repeatedly has evolved simultaneously with incipient matrotrophy, whereas in mammals, matrotrophy predated the origins of viviparity. Accordingly, the fetal membranes perform somewhat different functions in oviparous squamates vs. oviparous mammals, and in viviparous squamates vs. therian mammals. Furthermore, much recent work has revealed that even among squamates, viviparous reproduction is accomplished through highly - diverse morphological and physiological specializations, e.g., for gas exchange, nutrient provision, maintenance of pregnancy, and parturition. Given the large number of reptilian origins of viviparity, squamates offer broad potential for historical reconstructions of this reproductive pattern. However, no individual squamate clade seems likely to serve as a single "model" for the evolution of viviparity. Rather, evolutionary generalizations about viviparity ultimately must be based on phylogenetic analyses of historical sequences and functional attributes in multiple clades.

Physiological and molecular characterisation of lymphangiogenesis in regenerating gecko tails

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The Australian marbled gecko, *Christinus marmoratus*, has the ability to autotomise its tail by active contraction of the caudal muscles, and complete detachment of all tail tissues, including the lymphatic vessels. The lymphatic system is a network of vessels, which primarily function to maintain interstitial fluid balance by returning excess fluid to the blood. Following autotomy a new and complex tail is regenerated. Previous work has shown that lymphangiogenesis occurs in regenerating tails of *C. marmoratus* and appears to be regulated by an analogue of vascular endothelial growth factor (VEGF-C), which controls lymphangiogenesis in mammals. However, neither the exact nature of reptilian VEGF-C nor changes in the cellular matrix of the regenerating vessels are fully understood. This study investigates the physiological basis of lymphatic regeneration in geckos by measuring clearance (lymphatic and blood) and migration of two radiocolloids - 99mTc-antimony trisulphide (ATC; 10 nm) and 99mTc-SnF2 (1000 nm), and a small soluble molecule (99mTc-DTPA). The velocity of migration of these agents and the rate of local clearance is assumed to be a function of blood and lymphatic

capillary permeability. Each radiotracer was administered subdermally into original, fully regenerated (>24 weeks) and regenerating gecko tails at 6, 9 and 12 weeks following autotomy. Whole body scintigraphic images were obtained as a dynamic sequence using a scintillation gamma camera over 40 minutes. Preliminary results for 99mTc-ATC indicated that a functional lymphatic system was established after 6 weeks of regeneration. The cellular structure of regenerated tails differed from that of original tails, as both lymphatic speed and % migration were lower in regenerates than in originals. Results for 99mTc-SnF2 and 99mTc-DTPA demonstrated the exact nature of these differences. The physiological data obtained can be correlated with VEGF-C expression.

Assessing the influence of multiple stressors on amphibian populations

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Causes of world-wide amphibian declines probably do not have one single explanation, and the studies to date suggest that multiple stressors may be at work in affecting amphibian declines. Amphibians living in habitats where environmental problems are rife can clearly result in communities being exposed to a number of potential stressors; however, given that invasive species can spread throughout a landscape, and contamination and pathogens can be spread through water networks and aerial deposition, protected habitats can also be exposed to multiple stressors. We have assessed the effects of invasive species (fish and bullfrogs), pathogens (*Saprolegnia ferax*), and multiple chemical contaminants (including the insecticide carbaryl, herbicide atrazine, and ammonium nitrate fertilizer) on larval amphibian communities in a series of outdoor mesocosm experiments to determine how the addition of stressors impact amphibians and their food web. In many cases, we have found that a single stressor has a stimulatory response on amphibian survival and metamorph quality; however, the combination of two or more stresses can have negative effects on time, size, and survival to metamorphosis and suggests there are metabolic and physiological responses to multiple stressors. This suggests that even sublethal levels of stress in combination may negatively impact amphibian communities in ways not predictable from single chemical studies or by examining the effects of the chemicals on their food resources alone. However, we often find that amphibians are able to endure multiple stressor assaults, which suggest that some combinations of factors may be more serious than others. Our study is some of the first to examine the role multiple stressors play in shaping amphibian communities, and will help us evaluate the relative importance of stressors, understand the pathways through which they act, and predict critical interactions that may be important to amphibian communities in nature.

The risk associated with foraging modes: a comparison between lacertid foragers

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Foraging modes impose on foragers different risks of predation. For example, it is often assumed that active foragers are exposed to a higher risk than ambush foragers. However, when we look at species that do not lie near one of the extreme ends of the foraging mode spectrum, it is less clear which one is exposing itself to a higher risk. We wanted to create an index of vulnerability that is based on the equation for the probability to get killed by a predator (Lima and Dill, 1990). Foraging mode should modify the equation in three ways: high frequency of moves and long move durations increase the risk. In addition, high percentage of time spent in a vulnerable part of the habitat should also increase the risk. Due to the difficulties in obtaining absolute values of predation risk, we created a relative index, MOD, that compares the vulnerability of two species. We show that when $MOD > 1$, the foraging mode of the focal species exposes it to a higher risk of predation than the other. Similar comparisons can indicate whether juveniles are exposed to risk more or less than adults, or whether a species that shows flexibility in its foraging mode depending on habitat structure is exposed to higher risk in one habitat more than in the other. We demonstrate the usefulness of this new approach in a system with three lacertid lizards that react differently to anthropogenic habitat modification. We calculated number of moves per minutes, average move duration and percent of time spent in the risky, open habitat. The values of the relative MOD index suggest an explanation to the fact that only one species is doing well in the modified habitat, while the two other species concentrate their activity in the natural habitat.

Marine herpetofaunal diversity along Tamil Nadu, South East Coast of India

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Though reptiles form only a small component of animal life in the sea, there are about 60 species of snakes, seven or eight species of turtles, and a lizard species, which may definitely be called marine reptiles. The present study was carried out for the past two years along the coast of Tamil Nadu, which covers about 1026 km. The survey was undertaken in different ecosystems of the coastal arena. The survey finds, five species of marine turtle, which come under the order Testudines, suborder Cryptodira, and family Cheloniidae and Dermochelyidae. Among the five

species of turtles, *Chelonia mydas* (green turtle) is a herbivore and the other four are carnivores in nature, and all these species are only observed the Southern coastal area of Tamil Nadu (Rameswaram Islands, Gulf of Mannar, Marine Biospheres) and all these species are considered as endangered species. Nine species of sea snakes are also observed, and they belong to the order, Squamata, super order Serpentes, family Hydrophiidae, and subfamily Hydrophiinae and Laticaudinae. Of these, seven species of sea snakes such as *Hydrophis spiralis*, *Hydrophis cyanocinctus*, *Hydrophis (=Microcephalophis) gracilis*, *Enhydrina schistosa*, *Laticauda colubrina*, *Pelamis platurus* and *Lapemis curtus* are found to be common throughout the coastal area besides two estuarine species such as *Acrochordus (Chersydrus) granulatus*, *Cerberus rhynchops* which are frequent in Arasalar estuary, Karaikkal. The juvenile forms of *Cerberus rhynchops* are identified only from Pichavaram mangroves.

Ancient lineages and modern landscapes

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Africa, the 'Mother Continent', has a rich biological and cultural diversity. Its herpetofauna, like its human history, comprises ancient lineages, recent migrations and local extinctions. The landscape is a mosaic of pristine pockets and nurtured isolates in a ravaged sea. It is a microcosm of the modern world, with its threats, opportunities, hotspots and celebrations. In this opening address to a mini-symposium on 'African Herpetological Diversity', the overall diversity, origins and evolutionary history of the African herpetofauna is briefly sketched. Recent insights are summarised, and opportunities and constraints to future research highlighted. Herpetological studies lag behind the continental syntheses of birds and vegetation, and there is a need for the synthesis of local knowledge. This will allow the emergency of regional stories and continental models, that will place the African herpetofauna within its environmental history.

The effect of wetland cluster size and hydrology on the diversity and abundance of amphibian metapopulations during a 10-year study in the American Midwest

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The effect of wetland cluster size and hydrology on the diversity and abundance of amphibian metapopulations during a 10-year study in the American Midwest. Landscape factors can effect the survival and reproduction of wetland fauna. We used abundance data from surveys of 10 amphibian species that were collected from 1994-2003 throughout Jasper County, Indiana, USA. We tested the hypotheses that clusters

of wetlands would support more amphibians than isolated wetlands and that clusters with wetlands of varying hydrology would support more amphibians than clusters with wetlands of just one type of hydrology. Wetland clusters were identified from National Wetland Inventory Maps and defined as a group of wetlands in which neighboring wetlands are all less than 400m apart. We also categorized wetland clusters as having variation of hydrology from temporary to semi-permanent to permanent. The number of wetlands in a cluster was correlated with species richness, amphibian abundance, and the number of years with amphibian populations. Wetland clusters with 15 or more wetlands had significantly more species than clusters with 6 or fewer wetlands, significantly more abundance than clusters with 14 or fewer wetlands and significantly more years with amphibian populations than isolated wetlands. The number of wetland hydrology types in a wetland cluster was correlated with species richness, amphibian abundance, and the number of year with amphibian populations. Wetland clusters with wetlands of two or three types of hydrology had significantly more species, abundance and number of years supporting amphibian populations than wetlands with just one hydrology type or isolated wetlands.

Secondary contact of *Gallotia galloti* lineages within an island

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The lizard *Gallotia galloti* shows two primary mitochondrial DNA lineages within the Canary Island of Tenerife. Their origin appears to be populations on the ancient precursor islands of Teno and Anaga from which the present island was formed. Island-wide surveys have suggested relatively little mtDNA introgression between populations and a discordance between the phylogeographic pattern and morphological variation in adult males. We carried out a detailed analysis of mtDNA and morphology along a 65 km transect on the south-east facing coast. Mitochondrial DNA divergence was very low indicating that the initial vicariance or dispersal event that formed the two lineages occurred after the ancient islands had been joined. The fine scale sampling shows that considerable mtDNA introgression occurs between populations with a cline in haplotype frequency between the north and the south of the transect. The main transition area crosses the Güimar valley and it is feasible that the collapse of this valley played some role in determining the current pattern. There is no corresponding cline in body dimensions or scalation for males, but a weak pattern is found in females. These findings provide insights into the causes and maintenance of spatial structuring of genetic diversity.

Lizard energetics and the sit-and-wait versus widely-foraging paradigm

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The validity and demonstrability of the sit-and-wait (SW) and widely-foraging (WF) dichotomy among lizards has drawn much scientific attention. The observation that WF lizards travel longer distances through their environment creates the expectation of higher overall daily energy needs. While many foraging studies have focused individually on the physiological, morphological or behavioral correlates of foraging mode, one metric that encompasses all of these aspects at the whole-organism level is field metabolic rate (FMR). To determine if large-scale energetic differences do exist between SW and WF lizards we reviewed early comparative studies of FMR between species in addition to analyzing all relevant doubly-labeled water studies of FMR. We found the apparent dichotomy between SW (N=29) and WF (N=15) lizards was supported, with WF lizards expending approximately 32% more energy on a daily basis than same-sized SW species. Furthermore, the recent determination of the phylogenetic relationships among many lacertilians allowed us to explore the effects of phylogeny on energy usage. It has been suggested that because most SW lizards are iguanians and WF are scleroglossan (or autarchoglossans), any energetic differences may stem from the phylogenetic histories of these major clades. Once phylogeny was accounted for via independent contrast analyses, the energetic discrepancy between SW and WF was actually stronger, thus likely not an artifact of phylogeny at the major clade level. There were, however, strong taxonomic associations at the family level. We also used the data to evaluate the predictions of extremely high or low metabolic rates in certain lizards (*Varanus* and *Phrynosoma*) and will discuss these results.

Genetic diversity of *Podarcis lilfordi* in the Balearic islands

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There are two endemic lizards of the genus *Podarcis* in the Balearic islands, Spain. One of these, *Podarcis lilfordi* is found on two of the three islands groups within the archipelago. Specifically it is found on: 1) islets associated with the main island of Mallorca including Cabrera and associated islets, 2) islets off the coast of Menorca. Relatively recent extinctions on Mallorca and Menorca due to introduced predators/competitors explain its absence there and its persistence on tiny neighbouring islets. Morphological differentiation is

considerable, even between proximate islets, with many subspecies having been named by different authors. We have studied mtDNA (cytochrome b and 12S rRNA) of this species throughout its range. There is considerable diversity between the island groups but within-group diversity is variable. For example, mtDNA divergence between Menorcan islets is negligible, while that between Mallorcan islets is much more substantial. The considerable morphological variation among the former shows that phylogeography is not tightly-related to morphological differentiation. Possible scenarios that explain the morphological and mtDNA diversity are considered in relation to historical sea-level changes, land connections and ecological variation in the region.

Social monogamy and parasite loads in the Australian sleepy lizard *Tiliqua rugosa*

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Parasites can have significant impacts on individual fitness and reproductive opportunities in animal populations. Sleepy lizards in South Australia form monogamous pairs each spring, and in about 80% of cases the same two lizards pair again in the following year. Some pairs have been together for over 20 years. At our study site near Mt Mary, there are two tick species that infect the lizards, *Aponomma hydrosauri* and *Amblyomma limbatum*. These ticks have a detectable detrimental impact on lizard activity and agility. They also transmit a protozoan parasite *Hemolivia mariae* between lizards. Refuge sharing by lizards over a 6-8 week pairing period may increase exposure to parasites. Data from 34 878 random encounter captures of 7 520 live adult sleepy lizards over 22 years, confirm the long-term pair fidelity in many individuals. However there were cases where partnerships changed from one year to the next. The males involved had heavier tick loads than males that retained their female partners. Parasite infection may cause both a loss of vigour and a loss of mating partner for these lizards.

Effect of an anthropogenic disturbance on plasma corticosterone levels in the desert iguana, *Dipsosaurus dorsalis*

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Perturbations in an organism's environment can stimulate a suite of physiological reactions collectively known as the stress response. The stress response is generally presumed to represent an adaptation that promotes survival by restoring homeostasis (e.g., by mobilizing energy stores and curtailing energetically expensive processes that are not of immediate

importance). One major component of the vertebrate stress response is the hypothalamic-pituitary-adrenal axis. This axis is stimulated by the recognition of a stressor by the brain, resulting in the output of glucocorticoids from the adrenal cortex. These glucocorticoids are crucial to the reestablishment of physiological balance. However, chronic activation of the stress response leading to chronic elevations in glucocorticoids may have deleterious effects on the long-term health of a population, via suppression of growth, immune function, and reproduction. The goal of this study was to determine if glucocorticoid concentration in free-living desert iguanas increases with proximity to a high-traffic road. Baseline blood samples were collected from lizards living in a homogeneous habitat between 0 and 1000 m from a major road in the Coachella Valley of California, USA, from April to September 2004. Plasma was assayed for corticosterone (CORT), the main glucocorticoid in lizards and a proposed bio-indicator of stress in natural populations. Because variation in physiological stress can also be detected by examining the adrenal responsiveness to an acute stressor, a second blood sample was collected from a subset of lizards after fifteen minutes of handling. Additionally, the relative abundance of desert iguanas (number of lizards seen per unit effort) was determined by walking transects at 50 meter increments parallel to the road. These results will help determine if corticosterone level is a useful tool to monitor biological stress and population health in lizards and will help develop methods that can be used in applied conservation biology.

A comparison of four methods of estimating body condition in Malagasy freshwater turtles (*Pelusios castanoides* and *Pelomedusa subrufa*)

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Simple indices of body condition based on morphological variables can be used as indirect measures of the fitness and performance of turtles in both wild and captive populations. A common method of obtaining such indices is to use the residuals from a regression of 'mass' versus 'size'. Such analyses make a number of assumptions about the data that may - or may not - be met. Equally, there are different ways of measuring both 'mass' and 'size'. We compared the performance of four body condition indices based on measurements of large samples of *Pelusios castanoides* and *Pelomedusa subrufa* from several populations in Ankarafantsika National Park, NW Madagascar. The body condition indices were calculated as the residuals of regressions of (1) log mass versus log plastron length; (2) log mass versus log PC1 (calculated from 7 body size variables); (3) mass versus volume; (4) mass versus plastron length cubed. Although the four different body condition indices were highly correlated, in hypothesis tests of differences between seasons, habitats, species and

sexes they sometimes yielded conflicting results. Caution may therefore be needed in the selection, calculation and interpretation of body condition indices based on the morphology of turtles. A number of assumptions about the data that may – or may not – be met. Equally, there are different ways of measuring both ‘mass’ and ‘size’. We compared the performance of four body condition indices based on measurements of large samples of *Pelusios castanoides* and *Pelomedusa subrufa* from several populations in Ankarafantsika National Park, NW Madagascar. The body condition indices were calculated as the residuals of regressions of (1) log mass versus log plastron length; (2) log mass versus log PC1 (calculated from 7 body size variables); (3) mass versus volume; (4) mass versus plastron length cubed. Although the four different body condition indices were highly correlated, in hypothesis tests of differences between seasons, habitats, species and sexes they sometimes yielded conflicting results. Caution may therefore be needed in the selection, calculation and interpretation of body condition indices based on the morphology of turtles.

Strategic male calling effort in terrestrial toadlets

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In animals with high male mating effort every investment a male makes towards gaining a mate depletes resources needed to gain future mates. Theoretically, this trade-off should favor strategic allocation of mating effort. In the Australian toadlet *Pseudophryne bibronii* males construct terrestrial nests and use discrete call types for territory defense and mate attraction. Calling lasts several months and bears significant costs, such as emaciation and increased risk of dehydration. Given these costs, male toadlets were predicted to regulate their calling effort according to the risk of a territory being taken over by a rival male and the probability of attracting a mate. I tested this prediction in the field by placing either a male or female at the entrance of a calling (experimental) male burrow (nest site) and recording calling effort before and after treatment. When presented with both males and females experimental males responded by 1) increasing call rate, but this increase was almost twice as large in response to female presence and 2) increasing the proportion of territorial calls produced, but this change was much greater in response to male presentation. In response to female presence experimental males also adjusted the frequency and pulse repetition rate of the attraction call, characteristics known to influence female mate choice in anurans. The results suggest that males adjust calling effort adaptively in response to changes in the social environment.

Egg retention in the *Sceloporus spinosus* group (Sauria: Iguanidae): evaluating the cold climate model for the evolution of viviparity

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Viviparity in the Squamata has been interpreted as an adaptive strategy to reduce embryonic exposure to low temperatures. This hypothesis, known as the cold climate model, suggests that cold environments promote the gradual evolution of viviparity by increasing the ability of females to retain eggs and extend intrauterine embryogenesis. A comparison of these traits in oviparous species closely related to viviparous ones in the *Sceloporus scalaris* group supports the idea that extension of intrauterine embryogenesis facilitates the transition from oviparity to viviparity in the genus *Sceloporus*. To further test this idea, we sampled gravid females of the *S. spinosus* group, the oviparous sister group to the viviparous *S. formosus* group, from seven localities in Mexico. Females were maintained on a dry substrate to stimulate egg retention. Embryonic stage and eggshell thickness were recorded at the time of oviposition. Most females extended intrauterine embryogenesis beyond stage 30, which is the normal stage at oviposition for this group. However, maximum degree of embryonic development differed within and among females of same locality and among localities. Eggshell thickness and maximum embryonic stage exhibit a negative trend. Egg shell thickness and maximum stage of retention were not correlated to mean minimum temperature or precipitation during the reproductive season. These data indicate that maximum intrauterine embryogenesis in this group is associated with eggshell thickness, but that egg retention is not related to environmental factors. In contrast, variation in eggshell thickness and maximum embryonic stage exhibited a phylogenetic pattern, suggesting that their evolution is linked to divergent events within this group. This supports the role of extension of intrauterine embryogenesis in evolution of viviparity and suggests that environmental factors were not involved in reproductive mode shift. However, estimation of divergence times of *S. spinosus* clades may thus allow a more accurate reconstruction when extended egg retention evolved.

Size and shape variation between populations of the lizard *Psammodromus algirus*

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Psammodromus algirus is probably the most abundant lacertid in the Iberian Peninsula where it is widely distributed in Mediterranean environments. Although

this lizard depends on vegetation for foraging, thermoregulation and shelter, it occupies a wide variety of habitats with different degrees of plant cover, from forests and maquia to steppes and dunes. Here, we consider morphological variation in this species induced by habitat structure via sexual and natural selection. A total of nine biometric variables were measured in 616 lizards belonging to four populations from NE Spain. In order to minimise the environmental factors involved, all localities were coastal but at different latitudes; three were sandy areas and a fourth was a Mediterranean forest. Adult body size increased with latitude but sexual size dimorphism (male biased) was only found in the forest population. As in most lacertids, males had bigger heads and longer limbs and tails than females. Forest lizards of both sexes had bigger heads and longer limbs than the others. Moreover, different body parts showed different variation patterns between populations. Sexual shape dimorphism (SShD) in head length was higher in the forest population and decreased with latitude. No significant variation of SShD with locality was detected for the rest of the variables. Nevertheless, there were some indications for a decrease of SshD in hind limbs with latitude. Proximal causes of this morphological variation are changes in allometric growth whereas ultimate factors are ecological. A hypothesis based on life history, spatial social interactions and habitat structure is discussed.

Hypotheses regarding how *Batrachochytrium dendrobatidis* causes amphibian deaths

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At least two hypotheses exist concerning how *Batrachochytrium dendrobatidis* causes amphibian deaths: production of a lethal toxin and/or interference of ion and water uptake through the pelvic region. We tested whether or not *Batrachochytrium* produces a toxin by injecting northern leopard frogs, *Rana pipiens*, with broth in which this pathogen had been cultured for up to 4 weeks. Some test groups received one injection, while others were injected twice with broth extract from the same incubation conditions as their first injection. Control animals were injected with *Batrachochytrium*-free broth concentrated to the same degree as the broth in which *Batrachochytrium* had been incubated. Frogs injected with *Batrachochytrium* broth extracts died at about the same rate as control frogs injected with *Batrachochytrium*-free broth. Therefore, we conclude that, under the conditions of the experiment, *Batrachochytrium* do not produce a toxin that is lethal to this species. We tested the ion transport hypothesis with Woodhouse's toad, *Bufo woodhousii*, which were collected directly from the field. Since most of the animals tested positive for *Batrachochytrium* upon capture, animals were divided into one of four "sick score" groups, depending of the

presence of a variety of factors, such as skin redness, skin sloughing, lethargy, etc. Blood ions (Na⁺, Ca⁺⁺, K⁺ and Mg⁺⁺), blood osmotic properties, Na⁺ transport as measured with a Ussing apparatus, and preservation of tissue was conducted on these animals in the four stages of sickness. All ion concentrations, plus osmotic pressure, declined with the degree of sickness, though blood Ca⁺⁺ was independent of sick score. Na⁺ transport significantly declined with sick score, and the degree of tissue sloughing and presence of sporangia increased with sick score. We conclude from these preliminary data that hyperplasia associated with *Batrachochytrium* infection is correlated with, and may cause, significant disruptions of ions transport, leading to fatal disruption in muscle and nervous function.

Water balance in Australian desert frogs

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Twenty seven of Western Australia's 77 frog species survive in arid or semi-arid environments and almost all of these species burrow to access a more amenable microenvironment. Rainfall in WA's arid regions is unpredictable and patchy, so in some cases frogs may remain burrowed for several years. All species of the genera *Cyclorana* and *Neobatrachus* can form a cocoon while burrowed. This cocoon affords them substantial protection from water loss but also compromises water uptake from surrounding soil. Survival of species that burrow but do not form a cocoon is inextricably linked to the soil they burrow in. Under the instruction of aboriginal people we excavated two species in the Gibson Desert: the cocoon-forming *Neobatrachus aquilonius* and a species which does not form a cocoon, *Notaden nichollsi*. This provided an excellent opportunity to compare microhabitat selection and water balance regulation between a cocooning and non-cocooning species. *Notaden nichollsi* primarily burrowed in sand dunes while *Neobatrachus aquilonius* were found in soil with a higher proportion of fine particles such as clay and silt. Cocooned *N. aquilonius* were excavated at a claypan site while at a second dune-swale site they were found burrowed without cocoons. This represents the first report of a burrowed cocoon-former without a cocoon, the general assumption having been that cocoon formation is obligate in *Neobatrachus* and *Cyclorana*. Excavated frogs had plasma concentrations in the range of 195-324 mOsm, with significant differences found between species, burrowing sites and also between the two years that this work was undertaken. Variation in plasma osmolality was correlated with the moisture content and water retention properties of the soil surrounding the frogs. Our study indicates plasticity in behaviour and physiology of Australian desert frogs that has not previously been appreciated.

Phenological change in coexisting populations of *Triturus*: inter- and intra-specific differences in response

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Climate and weather affect phenological events in a wide range of taxa, and differing responses have been shown to disrupt ecological interactions. Amphibians might be particularly sensitive to climatic change, but few studies have addressed climatically mediated change in phenology, particularly comparing closely related species or sexes. Here, we test the hypothesis that changes in spring temperature result in phenological change among *Triturus*, and examine inter- and intra-specific differences in response. Coexisting populations of *T. helveticus* and *T. vulgaris* at a pond in mid-Wales (53°12'59"N 3°27'3"W) were monitored using pitfall traps along a drift fence during 1981-1987, and again in 1997-2002. Spring temperatures taken from the Central England Temperature series explained up to 81% of between year variability in median arrival date, with a significant advance of three to five days with every degree centigrade increase. Changes were greater for *T. helveticus* than *T. vulgaris*, and greater for males than females of both species, resulting in an increasing temporal separation between arrivals of male *T. helveticus* and all other groups. These data illustrate for the first time how the response to climatic change might differ between both sexes and species of sympatric amphibians.

Are there un-noticed amphibian declines in southern Africa?

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Namaqualand is an extremely arid area in south western South Africa. Many amphibians survive in this hostile environment by breeding in temporary pools, or by remaining in permanent springs. Although the area falls within the winter-rainfall region, some amphibians such as *Tomopterna delalandii* will breed in summer when there is sufficient rainfall. Generally the amphibians occur in small numbers in localised populations. Although small populations should be easier to monitor, they may be less easy to find with erratic rainfall. I review evidence for local declines in some species, usually associated with human activity. The presence of chytrid fungus has been documented. Some species, such as *Breviceps macrops*, although living in a threatened habitat, show robust populations. The small number of monitoring projects in southern Africa suggests that there may be many un-noticed population declines throughout the area.

Herpetofauna of a forgotten mountain: Gunung Murud, Sarawak, northern Borneo

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The results of an inventory of the herpetofauna of Gunung Murud (elevation 2,423 m ASL), Sarawak, Malaysia (northern Borneo), conducted during expeditions to the mountain between 2000-2004 are presented. The first collection on this mountain was made in 1922 by Eric Georg Mjöberg (1882–1938), Curator of the Sarawak Museum, during a general reconnaissance-mountaineering expedition. In total, 11 species of reptiles and 20 species of amphibians are now known, the fauna of the massif generally similar to that of Gunung Kinabalu, as the discovery of some co-occurring species (e.g., *Leptobrachium montanum*, *Meristogenys whiteheadi*, *Philautus petersi*, *Rhacophorus angulirostris*, *Rhacophorus baluensis*, *Cyrtodactylus baluensis*, *Brachymeles apus*, *Stoliczka borneensis*, *Amphiesma saravacense* and *Rhabdophis murudensis*) reveals. However, it also shows significant endemism (including a new species of *Megophrys*, two species of *Philautus*, a new species of *Polypedates*, *Gonocephalus mjobergi*, *Phoxophrys spiniceps*, *Sphenomorphus murudensis*, *Sphenomorphus* new species and *Calamaria hillenuisi*), both at the middle elevations (1,500 m ASL), as well as within montane limits (> 2,000 m ASL), thus supporting the plea for enhanced protection of Murud for its unique herpetological diversity.

Sex ratios of river terrapins (*Batagur baska*) in the head-starting facilities of Malaysia

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In Malaysia where viable wild populations of the critically endangered river terrapin (*Batagur baska*) are known to exist, conservation programmes involving *ex-situ* egg incubation, head-starting and release of head-started terrapins have been in place since the 1970's. However, these efforts have not been manifested in population recovery. One of the concerns is that artificial incubation of eggs could have resulted in the release of sex-biased *Batagur* to the wild. In order to investigate this problem, river terrapins from three head-starting facilities and representing different cohorts were sexed using the non-invasive method of endoscopy. 13 six-month old and two four-year old *Batagur* that had been incubated in styrofoam boxes kept indoors in Kolej Universiti Sains dan Teknologi Malaysia (KUSTEM) were all males. In the Bukit Paloh head-starting facility in Terengganu, where eggs are incubated in outdoor sandnests, seven 18-month old *Batagur* sexed were all female while of ten three-year

old examined, four were males and six were females. In Bota Kanan, Perak, where eggs are incubated in an open air fenced off area, of 15 four-year old *Batagur* sexed, three were males while 12 were females. Of six eight-month olds examined, there were four were males and two females. In conclusion, indoor incubation in styrofoam boxes produced only males, while in-ground incubation outdoors sometimes produced all females and sometimes a combination of both males and females. This is possibly related to ambient temperatures prevailing in different years. There is a need to conduct temperature-controlled incubation trials to fully investigate TSD in *Batagur*. This preliminary study has also demonstrated that endoscopy is a useful non-lethal method for determining the sex of relatively small *Batagur*.

Reproductive trade-off in female of Argentine *Boa constrictor* (Boidae)

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Linkages between reproductive ecology and life history represent trade-offs between size and number of offspring, cost of producing offspring, seasonal production and local environmental variation. When costs of reproduction are relatively high, as in viviparous snakes, two mechanisms may counterbalance these costs, producing larger broods and lowering the frequency of reproduction. The geographical distribution of viviparous species raises additional questions. Viviparous species might be expected to occur in temperate zones where temperatures are unfavorable. In these areas, the female could regulate her body temperature behaviorally and thus regulate the temperature of developing embryos. Various hypotheses suggest that the benefit of viviparity lays in the acquisition of an appropriate range of temperatures during incubation. The Argentine territory supports the world's largest and southernmost population of *Boa constrictor occidentalis*, a threatened species. Reproductive females maintain a higher and constant body temperature, whereas non reproductive females do not. This thermoregulatory behavior could have favored the species adaptability to diverse environments enabling its wide range of distribution. The study of reproductive behaviour in several populations subjected to different environmental pressures would be of great use to answer new questions.

Conservation genetics of Malagasy amphibians

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On Madagascar, the fourth largest island of the world, 100% of the native amphibian species are endemic. Habitat destruction such as deforestation with the practice of slash-and-burn agriculture and heavy anthropogenic pressure negatively affect amphibian survivorship and distribution. In particular cophylinae microhylids and some clades of mantellids are sensitive to forest fragmentation and loss of habitat. Additionally some colourful species of the genera *Mantella*, *Dyscophus* and *Scaphiophryne* are exported in high numbers for the pet trade. In the framework of an international collaboration for the conservation of the Malagasy herpetofauna, we are in the process of undertaking genetic surveys of Malagasy amphibians. Our research includes constructing robust phylogenies, resolving the taxonomic uncertainties, identifying genetic units for conservation, resolving the extent of gene flow among populations and correlating genetic variability and ecology. Our work so far involved the *Mantella madagascariensis*, *M. cowani* and *M. bernhardi* species groups, *Mantella expectata* and *Scaphiophryne gottlebei* (all on CITES appendices I or II), of which mitochondrial and nuclear sequences (cytochrome b, Rag-1, Rag-2) and microsatellite data were assembled. The clarification of taxonomy uncertainties and the identification of conservation units directly contribute to conservation efforts and export quotas, and will be helpful in defining possible strategies of sustainable use of these frogs.

The work is done in collaboration with colleagues in Amsterdam, Berkeley, Torino, Omaha and Antananarivo.

Locomotion in Australian monitor lizards

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Locomotion is involved in almost every aspect of behaviour and has been shown to have a significant effect on the ability of an organism to perform in a given environment but most importantly, it constitutes the difference between eating and being eaten. While locomotion could be studied in any group of organisms, lizards are good subjects as they are abundant, easily observed and relatively easy to capture. However despite this relatively few lizards have been studied to date, and most have been within a small size range. So what happens when lizards get really big? Typically lizards are thought to have a sprawling limb posture where the legs are swung out to the side while they run, however many larger lizards have been observed running more upright tending to bring the legs underneath the body like the dinosaurs did. At what point does this transition occur and why? Australian monitor lizards are the perfect group to study the evolution of size since they can span five orders of magnitude within a single genus. Moreover they have undergone extensive adaptive radiation within Australia which allows us to test the adaptive significance of certain features. Do lizards that climb trees run differently from those that run on sand, or swim? We

use three dimensional motion analysis systems to examine the locomotory stride of lizards. We create a model of each lizards stride and from this model measure a series of variables which characterize its stride (such as hip height at footfall, changes in the knee angle etc). We can then compare strides across many different species from the burrowing 8 gram *Varanus brevicauda* to the widely roaming 7000 gram *Varanus panoptes*.

Ranaviruses as emerging disease threats to amphibian populations

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The suspected major causes of global amphibian declines include commercial use, introduced species, land use change, global change, toxins, and infectious diseases. A chytrid fungus, *Batrachochytrium dendrobatidis*, and ranaviruses are generally regarded as the two primary emerging infectious diseases that are threats to amphibian populations. Each of these major groups has a wide host range and can affect populations differently; viruses generally cause host populations to fluctuate, while declines, even extinction of amphibian populations, are attributed to chytridiomycosis. Ranaviruses are double-stranded DNA viruses that are globally distributed and infect lower vertebrates including fish, amphibians, and reptiles. In this report I will review how tiger salamanders (*Ambystoma tigrinum*) are serving as a model for understanding virus transmission, virulence, epidemiology, and the movement of viruses in commerce. As amphibians are transported for food, pets, and bait, there is evidence that viruses move with them facilitating the spread of infectious disease and providing conditions conducive to viruses switching among lower vertebrate hosts. Interdisciplinary projects that integrate the skills of researchers from molecular biology to ecology have supported rapid progress in understanding ranavirus biology in amphibians from gene sequences of viral pathogens to host-pathogen population dynamics.

Are there differences in thermal balance, body temperature and activity between melanistic and non-melanistic species of cordylid lizards in the Western Cape?

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Species of cordylid lizards in the Western Cape of South Africa present a unique opportunity to test the theory of thermal melanism due to the occurrence of closely related melanistic and non-melanistic species in distinct thermal environments. Melanistic species (e.g. *Cordylus niger*, *C. oelofseni*, *C. capensis*) occur in cold-

foggy peninsular or montane areas, whereas non-melanistic species (*C. cordylus*, *C. polyzonus*) have a broader range encompassing coastal and inland, usually warmer areas. The fact that species of melanistic cordylid lizards are restricted to areas characterized by high incidence of fog, reduced solar radiation and cool temperatures suggests that melanism is a phenotypic trait necessary for cordylid lizards to survive/optimize their energy budget. This paper first presents a theoretical analysis of thermal balance of melanistic and non-melanistic cordylid lizards. By establishing warming-up curves of melanistic and non-melanistic cordylid lizards as well as copper models (Te) that have similar reflectance as the lizards, we demonstrated that under controlled conditions, heating rates of melanistic lizards were significantly higher than for non-melanistic lizards (for models: ANCOVA $F(1, 47) = 11.702$, $P < 0.01$, covariate = model mass). We then established a simple biophysical model to compare the influence of a number of variables (e.g. solar radiation, wind) on body temperatures (Tb) of melanistic and non-melanistic cordylid lizards and established predictions on physiological and behavioral mechanisms of melanistic and non-melanistic lizards. Finally, we tested the predictions made under warm/foggy conditions by determining (1) physiological data: thermal preference and tolerance (CTmax) and, (2) field data: body temperatures, activity patterns, thermal profiles and operative environmental temperatures (Te) of melanistic and non-melanistic cordylid lizards in three field localities, during foggy and hot summer days. Our ultimate goal is to relate distribution, physiology and ecology in order to understand the effect of climate on these species.

Historical and ecological determinants of species richness in the lizard fauna of Australia's wet tropics

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I tested the idea that local species richness was a subset of regional species richness by looking at tropical lizard assemblages at the local scale across habitat types and biogeographic regions in Australia's wet tropics. Levels of species richness at a local (one hectare) scale were found to be significantly higher in eucalypt forest than adjacent rainforest. Using a combined approach of physiological and behavioural tests on individual species and data on regional species diversity and historical forest contractions it was established that the present patterns of species diversity in the rainforest habitats were originally established by extinction patterns due to rainforest contractions during the Pleistocene ice age. These patterns appear to have been maintained by the adaptive constraint of the thermal environment places on the remaining suite of species in the regional pool. Species diversity in eucalypt forest maintained a

constant local level among differing regional species pools, indicating local, ecological saturation. Thus it appears that while regional scale processes have created the current species patterns in this area, the patterns are being maintained by niche saturation in one habitat type (eucalypt) and adaptive constraint in the other (rainforest). Therefore it appears that in this system ecological and evolutionary processes are constraining species richness, but these two processes are operating to different degrees between habitat types.

Assessment of site occupancy modelling as a technique to monitor the threatened New Zealand frog *Leiopelma hochstetteri*

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Given current concerns regarding the status of amphibian populations around the world, the development and implementation of rigorous monitoring programs is a high priority for amphibian conservation and management. In New Zealand, monitoring of the threatened Hochstetter's frog (*Leiopelma hochstetteri*) has proven problematic. Previous attempts to monitor this species have been based on either indices of abundance or capture-recapture. Neither approach has been effective. We assessed the site occupancy models of MacKenzie et al. as a potential alternate approach to monitoring Hochstetter's frog populations. These models incorporate estimates of detection probability to generate unbiased estimates of the number of sites occupied by a species in an area. We obtained estimates of spatial and temporal variation in detection probability of juvenile and subadult/adult frogs to determine whether the sampling effort required for a fully-implemented monitoring program based on site occupancy is likely to be prohibitive. Detection probabilities were generally found to be high, indicating that this method has the potential to generate unbiased estimates of site occupancy based on small sampling effort. The results also indicate that, in many instances, it may be possible to separately monitor juvenile and subadult/adult components of populations, thereby allowing a more rigorous assessment of populations rather than simple presence/absence of the species at sites. Given the small size and cryptic nature of Hochstetter's frog, the positive results of this study indicate that site occupancy modelling may be applicable to monitoring other herpetofauna species where more traditional rigorous methods cannot be applied.

Bone growth patterns as Indicators of life history parameters in desert tortoise (*Gopherus agassizii*) populations

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Ecological constraints are known to influence bone growth strategies, and thus life history strategies, in a wide variety of amphibians and reptiles, however few such studies have been done on tortoises. *Gopherus agassizii* are long-lived tortoises, living in a habitat where their survival is extremely dependent on temperature and resource availability and quality. We obtained carcasses ranging in size and age from three different geographic areas: Arizona, East Mojave and West Mojave Desert in the USA. We also sectioned a sample of known-aged tortoises to validate the skeletochronological methods used in obtaining age estimates for each population. These populations were chosen because they represent a wide range of inter- and intrapopulation growth strategies in desert tortoises living in extreme arid environments. We examined various skeletal elements to investigate individual growth histories, variation with age and possible population trends. Results showed that bone microstructure and growth ring formation differed considerably within and between individuals from all populations. In general, the smallest juveniles exhibited fast growing embryonic bone. As body size increased, bone tissue varied from parallel-fibered bone (intermediate growth rate) to fibrolamellar bone (fast growth rate) with many transitions between these two bone tissues. Bone remodeling and remodeling rates differed within populations, as did the expression and distinction of growth rings. Some West Mojave juveniles showed segmented, sac-like structures in the medullary cavity area, the function of which is unknown. The range of desert tortoise bone microstructure was surprising because such variation is not common within single reptile species. This is the first study attempting to answer questions about tortoise biology across a broad geographic scope and time range and has the added advantage of not having to harm, kill or disturb living animals of this threatened species.

Chytridiomycosis - an emerging disease threat to amphibian populations

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Chytridiomycosis is a skin disease of amphibians caused by a zoosporic, chytrid fungus *Batrachochytrium dendrobatidis*. It was first discovered in captive amphibians during the 1990s, and was

reported as the proximal cause of mortality events in declining amphibian populations of Panama and Queensland, Australia in 1998. Since then, a great deal of research into its pathology, etiology, ecology and impact on host populations has been conducted by researchers in the USA, Australia and other countries. Here, we report some significant recent findings. These include hypotheses on the origin of chytridiomycosis and the causes of its recent emergence in some populations. Recent findings show that some populations of susceptible species can persist in the presence of the disease and that in others, the pathogen continues to cause severe, rapid depopulation. Other work has examined how this disease causes death in amphibians, and how immunological defenses and behavior act to fight primary infection. Finally, these data, information on the biological characteristics of the pathogen and on the life history and behavioral traits of host species allow us to deduce why some species decline and others persist as this disease moves through populations.

Molecular DNA variation and mitochondrial sequence analysis of *Triturus v. vittatus* (Urodela) at different breeding place altitudes at its southern distribution limit

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Molecular DNA variations in sub-species *Triturus vittatus vittatus* larvae at different breeding places in northern and central Israel, its southern distribution limit, were studied. Altitudes ranged from 740 meters above sea level (ASL) to sea level. Genetic variations were studied using RAPD-PCR and sequencing of conserved and variable mitochondria DNA genes, the cytochrome b fragment and the most variable part of the mitochondrial genome, the control region (D-loop). The cDNA sequence of cytochrome b fragment (413 bp long clone) was determined and differed in only four base pairs, starting at nucleotide position 32 (Nahalit pond, altitude of 665 m ASL), 237 (Amiad, 212 m ASL), 250 (Dovev, 740 m ASL), and ending at 355 (Nahalit). Dovev, the highest altitude pond examined in this study, was the most variable. The cDNA sequence control region fragment was determined from a 569 bp long clone and differed in seven base pairs, starting at nucleotide position 7 (Afeka pond, 15 m ASL), 102 (Amiad), 103 (Afeka), 294 (Afeka), 390 (Dovev), and ending at 565 (Amiad) and 567 (Nahalit). Afeka, the lowest altitude pond and farthest away from the others, was the most variable followed by Dovev at the highest

altitude. The control region was found to be more variable in the lowest and highest altitude ponds, possibly being affected by differences in ecological conditions.

Are cannibalistic morphs of the tiger salamander obligatory cannibals?

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Tiger salamanders exhibit alternative trophic morphologies, with cannibals developing a larger head and longer teeth than typical larvae. Resource partitioning is known between morphs, with cannibal morphs usually foraging on conspecifics and rarely on small organisms. Our aim was to determine whether the cannibal and typical morphs shift their diets across time and particularly whether conspecifics are necessarily the main prey of cannibals and plankton the primary prey of typicals. We found that only the cannibal morph foraged on conspecifics, but not all the time. Cannibalism typically occurred only early after the ontogenetic divergence between morphs. Cannibals shifted their diet later in the summer to plankton, and this ontogenetic shift led to dietary overlap with the typical morph. In contrast to other studies, our findings suggest that the cannibal morphology actually allows the consumption of a larger variety of prey, rather than specialization on specific resources (i.e., conspecifics). The outcomes of the cannibalistic ontogenetic pathway include a higher biomass intake from food and a larger size than typicals. From a foraging perspective, the cannibalism pathway is clearly advantageous over the typical morphology. However, the increased diet breadth of cannibal morphs found in this study suggests that the maintenance of the polyphenism is more complex than has previously been suggested.

Structure of the herpetofauna of two wildlife management areas in Ouachita Parish, Louisiana, USA

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Ouachita (OWMA) and Russell Sage Wildlife Management Areas (RSWMA) are state-owned and managed public lands in Ouachita Parish, northeast Louisiana. Both are comprised of bottomland hardwood forest within the Bayou Lafourche floodplain, although OWMA also has extensive areas of reforested

agricultural fields. Topography is flat and poorly drained with numerous sloughs and shallow bayous. Backwater flooding occurs frequently. Between the two WMAs, 26 500-meter transects were marked. Sampling was conducted along the transects by means of drift fence surveys with funnel and pitfall traps, visual encounter surveys, and coverboard surveys. Visual encounter surveys (VES) completed between the months of April 2003 and November 2004 yielded a sample size of 232 individuals encompassing 25 species for OWMA and 234 individuals encompassing 23 species for RSWMA. The Morisita index of similarity (VES) for OWMA and RSWMA is 0.80. Drift fence surveys completed September through November 2003, April through June 2004 and September through November 2004 yielded a sample size of 306 individuals encompassing 25 species for OWMA and 391 individuals encompassing 23 species for RSWMA. The Morisita index of similarity for the drift fence surveys of OWMA and RSWMA is 0.85. Simpson's index of diversity for the VES data is 0.907 and 0.882 for OWMA and RSWMA, respectively, indicating great heterogeneity in relative abundance of species. It appears the two sampling techniques (VES and drift fences) are equally valid, giving very comparable indications of species richness and community structure.

Phylogeny, age and morphological evolution of the Australian agamid radiation

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The acrodont lizards usually recognised as the Agamidae include a distinctive Australian radiation, largely consisting of terrestrial and arid-adapted forms. We address two controversial conclusions that have stemmed from recent phylogenetic studies of agamids using mitochondrial DNA. The first is the suggestion by Macey and colleagues that agamid phylogeny tracked the break-up of Gondwanic landmasses and terranes, with an implied age of origin for the Australian clade as middle Mesozoic (160 Myr BP). The second is the conclusion of Schulte and Melville that morphological evolution within the Australian clade was characterised by extensive homoplasy, such that few of the morphotypic groups traditionally regarded as genera could be shown to be monophyletic. The relatively rapid rates of evolution of the mtDNA sequences used in these studies may have yielded misleading data in that basal branches in the published phylogenies are poorly resolved and estimations of branch length (and therefore time) between basal nodes are difficult to estimate - both due to saturation of the mitochondrial sequences when divergence times are old. We address these two problems through re-analysis of the published data together with new molecular sequence

data from more slowly evolving nuclear gene sequences. Our recalculation of divergence times yields much younger estimates for the origins of agamid clades, such that the origin of the Australian radiation is likely to have been during the early-middle Tertiary (<40 Myr BP). Our data support the findings of Schulte and Melville; molecular data from combined nuclear and mitochondrial sequences confirm that Australian agamids show a high degree of homoplasy in what have been regarded as taxonomically important morphological characters.

Testing for among-generation adjustment to offspring sex ratios: clinal variation in sex-determining attributes in the water dragon, *Physignathus lesuerii*

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Animals with environmental sex determination (ESD) that span climatic extremes should possess compensatory variation in some sex-determining attribute to produce viable sex ratios. This compensation can be achieved in two ways: (1) among-generation evolution of sex-determining attributes of the mother/embryo (e.g., pivotal temperatures, nest site choice, timing of nesting, nest depth); or (2) facultative sex allocation. Using field data and laboratory experiments we investigated clinal and altitudinal variation in among-generation sex-determining attributes in a lizard with ESD, the eastern water dragon, *Physignathus lesuerii*. Water dragons range from hot tropical to cool temperate climates, and we studied five populations spanning 16.5-35.5° S, with the southernmost population inhabiting high altitudes. Air and soil temperatures varied considerably across the sites during the time when eggs are incubating in nests. Using hemispherical photography and gap light analysis we found significant, directional variation in nest site choice among sites, with dragons nesting in more open areas in cooler climates. Timing of nesting also varied predictably across sites, but was insufficient to compensate for clinal variation in climate. Incubation experiments indicated that pivotal temperatures did not differ significantly among sites, nor did nest depth. We conclude that water dragons compensate for differences in climate primarily through nest site choice, and we hypothesize that this compensation is sufficient to maintain viable operational sex ratios across populations spanning climatic extremes. Current work is focusing on the ability of water dragons to allocate sex facultatively.

The first record of a polystomatid monogenean from a caecilian host

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Monogenean flatworms are mainly parasitic in lower aquatic vertebrates including fish, anurans and chelonians. The parasite family Polystomatidae is represented by 20 genera. *Diplorchis*, *Eupolystoma*, *Mesopolystoma*, *Metapolystoma*, *Neodiplorchis*, *Parapolystoma*, *Parapseudopolystoma*, *Polystoma*, *Protopolystoma*, *Pseudodiplorchis*, *Riojatrema*, *Sundapolystoma* and *Wetapolystoma* are known from anuran hosts, *Pseudopolystoma* and *Sphyrnura* from urodelid hosts, *Neopolystoma*, *Polystomoidella* and *Polystomoides* from chelonians, *Concinocotyle* from the Australian lungfish and *Oculotrema* from a mammal, the hippopotamus. Of the presently known 153 polystome species no less than 61% are known from anuran hosts while 3% are known from urodelid amphibians. Until now the Gymnophiona or Apoda was not known to harbour any polystomes. This paper reports the first finding of polystomes from the urinary bladders of *Caecilia* cf. *crassisquama* and *C.* cf. *gracilis* from Ecuador and Peru, respectively. This new parasite shares various morphological features with other polystomatid genera. Parasites are small with a maximum body length of 2mm. The two-gut caecae are not confluent posterior with any diverticulae or anastomoses. Haptor with six well-developed suckers and one pair of hamuli. Single follicular testis in mid-body; ovary small; vaginae present; single large operculated egg in short uterus leading to armed genital bulb. Larval stage and phylogenetic position are not known. Polystomes can only infect new hosts in an aquatic environment. Polystomes of amphibian hosts, with a brief contact to water, usually have a single large uterus filled with eggs that are released at once when the host enters the water to breed. On the other hand, polystomes of an aquatic frog like *Xenopus* lack a uterus altogether and eggs are released more or less constantly. Virtually nothing is known of the ecology of the caecilian hosts, but the single egg in the uterus suggests that these species spend a considerable time in water.

Seasonal changes in testicular morphology in the African clawed frog, *Xenopus laevis*: a histometric analysis

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Although *Xenopus laevis* has been studied for decades around the world we know very little about its basic biology including its reproduction under natural conditions. This is surprising that we know so little about an animal for which much of the genome has been sequenced. The aim of this study was to characterise the reproductive biology of the clawed frog over a period of 14 months. On a two-weekly basis during the breeding season and a monthly basis for the rest of the study period 20 male and 20 female frogs per month were collected from three sites. Morphometric measurements and blood samples were taken for all animals, gonads examined at the gross morphological level, and also fixed for histological analyses. Gonads were serially sectioned, stained with H&E and permanently mounted. The reproductive state of the gonads as a function of seasonal changes was determined by means of histometric analysis. Photomicrographs were taken of the tissue sections and the number of individual testicular cell types per unit area were scored quantitatively. The histological slides of gonads also were examined for gonadal anomalies including testicular oocytes. Water quality parameters and environmental data were collected at all three sites for the study period. Spermatogonia, spermatocytes, spermatids and sperm were present throughout the year with limited fluctuation in fractional volume. Testicular oocytes were observed in frogs from all three sites at a background incidence of 5-7% and appear to be a natural phenomenon. The relevance of this in relation to hormonal cycles will be discussed.

Reproduction and viviparity in *Typhlonectes compressicauda*, Dumeril and Bibron, 1841 (Amphibia, Gymnophiona)

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Typhlonectes compressicauda is the best known member of a Neotropical radiation of semi-aquatic and aquatic caecilians (Typhlonectidae) that share a number of derived features, some of which are associated with their distinctive form of viviparity. *T. compressicauda* is common in the Kaw Marshes of

French Guiana and has a very broad distribution throughout the Amazon. Given the general lack of information on reproduction on caecilians, *T. compressicauda* has been the subject of perhaps the most extensive investigations although its reproduction is in many ways highly derived and far from typical of caecilians in general. The reproductive cycle is yearly in males and biennial in females. During pregnancy (6 to 7 months long), some anatomical variations affect both the uterine wall and embryos. Each embryo develops first from the yolk mass, then, after the intra-uterine hatching, the embryo feeds upon the secretions of uterine wall, and to finish, the exchanges between the mother and embryo are assumed with a placenta-like structure implying both the embryonic gills and the uterine wall. The examination of development of several organs allowed us to observe a period of metamorphosis. The hormonal regulation of pregnancy implies the ovarian corpora lutea and the pituitary gonadotropic and lactotropic cells, all showing variations narrowly linked to the pregnancy. The majority of caecilians species are oviparous, thus *T. compressicauda*, and presumably all typhlonectids, display a relatively derived reproductive mode for caecilians. Among viviparous caecilians, the typhlonectids also appear particularly advanced in the extent of maternal contribution to the young and the specialization of the embryos for intra uterine life.

Increased occupancy, a possible syndrome of a declining population: the case of the green toad in Israel

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Circumstantial evidence in recent years has suggested a decline in the population of the green toad (*Bufo viridis*) along the coastal plain of Israel. The question is, is this indeed so, or is it rather a manifestation of temporal variability in recruitment. Presence-absence records over the past 25 years indicate a decline in the occupancy of two critically endangered amphibians in Israel: the banded newt (*Triturus vittatus*) and the spadefoot toad (*Pelobates syriacus*). However, we found that the occupancy of the green toad had slightly increased (from 57% to 77%) over that period; unexpected for a species suspected of declining. Site occupancy records do not necessarily reflect population state; a single breeding couple occupying one site would give the same occupancy record as that of many couples. Indeed, we found sites with less than five breeding couples. In such cases, a high number of occupied sites do not negate the possibility of a population decline. We suggest that in semi-arid and arid regions where pool availability is naturally low, generalist amphibians will tend to occupy both optimal and sub-optimal habitats, of which the latter are less or unproductive. Use of sub-optimal habitats is expected to increase in situations where habitat availability has

declined due to destruction by human actions. This may result in population decline. This conclusion is substantiated by our records of affected pools (sub-optimal) where the green toad breeding population is still large, but there is no metamorph recruitment. We therefore suggest that under conditions of declining habitat availability, a generalist species like the green toad may be lured into breeding in sub-optimal habitats. Consequently, a high number of occupied sites can coincide with declining recruitment. Combined with isolation, this trend may eventually lead to local extinction.

Phylogeny and duplicate gene evolution in African clawed frogs

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The phylogeny of African clawed frogs is complex because genome duplication via hybridization (allopolyploidization) caused evolutionary lineages to reticulate. We have explored evolutionary relationships and molecular evolution of duplicated genes in clawed frogs to: (1) examine the fate of paralogs of this gene at the DNA level in terms of recombination, positive selection, and gene degeneration, and – in the absence of extensive recombination among alleles at different paralogs – to (2) test phylogenetic hypotheses about the origins of polyploid species. We found that recombination between duplicated copies of the RAG-1 gene is infrequent, and that degeneration of some paralogs has occurred in octoploids and dodecaploids via stop codons and frameshift mutations. Simulations and phylogenetic analyses of RAG-1 and mitochondrial DNA support one origin of extant tetraploids in *Xenopus* and at least one origin in *Silurana*, five independent allopolyploid origins of extant octoploids, and between one and two allopolyploid origins of extant dodecaploids. We have used information from mitochondrial and nuclear DNA to estimate a reticulate phylogeny of clawed frogs that charts bifurcating and reticulating relationships, and identifies maternal and paternal ancestors of allopolyploids. Our results also implicate gene ancestry as a factor that could influence the genetic fates (gene silencing, degeneration, redundancy, and/or novel function) of duplicated genes in allopolyploid species.

The role of pesticides in amphibian declines in California, USA

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Nearly every species of native anuran in California is undergoing population declines. The most significant declines are occurring in the Sierra Nevada Mountains,

a region that lies just east of the heavily agriculturalized Central Valley of California. For about 10 years, compelling circumstantial evidence has suggested that the prevailing westerly winds were blowing pesticides from agricultural areas in the Central Valley up into the mountains where some of the most significant amphibian declines have been documented. We have collected water, sediment, air, snow, and amphibian tissue samples to evaluate pesticide concentrations both in the environment and in native species of amphibians. We have detected all of the most commonly used agricultural pesticides in the amphibian tissue samples, and in most of the environmental samples. Initially, it was unclear whether the concentrations that we found in amphibians and in their environment were sufficient to cause either lethal or sublethal impacts. Recent laboratory experiments have documented greatly reduced survival of tadpoles when exposed to concentrations in the parts per billion range. This provides compelling evidence that amphibian declines in California are tied to the extensive use of pesticides.

Anoline lizard visual ecology: do habitat light spectra matter?

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A fundamental premise of visual ecology is that animal visual systems and signals have evolved in response to habitat light spectral properties. Work on aquatic systems has strongly supported this conclusion. In terrestrial systems ambient light spectra differences are less dramatic. None-the-less Endler (1993) showed that there are localized differences in down-welling irradiance spectra, arising from differences in vegetation density and distribution. I have been exploring the role of habitat light in the evolution of visual systems and dewlap colors in anoline lizards for fifteen years. When habitat irradiance is measured parallel to the ground – which is appropriate because both eyes and dewlaps are oriented this way – among-habitat differences in irradiance spectra are greatly reduced, and background radiance spectra differ very little. Moreover, since visual systems exhibit chromatic adaptation, modest differences in irradiance spectra are unlikely to be important. With a few notable exceptions, I have found few among-species differences in anoline visual systems, and can find little evidence that habitat light spectra favor certain dewlap colors over others. However, clear relationships seem to exist between signal design and total habitat light intensity. I hypothesize that these differences have arisen from the need to maintain integrity of the information contained in the color signal. In dark habitats, color discrimination is probably limited and signals must either be very bright (highly reflective and/or transmissive) to provide sufficient quanta to drive color vision, or must rely on stark bright-versus-

dark contrasts as a source of information. In very bright habitats, dewlap pigment must be sufficiently dense to prevent strong transmitted light from substantially altering the color appearance of the signal. Dewlaps from partial shade habitats represent compromises between these extremes. Thus habitat light intensity has probably been far more important than habitat light spectrum in the evolution of dewlap colors.

Close contacts of the giant kind: on placental interfaces in matrotrophic lizards

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The EXTRAembryonic ectoderm (ET) is a component of virtually all known placental organisations in amniotes. In mammals, some ET cell populations (i.e., from the trophoblast) display invasive mechanisms one would expect only from a science fiction film. These cells are often unusually large and multinucleated (so-called Giant Cells). Curiously, one ENCOUNTERS Giant Cells of ET origin also in African and South American scincids displaying extreme matrotrophy. Although these lizards share some UNUSUAL placental features indicating possible CLOSE relationship, they differ in specializations for placentotrophy, particularly in Giant Cell characteristics. These cells mediate CLOSE proximity of maternal and fetal tissues in at least three types of placental organisations found in these skinks. In one kind (African Eumecia), Giant Cells process large quantities of uterine secretions for uptake by the embryo. In a second kind (New World Mabuya), Giant Cells form an absorptive placentome and in the THIRD KIND they eliminate the uterine epithelium. The latter kind, found in the African skink *Trachylepis ivensi*, represents the only known example of an endotheliochorial placental arrangement recorded in any non-mammalian amniote.

Can habitat modification affect the foraging methods of semi-aquatic snakes?

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One of the most significant factors impacting amphibian and reptile communities is habitat modification by humans. Disturbances can cause direct mortality but often have more subtle effects on the organisms. For example, changes in habitat structure can affect the ability of predators to forage efficiently. In stable communities competition often drives species to be specialists in foraging methods and this process has often been assumed to increase diversity. When

disturbance changes the availability of particular prey we normally expect decline or extinction of some species, but this is not always evident. Indeed, habitat modification can often change the structure of the environment without necessarily removing the prey. Since these changes might affect the success of particular foraging modes one factor that may be important in studying the effect of habitat disturbance is the foraging methods of the predatory species. Shifts in foraging modes may be difficult to obtain but two aspects of community composition are useful to see if foraging mode may be involved in the response of a community to disturbance. The most obvious is how do individual species forage prior to and after the disturbance. Responses such as prey switching or declines in percentage with food may be related to the flexibility of the species in foraging methods. For example, floodplain suppression in an east Texas bottomland forest caused a decline in fish availability. The active foraging yellow-bellied water snake, which normally ate fish, changed its foraging behavior whereas the western ribbon snake, which normally ate amphibians, did not change strategies. The increased vegetation near the waters edge where it foraged likely impacted the ambush predator, the western cottonmouth in different ways. Another indication that these predators were affected by the lack of fish in ephemeral pools was a shift in the abundance ranking of particular species.

Both niche apportionment and dispersal influence snake assemblages in East Texas bottomlands

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The distribution of abundance among species can give insight into the significant ecological features of that habitat. When a single factor dominates the ecology of an assemblage, resource partitioning is predicted to be involved in the abundance ranks of the dominant species, whereas random processes such as dispersal and extinction are important for the less abundant species. This produces a log series abundance curve with a few abundant species and a large proportion of "rare" species. Bottomland hardwood forests are important endangered ecosystems that support a large diversity of organisms. Detritus from flood pulses supports a high biotic production that translates into high prey availability for carnivores like snakes. We examined the abundances of snake species in the Old Sabine Bottom Wildlife Management Area, a 2300-hectare bottomland deciduous forest in northeastern Texas for three years (1998-2000). Nineteen species of snakes were recorded but only 10 to 14 species were found within any given year. Three semi-aquatic species, the western ribbon snake (*Thamnophis proximus*), yellow-bellied water snake (*Nerodia erythrogaster*), and western cottonmouth (*Agkistrodon piscivorus*) accounted for 74% of all captures. Although these species eat the same prey, their foraging

methods are different. In other surveys in northeastern Texas bottomlands, most of the same snake species were found and semi-aquatic species were usually most abundant. Intermediately abundant species of snakes have a wide variety of diets and ecology that were reflected in the variation in their numbers within years and among studies. The rarest species were present in some studies and some years but not in others. We suggest that niche apportionment is involved in the numbers of the most abundant species and to some degree influences the abundance of mid-level species. Dispersal and extinction are likely the mechanisms for the presence or absence of rare species at particular sites among years.

Kidney function in Western Australian agamid lizards

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Western Australian agamid lizards are diverse and inhabit most of the state's habitats, which range from very arid to relatively mesic. As reptiles, their kidneys are generally regarded as being poorly capable of reclaiming water, with no structural or functional specialisations for this task. It was hypothesised that the kidneys of desert lizards in particular would show evidence of functional and structural adaptations to their arid environment, compared with lizards from more mesic areas. To examine this, the kidney function of the desert-inhabiting western-netted dragon, *Ctenophorus nuchalis*, the salt-lake dragon, *Ctenophorus salinarum* and the cosmopolitan western-bearded dragon, *Pogona minor*, was studied. The effect of hydration, dehydration, hypernatraemia and hypervolaemia on renal clearance parameters such as glomerular filtration rate, urine flow rate and fractional reabsorption of filtrate was estimated. For each treatment measurements of arginine vasotocin (AVT) were made. Responses to the physiological treatments were similar among the species: as expected, water-loaded and volume-loaded animals had higher urine flow rate than dehydrated or salt-loaded animals. The species varied in the way they achieved this, by altering vascular (glomerular filtration rate) or tubular (fractional reabsorption of filtrate) responses. These variations may reflect renal physiological adaptations to the animals' environment.

Returning the pool frog *Rana lessonae* to England: lessons for amphibian re-introduction policy and practice

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The pool frog *Rana lessonae* has been the centre of a conservation dilemma in the UK due to its uncertain

status. It has been the subject of introductions from central and southern Europe since the early 1800s, and therefore the accepted position has been that all UK *R. lessonae* populations are descended from these introductions. However, early UK literature sources and recent discoveries of isolated, native *R. lessonae* populations in Scandinavia suggested that the species may in fact have been present as a native prior to the introductions. Genetic, bioacoustic, archaeozoological and archival research was undertaken to assess the status of the species. The results provide compelling evidence that *R. lessonae* was in fact native to the UK, and furthermore the UK population appears to be part of a distinct northern clade. Unfortunately the native populations have undergone declines, with the last one becoming extinct in the 1990s. A re-introduction was therefore proposed to restore the species to its former UK range, using animals translocated from Sweden. A great deal of work has been undertaken to ensure the project fully complies with the IUCN/SSC Guidelines For Re-Introductions. This has generated a number of studies which might prove useful for others planning amphibian reintroductions. The first and fundamental issue was to establish whether the species is native or introduced, and the research strategy employed may be instructive for others assessing the conservation value of populations of uncertain origin. Other topics addressed include: appropriate taxonomic levels for conservation, habitat assessment and restoration, legislation, translocation methods, disease risk assessment, monitoring methods, success criteria and public awareness. A reintroduction strategy has been produced which details how each element of the IUCN/SSC Guidelines has been addressed. The project has demonstrated excellent partnership between government conservation agencies, scientists, business and the voluntary sector.

Bringing amphibians back from the brink: the Mallorcan midwife toad (*Alytes muletensis*) recovery programme

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The conservation programme for the Mallorcan midwife toad or ferreret (*Alytes muletensis*) has resulted in this species being the only amphibian species in the recent global amphibian assessment to be downlisted from 'critically endangered' to 'vulnerable'. This has been achieved through some 25 years of collaborative conservation work following the discovery of an extant population in Mallorca in the late 1970's. Toads are now known from 33 sites in the Serra de Tramuntana mountains, of which about 10 stem from reintroductions of captive bred animals. The recovery programme has evolved from one initially based on adaptive management to one that is now using scientific methodology to inform the decision-making process.

Consequently, conservation actions (i.e. advocacy, captive breeding and reintroduction, annual population censuses, habitat management and creation, predator management) are being guided by research on habitat selection, population and reproductive biology, the impact of introduced predators, and genetic and biomedical assessments of wild and captive populations. This integration of conservation research and action has been achieved by a relatively small team of people representing government and non-government organisations in Mallorca, zoos, Universities and research institutes.

Population status of Madagascar side-necked turtle (*Erymnochelys madagascariensis*) at Ankarafantsika National Park, Madagascar

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Populations of Madagascar side-necked turtle (*Erymnochelys madagascariensis*) were studied over a two-year period at Ankarafantsika National Park. Turtles were caught using a number of methods (baited traps, nets, hooks and line, and incidental collections). Population sizes and densities were low in all populations. Juveniles were most frequently captured, and from some populations mature turtles were almost absent. Age structures differed between populations, but all showed signs of the larger size classes being affected by human exploitation. Adult sex ratio at all sites was largely male-biased. The small number of potential breeders, particularly the absence of large females, is a worrying scenario for the future of turtle populations in the National Park. Local subsistence fishing plus illegal commercial fishing operations with more efficient techniques (long seine nets) were both directly affecting the turtle populations by regular accidental captures. Captured turtles were consumed locally, remains of turtles were often found in villages and forest camps, but *Erymnochelys* (as opposed to fish) is generally not traded. Interviews with the local communities confirmed that *Erymnochelys* had severely declined in the last 10-20 years even though the species was generally not specifically targeted, but rather incidentally exploited. *Erymnochelys* is more sensitive to exploitation than the sympatric, non-endemic *Pelusios castanoides* and *Pelomedusa subrufa* which do not seem to be rare at Ankarafantsika. The critically low population status of *Erymnochelys* resembles that of the endemic cichlids of western Madagascar which are also critically endangered due to over fishing of their habitat and due to competition with and predation by introduced, exotic fish species. However, there was no evidence that natural or introduced predators were responsible for the past or recent decline of *Erymnochelys* populations.

The distribution of *Batrachochytrium dendrobatidis* in Europe

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Batrachochytrium dendrobatidis is a globally distributed and recently emerged pathogen of amphibians implicated in many population declines, extirpations and some species extinctions. While numerous amphibian species have been shown to be infected by the fungus, the majority of these cases involve sick and/or dying animals and declining populations. This is the case for at least two species of amphibians in Europe: *Alytes obstetricans* in Spain and *Bombina pachypus* in Italy. However, the potential exists that *B. dendrobatidis* is capable of sublethally infecting amphibian species and may therefore exhibit a broader distribution than is reflected by locations where fungal-related declines are occurring. We undertook an opportunistic survey of European amphibians using molecular techniques to determine if the pathogen exists outside the two locations in Spain and one in Italy where declines have been recorded. Our results show that *B. dendrobatidis* occurs in at least six European countries and infects at least 14 European species, not including both of the declining species. Furthermore, sublethal chytrid infections were detected in apparently healthy and breeding adult amphibians as early as 1998. Our results show that chytrid has a patchy distribution outside the foci of declines and can apparently coexist with several species, possibly under certain ecological conditions.

Effects of translocation and density the biology of the Turks and Caicos iguana, *Cyclura carinata*

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Historically the Turks and Caicos iguana (*Cyclura carinata*) was found throughout the Turks and Caicos Islands, located at the southeastern terminus of the Bahama Archipelago in the West Indies. Due to negative impacts associated with European colonization, especially the introduction of mammalian predators, *C. carinata* is now restricted to less than 5% of its historic range and ranked Critically Endangered on the IUCN Red List. In response to threats from introduced mammals and human development, iguanas were translocated in January 2002 and 2003 from two large but threatened island populations to four small protected islands with suitable habitat but lacking extant iguana populations. Translocation islands received 18-82 adult iguanas of equal sex ratio from one of the two source islands, depending upon their

area (1-12 ha) and estimated adult carrying capacity. To study translocation success/failure, source and translocated populations were monitored 2-3 times annually between 2002 and 2005. Relative to iguanas on the source islands, translocated iguanas experienced significant weight loss, increased corticosterone and movement levels, and other signs of stress one month post-translocation. These effects were short-lived, however, and by five months post-translocation adult iguanas on translocation islands had established normal movement patterns and were exhibiting normal or increased growth rates relative to source populations. Successful reproduction has occurred on all translocation islands each year since reintroduction and iguanas hatched on translocation islands are exhibiting growth rates 2-4 times that of juveniles the same age on source islands. This has resulted in a significant decrease in age at maturity on translocation islands, relative to source islands, from 6-7 years to 2-3 years. We attribute increased growth rates on translocation islands to decreased intraspecific competition (i.e., density), relative to source populations, and predict that growth rates will return to baseline as density increases and the populations approach carrying capacity.

Sex determination and sex allocation – bridging the gap

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Sex determining mechanisms, sex ratio evolution and sex allocation are inextricably linked. If sex chromosomes determine sex according to the rules of Mendelian segregation, then the primary sex ratio is under strict control and identifying the mechanisms by which sex ratios can be adjusted in GSD species remains a major empirical and theoretical challenge. If instead sex is determined by the environment, the primary sex ratio is controlled by the interaction of that environment (or associated cues) with the organism's physiological and behavioural response to it. Reptiles with TSD have obvious and tractable maternal mechanisms for varying offspring sex ratio and for differential sex allocation. In this talk, I will begin with a focus on temperature dependent sex determination. Where are we on the mechanisms front? Are reptiles predisposed to developing TSD, and if so, does this give us an inkling as to possible mechanisms? How do we bridge the gap between controlled laboratory experimentation and field studies? Reptiles with TSD are appallingly vulnerable to climate change, or are they? What responses do they have in their arsenal to persist in the face of climate change? Can latitudinal variation be used as a surrogate for climate change, and if so, do we have any evidence that sex ratio variation contributes to the demographic processes that limit the distribution of a TSD reptile? Many of these questions on sex determination and its significance in reptiles benefit from being asked in the context of sex

allocation theory, and there are exciting developments on the horizon brought about by new molecular technologies. The scope of this talk will be broad, and will focus on the fundamental challenges we face in gaining a satisfactory understanding of reptile sex determination, its evolution and its implications for conservation.

ShellShock

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In September 2004, with the help of internationally renowned turtle conservationists from around the world, the European Association of Zoos & Aquaria (EAZA) launched "ShellShock", a conservation campaign focusing on the world-wide plight of turtles and tortoises. EAZA member institutions have united under this cause to promote awareness, raise funds, and maximise European zoo's contribution to turtle and tortoise conservation. The ShellShock campaign has three objectives: 1) To raise awareness of the extinction crisis facing this group of reptiles. Considered by some to be less charismatic than mammals and birds, tortoises and turtles nevertheless have the capacity to evoke great affection and sympathy amongst the 125 million visitors to EAZA member zoos each year. The campaign highlights the many threats to these ancient reptiles and the actions needed to save them. 2) To raise dedicated funds for in situ turtle and tortoise conservation projects. Many species might still be saved in the wild with appropriate conservation action. Shellshock is raising money to support priority initiatives in range countries including field surveys and life history research, educational and training initiatives, and the development of viable captive assurance colonies. 3) To promote participation in 'Turtle Arks' - ex situ safety-nets for priority species. The only hope of survival for many species of tortoise and freshwater turtle in the short-term is captivity. Assurance populations established and managed specifically for this purpose provide a glimmer of hope for those species on the very brink of extinction in the wild. These Turtle Arks require the participation of many more aquariums and zoos if viable populations are to be maintained. ShellShock promises to be a significant force in turtle and tortoise conservation and the campaign logo will become a widely-recognised symbol of the valuable contribution zoos can make to international conservation activities both in captivity and in the wild.

Mechanistic biochemical and physiological models interplay to offer a new tool to understand temperature-dependent sex determination

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Temperature-dependent Sex determination has been studied mostly using artificial incubations with constant temperatures. However, the interpretation of these results in natural conditions are not straightforward because the fluctuation of temperatures affects both sex determination and embryonic growth rate which in turn changes the thermosensitive period of incubation. We built a mechanistic and statistic model of temperature-dependent sex determination for the European Freshwater Turtle, *Emys orbicularis*, taking into account temperature effect on embryonic and gonad growth and aromatase enzyme regulation as well as estrogen effect on growth of the gonad. After validation of the model, we will discuss some ecological and evolutionary implications of this new model.

North-Atlantic global climate influences the nesting behaviour of leatherback turtles in French Guiana

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The leatherback sea turtle has a largest range of distribution, extending from 5° North to 15° South latitude. Awa:la-Ya:lima:po beach (French Guiana, South America) is considered as the largest leatherback population. Environmental variations reflected by the North Atlantic Oscillation have been documented to affect reproduction in marine vertebrates through effect on abundance of zooplankton and fish within the same year. Based on 16 years of data collected on leatherback sea turtles nesting in French Guiana, we show that the North Atlantic Oscillation (NAO) influences the individual female reproductive investment, the breeding season timing and the probability of skipping reproductive season but with a lag of several years. We propose that the North Atlantic Oscillation effect is mediated by the sea surface temperature at the feeding grounds identified by stranding reports and satellite tracking. This climatic effect can profoundly affect the dynamics of nesting on the beaches of French Guiana and can potentially mask a trend in nesting females. These findings highlight the lack of knowledge of the proximal causes of population dynamics of this highly endangered species.

Genetic differentiation of the European cave salamander *Proteus anguinus* (Proteidae)

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The European cave salamander *Proteus anguinus* is distributed along the Dinaric karst of the western

Balkan Peninsula. Two subspecies are currently recognised, the troglomorphic *P. a. anguinus* and the morphologically distinct, pigmented *P. a. parkeji* from southeastern Slovenia. To reveal genetic variation and potential cryptic taxonomic diversity of *Proteus anguinus*, mitochondrial control region and flanking sequences were analysed. Phylogenetic relationships among haplotypes were inferred using parsimony, maximum likelihood and Bayesian inference. On all genealogical trees the clades of haplotypes from the following regions are well supported: (1) the Istrian Peninsula, (2) a broad geographical area of the central and southern Dinarides, (3) southeastern Slovenia, and (4) southwestern Slovenia. The Istrian clade appears basally on all trees. While the population inhabiting the western Slovenian karst appears homogenous, three distinct lineages can be discerned in the southeastern part of Slovenia and four within the central and south Dinaric clade. The pigmented subspecies does not form a monophylum with the white subspecies from the same hydrographic area. The average uncorrected sequence divergence among the four major clades ranges from 0.054 to 0.125, which equals or exceeds the level of variation in the *Ambystoma tigrinum* species complex (0 - 8.5%; Shaffer & McKnight, 1996). Applying the molecular clock calibrated on *Euproctus* species (Steinfartz & al., 2000) we roughly place the timing of the split between the Istrian, central and south Dinaric, and Slovenian populations in Miocene, 10.5 – 7.25 millions of years ago. The split between the southeastern and southwestern Slovenian populations would have occurred in the upper Miocene to lower Pliocene, 6.6 – 4.4 Ma. These estimates are comparable to the separation times of major *Salamandra* species (5 – 13 Ma; Steinfartz & al., 2000).

Conservation biology of caecilians (Amphibia: Gymnophiona)

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Amphibians are generally considered threatened, with an increasing number of populations declining or extinct. Most discussions of “amphibian” decline pertain only to anurans and, to a lesser extent, caudates. As with knowledge of the group in general, information on caecilian conservation biology is woeful. In the 2004 Global Amphibian Assessment, less than 3% of caecilian species are recognised as threatened or extinct, compared with nearly one third of anurans and one half of caudates. However, two thirds of all caecilian species are data deficient, compared with 12% and 22% for caudates and anurans, respectively. The literature contains some precise, even quantified statements about caecilian decline, but none of these claims is well supported. The brute fact is that no monitoring of caecilians has ever been carried out and estimates of abundance have only been made for a handful of populations. The general instability of

caecilian taxonomy, lack of workable identification keys, and requirement for dedicated fieldwork mean that anecdotal reports of population trends are not particularly useful at this point. For most caecilians, positive conservation assessments are prevented by considerable vacuums in knowledge, especially of taxonomy, distribution and ecology. Many caecilian species are known from very few specimens, and very little dedicated fieldwork has been carried out. Despite widely held generalisations, some terrestrial caecilians thrive in naturally unforested or even highly disturbed habitats and can occur in high abundance. Recent studies indicate how much basic work remains to be done, but also demonstrate that some caecilian field research is feasible. Full monitoring might prove to be unmanageable for most species, so that alternative, pragmatic approaches need to be devised. Marked improvement of the situation will only happen through much greater study of caecilians. In particular, much more fieldwork is required, including the regular collection of voucher specimens.

Captive breeding of amphibians: conservation or cosmetic surgery?

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Captive management and breeding can contribute to the conservation of amphibians through reintroduction programmes, research relevant to wild populations, public education and the generation of conservation funds. Indeed, their generally small size, high fecundity, low maintenance requirements and ‘hard-wired’ behavioural repertoires make amphibians better subjects for conservation breeding programmes than many higher taxa. However, as many species face threats that are not easily neutralized, the likelihood of successful reintroduction for these species may be low. Moreover, despite some imaginative research and education programmes, there has been very little evaluation of such initiatives with respect to their effectiveness in informing or financing amphibian conservation or raising public awareness. Zoos and aquaria support relatively few amphibian conservation breeding programmes when compared to their involvement with other taxa. The widely held perception that amphibians are less attractive to paying visitors than ‘charismatic megafauna’ may be responsible for this lack of investment. Nevertheless, surveys of zoo visitors have shown that large animals are not necessarily more popular than small animals, and when enclosure costs are taken into account, displays of small animals are no less profitable than displays of large animals. Furthermore, conservation research and breeding programmes for amphibians can represent good value for money in terms of conservation impact relative to the investment of finances and other resources. Although most species of amphibians bred in captivity are not species of conservation interest,

there have been some notable success stories. For example, conservation research, breeding and reintroduction has resulted in the Mallorcan midwife toad being down-listed from 'critically endangered' to 'vulnerable' in the recent Global Amphibian Assessment. Such programmes provide templates for how zoos, research institutes and government and non-government organisations can successfully collaborate to realise their potential in this field and halt amphibian declines in the wild.

Parthenogenesis in the Burmese python, *Python molurus bivittatus*

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Parthenogenesis among reptiles is seldom observed. Only a few species from the order of the *Squamata* have the ability to reproduce asexually. Most are obligatory parthenogenetic species that consist (almost) entirely of females that can reproduce solely through parthenogenesis. Sexual species that only sporadically reproduce through parthenogenesis are rare. A female *Python molurus bivittatus* from Artis Zoo - Amsterdam was presumed to have reproduced parthenogenetically, since she never had met a male, but produced eggs with embryo's. Parthenogenesis has not been shown for the Boidea family previously. We performed parentship analyses on the animal and seven of her embryos using microsatellites and AFLP. Four microsatellite loci have been developed for this study, which are presented in this paper. Combined with three loci developed previously for other snake species, microsatellites nevertheless revealed too little variation to draw conclusions. With AFLP however we were able to confirm that the female from Artis Zoo reproduced parthenogenetically. However, the offspring are genetically identical to their mother. The meiotic pathway that produces the diploid egg cell appears to be different than in previous reports on sporadic parthenogenesis in snakes. The same methods revealed extremely interesting results in another presumed case of parthenogenesis in captive bred *Python molurus bivittatus*. These results will be discussed in this presentation.

Does security matter: ecology of an arid zone river turtle, *Emydura macquarii emmotti*

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We set out to determine the physical and biological parameters that enable freshwater turtles to persist in a highly variable Australian arid zone river system-Cooper Ck. To answer this question we studied a Chelid turtle, *Emydura macquarii emmotti* across five regions of the Cooper Ck catchment. We determined

growth, population size, diet, and size at maturity for each population. We combined this ecological data with data on geomorphological and limnological aspects of the waterholes to explain the interaction between turtle population dynamics and the spatio-temporal aspects of Cooper Ck. Turtle densities correlated positively with increasing levels of waterhole persistence, despite the fact that waterhole persistence correlated negatively with primary production. We found that turtles in our study faced important trade-offs between survivorship and contribution to recruitment. We infer that waterhole persistence is the most influential factor determining the distribution and abundance of this species over the entire basin.

Preserving the diversity of the desert tortoise (*Gopherus agassizii*): reassessing conservation units

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Preserving genetic and ecological diversity is an important objective of the desert tortoise Recovery Plan. Although the desert tortoise exhibits considerable variation throughout its range, the spatial structure and genetic basis for this variation remains unclear. When the Mojave assemblage of the desert tortoise (*Gopherus agassizii*) was listed as threatened, in 1990, under the U.S. Endangered Species Act (ESA), the U.S. Fish and Wildlife Service (USFWS) addressed these differences by designating six Recovery Units in the species Recovery Plan. These units, consistent with the concept of the evolutionarily significant unit (ESU), have a common purpose of conserving genetic diversity and unique evolutionary trajectories. However, the currently assigned Recovery Units are not consistent with ESA policy. The USFWS policy (1996) for recognizing unique spatial units of a listed species as Distinct Population Segments (DPS) is based upon discreteness, significance, and conservation status. A scientific assessment of the Mojave Desert Tortoise Recovery Plan prompted scientists and managers to review the current conservation units in relationship with the DPS policy. We have reviewed recent genetic and ecological data, and suggest revision to the boundaries of current conservation units to a new distinct population segment hypothesis, which more accurately captures the intraspecific diversity of the desert tortoise.

Amphibian declines and extinctions: what can we expect in the next five years?

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It is becoming increasingly clear that recent declines and extinctions among amphibians are not a uniquely

amphibian phenomenon, but are but one aspect of a global mass extinction process. In particular, biodiversity in the Earth's freshwater habitats, threatened by a number of factors, is declining faster than any other biome. While the remarkable efforts of the herpetological community over the last 20 years have enabled us to better understand the nature, extent and causes of amphibian declines, the task of stopping or reversing the process becomes more daunting as the scale of the decline phenomenon becomes apparent. Herpetologists are making considerable advances in developing techniques and strategies to conserve endangered amphibians, but we can only expect these to protect a small number of species from extinction. It is clear that those of us who are concerned with the conservation of amphibians are going to have determine their priorities, a process that will involve some difficult decisions.

Complex program to save the Hungarian meadow vipers (*Vipera ursinii rakosiensis*) from extinction

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At present time this small venomous snake can only be found in Hungary. During the last century the subspecies lost most of its previous area in the Carpathian-basin, remaining only in small and isolated populations. Recent estimations put its numbers below 500 individuals. MME BirdLife Hungary with Kiskunság and Duna-Ipoly National Parks started a complex program to establish the background of preserving this unique subspecies for the future. The four-year program is funded by the Ministry of Environment and Water Affairs and the EU LIFE-Nature fund. The program consists of four major pillar: habitat reconstruction, monitoring and related studies, publicity campaign and the start of the Viper Conservation and Breeding Centre. Habitat reconstruction is urgent to turn forests, planted some 20 years ago on elevated parts of certain habitats, into grasslands providing safe hibernating places. Monitoring of recent populations will try to describe recent habitats with objective parameters, to prepare guidelines for their management. The active protection of a venomous snake can be difficult to accept for the general public, therefore we will use every opportunity overcome this problem. Experts fear that some isolated population due to their size are unable to grow whilst the best management effort either and their reinforcement is inevitable in order to keep them. The Viper Conservation and Breeding Centre is started with 10 adult individuals, collected from different populations. The minimised predation and maximised food abundance provided by the Centre's seminatural conditions will result higher recruitment rate than in wild populations. As the Centre started operating this year we have our first results: two females, mated in the Centre, gave birth to 25 offspring in August 2004. In

the future their repatriation can take place step by step to the selected habitat, enlarged by that time thanks to the grassland restoration.

Comparison of two isolated *Vipera ursinii moldavica* populations of the Romanian Danube-Delta

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During the autumn of 2002 and 2003, we managed to examine 44 meadow viper (*Vipera ursinii*) from two different population in the Romanian Danube-Delta. We examined 29 animals from population near Sfântu-Gheorge and 15 individuals from Periteasca, of which 20 was male (45.5%) and 24 was female (55.5%). Twelve of the observed animals was born that year (27.3%), 8 of them was subadult (18.2%) and 24 was adult (54.5%). We recorded several morphometric data on every animal and we collected blood-samples from 25 adult individuals: 18 samples from Sfântu-Gheorge (10 males, 8 female) and 7 from Periteasca (2 males, 5 females) for genetic analysis using RAPD and microsatellite DNA methods. We included 27 morphological characters, 87 polymorph alleles found with 14 decamer primers and alleles found at 6 microsatellite loci. Average similarity was 46% based on morphological data, while 67% based on RAPD results, with no significant differences between the two populations. Average heterozygosity was 67% in the Periteasca population and 70% in the Sfântu-Gheorge population.

Developmental origins of the sternal elements in Anura

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In the anuran pectoral girdle, sternal elements are components of the zonal area located ventral and medial to the glenoid fossae. A prezonal element, termed the omosternum (or episternum), is situated anteriorly to the procoracoids. Two types of the omosternum may be recognized according to their developmental origins. The first type, occurring in one of the most ancient anuran families (Discoglossidae), takes its origin from a single primordium and remains as a rod-like cartilage during the whole lifetime. The second type, which is typical for the family Ranidae, develops from a pair of cartilaginous centra and enchondral ossification occurs only in its posterior part. Postzonal elements are situated posteriorly from the epicoracoids. The xiphisternum in the representatives of the family Discoglossidae develops from two cartilaginous rods, which later fuse with one another and join the epicoracoids. The sternum of e.g. *Xenopus*

and *Rana* arises in a similar way as the xiphisternum of *Discoglossus*, but later it fuses into an unpaired element. On the contrary, the sternum of *Bufo* seems to develop from a single cartilaginous element. The anterior part of the sternum in *Rana* ossifies long after the metamorphosis, in contrast to the xiphisternum in the Discoglossidae and sternum in *Xenopus*, which both remain unossified. Although all sternal elements of adult frogs are ultimately unpaired, they obviously develop in different ways

Foraging mode may indicate why growing-up lizards lose their infant costume of blue tail and striped body

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Ontogenetic changes in color and pattern that are not directly related to reproduction are very common among many taxa, yet, this still is a poorly studied phenomenon. One example is conspicuous colors in the tails of fish, amphibians and reptiles that fade out later in life, raising the question: Why juveniles evolved these colors, exposing themselves to increased predation risk. Few studies that explored this question manipulatively tested the adaptive value of the conspicuous tails in juveniles. We took a different direction, focusing on the reasons for the subsequent loss of color and we deal with the alteration in body pattern too. We observed the blue tailed, newly hatched *Acanthodactylus beershebensis* in the field and compared five parameters of their behavior to that of older individuals that already lost their neonate coloration. The striped blue-tailed hatchlings foraged more actively than the three weeks old juveniles and spent longer time in the open microhabitat. The results suggest that an alteration in activity may be a major factor affecting the ontogenetic color and pattern change. Active lizards that forage in open habitat increase their probability to be attacked by ambush predators. As a result, conspicuous colors that may deflect the predator attack to the expendable tail may increase the prey probability to survive the attack. The results supports the cited relationship between striped pattern and active foraging and thus may suggest that our explanation may be appropriate for many other species that have conspicuous tail accompanied by a striped pattern.

The use of scent discriminating dogs to locate desert tortoises in the wild

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Federally threatened desert tortoises (*Gopherus agassizii*) occur throughout the Mojave Desert, though populations are declining. Existing methods for

surveying desert tortoises rely on the ability of people to see tortoises, and because even the best-trained people have difficulty seeing tortoises, results are often not very accurate. This is further exasperated by the fact that tortoises spend as much as 95% of their time underground. The use of dogs for locating wildlife has been neither rigorously tested nor scientifically documented, although detection capabilities of dogs in other disciplines, namely law enforcement, have been studied and are well documented in laboratory settings. We developed a series of experiments to test the efficacy and reliability of dogs to locate tortoises on the surface, in burrows and of all size and sex classes in the wild. In addition, we ran one-to-one comparisons with human only teams. We also wanted to assess how far away dogs might be able to smell tortoises and locate them (this measurement is called "detection distance"). And, we wanted to evaluate environmental conditions that might or might not effect scenting conditions. Dog teams found more tortoises than human only teams, including smaller size classes and more tortoises in burrows. Dogs were an efficacious, accurate, and cost-effective means of locating desert tortoises. Safety for tortoises was paramount, and some dogs were deemed unsuitable for tortoise work, though they may be well suited for other non-wildlife related scent work. Because of this fact we are working with the United States Fish and Wildlife Service to develop wildlife detection dog standards and certification program. The implications of this research for tortoise conservation and management are important in that dogs may be used to effectively and reliably survey desert tortoise populations either as a stand-alone tool or in conjunction with other survey methods.

Geographic variation in a far-flung archipelagic marine sea snake, *Laticauda colubrina*

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The *Laticauda colubrina* complex consists of two named species, *Laticauda colubrina* and *Laticauda frontalis*. The range of *L. colubrina* extends from the Andaman Islands eastwards to Palau, northwards to the Ryukyu Islands, and southeastward to Tonga. *L. frontalis* is restricted to Vanuatu where it is sympatric with *L. colubrina*. The geographic variation in the widely distributed *L. colubrina* was subjected to three approaches, an hierarchical analysis, a phenetic analysis, and Principal Components analysis. Thirty-eight characters were used for the analysis and slightly different geographic patterns emerged for various ones. These three approaches, however, converged to indicate that at the infraspecific level this species can be separated into several geographic components, (1) a north-south axis comprising populations from Sabah, the Philippines, Taiwan and the Ryukyus, (2) and east-west axis of populations from the Andaman Islands through Papua-New Guinea, and (3) various

populations at the various island groups of the eastern island chain. In the latter each island group has some distinctive features. These patterns are described, but most of the different demes are not awarded nomenclatural recognition. Two entities are distinct, however, and are being described as new species, (1) the population on New Caledonia, and (2) populations in southern Papua.

Seasonal changes in plasma sex steroid concentrations and gonad growth in wild African clawed frogs, *Xenopus laevis*

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As outlined in a parallel study (Du Preez) little is known about the basic biology of *Xenopus laevis* including its reproduction under natural conditions. Knowledge of the reproductive biology is of particular interest because previous investigations designed to assess the risk of chemical exposure on reproductive parameters such as plasma sex steroids and gonad growth in *X. laevis* revealed relatively great natural variabilities among individuals within a population. *X. laevis* have an extended breeding period but physiological processes related to reproduction also undergo distinct seasonal changes, making it often difficult to directly compare results from different studies. This study was designed to collect data from male and female frogs at multiple times during the reproductive cycle between May and December 2003 in order to better understand the reproductive physiology and associated variabilities in *X. laevis* that occur under natural conditions. Morphometric measurements and blood samples were taken for all animals, and gonads examined at the gross morphological level, and also fixed for histological analyses. Frogs were analyzed for parameters such as gonad growth and plasma sex steroid hormones (testosterone and estradiol). GSI values of frogs of both sexes increased steadily during the sampling period. Greatest GSI values in males were 23 +/- 0.02% (mean +/- SEM), 22 +/- 0.02%, and 25 +/-

0.03%, and occurred at all three sites during late October. In females maximum GSI values were reached in the months October and November with values reaching from 4.1 +/- 0.8% (site B) to 8.4 +/- 1.2% (site A). Plasma T concentrations showed two peaks during the sampling season with highest concentrations measured during June/August (males: 24-143 ng/ml; females: 23-157 ng/ml) and a second increase starting later during October/November. While at two of the sampling sites plasma T concentrations in frogs of both sexes were significantly positive correlated ($p < 0.05$) with rainfall no such correlations were observed at the third location, indicating that reproductive hormones may depend on multiple environmental factors.

Calcium transport across the uterine epithelium of pregnant lizards

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Calcium is a major requirement for developing embryos, but not enough is present in egg-yolk to sustain embryonic development in most reptiles. Consequently, the eggshell acts as an extra-lectithal source of calcium in amniote vertebrates, including squamates. A number of anatomical and physiological changes must accompany the evolutionary transitions from oviparity to viviparity, including the reduction or elimination of the eggshell. Viviparity has evolved in approximately 100 lineages of squamate reptiles. In our quest to understand the evolution of viviparity, we are currently characterising the calcium transport mechanisms of birds and lizards. To date, we have used indirect immunofluorescence to characterise calcium channels in the uterus of a targeted range of species of *Eugongylus* group skinks and bird species. We have studied Ca²⁺ATPase channels in a number of species at various stages during pregnancy. During egg-shelling, apical localisation of Ca²⁺ATPase channels were found in the glandular epithelial cells of the uterus in the oviparous lizard *Lampropholis guichenoti* and the quail. It is proposed that this allows the movement of calcium against its electrochemical gradient into the lumen of the glandular duct and ultimately to the uterine lumen and developing embryo. Interestingly, structurally similar shell glands occur in the uterine stroma of viviparous species, although we have seen them only in non-pregnant female *Pseudemoia spenceri*, where they have little Ca²⁺ATPase activity. Our findings suggest that the down regulation of CaATPase may be an important contributor to the evolution of viviparity.

Laterality in animal signaling: proximate and evolutionary perspectives

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The two brain hemispheres are lateralized in many aspects, including anatomical asymmetries in diverse parts of the brain, motor asymmetries (limb use, turning directions, production of vocalizations), and asymmetry in eye use for diverse tasks including predator inspection, foraging, prey capture, and social tasks (conspecific recognition, aggression, mating). Recent works suggest hemispheric specialization could optimize anti-predator vigilance with other tasks such as sleeping, foraging, and social interactions. Relatively few studies have examined lateralized behaviors in free-ranging animals. Here I focus on aggressive behavior. A small but taxonomically diverse number of vertebrates have a left-eye preference or bias in aggression, typically demonstrated by greater aggressive responses when appropriate conspecific stimuli are viewed in the left visual field (LVF) compared to the right visual field (RVF). The degree of decussation of retinal efferents to the left versus right hemispheres varies taxonomically. Lateralized aggression may be widespread in lizards, but more species require study. I review field studies of laterality in male lizards, focusing on territorial aggression, and in female lizards, focusing on aggressive rejection displays. Males are facultative in expressing lateralized aggression. In tree lizards (*Urosaurus ornatus*), males that turned to use the LVF were significantly more likely to be larger than their opponent compared to males that continued to use their RVF during aggressive display. Such facultative expression suggests interesting areas for future study. Do LVF inputs into the right hemisphere alter subsequent behaviour of a lizard, and/or whether lizards with different motivational states use brain lateralization of aggression to alter the nature of social encounters? What are the neuroendocrine bases and consequences of lateralized aggression?

Reproductive nutrition of female desert tortoises (*Gopherus agassizii*): the importance of dietary protein in spring and summer

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Energy budgets suggest that nitrogen is a limiting resource for egg production in the desert tortoise. Also, the reproductive output of female *G. agassizii* seems to depend upon stored nutrient reserves and the availability of nutrients in spring. In a two-part trial beginning in spring, we evaluated the importance of dietary nitrogen intake to egg production by female desert tortoises. Females were assigned pelleted diets ranging from 0.5 to 3.0% N (g N/g dry matter), nitrogen consumption was measured, and egg production was quantified. After correcting for body size, dietary treatments in the first spring affected the size (number of eggs) of the first clutch; clutch size tended to be small for the two low nitrogen treatments (0.5 and 1.0% N). Egg size and composition were not correlated to dietary nitrogen concentrations, food consumption, or nitrogen consumption during the first spring. In the second spring, the size of the first clutch was correlated to female body size, the amount of N consumed since the previous reproductive season and the amount of N consumed prior to hibernation. Most (88%) of the nitrogen consumed after the first reproductive season was consumed before females hibernated, and most (90%) of the nitrogen in the eggs is located in the yolk. The correlation of clutch size to pre-hibernatory nitrogen consumption is probably linked to pre-hibernatory vitellogenesis. Our results add mechanistic insight into proximate controls of reproductive output and emphasize the complex temporal influences of resource acquisition upon reproductive success.

Basking lizards in the subarctic: thermoregulation of the common lizard (*Zootoca vivipara*) under environmental challenge

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The costs of behavioural thermoregulation in ectotherms should increase with decreasing quality of the thermal habitat to the point where lizards should turn into thermocomformers. However, the cost-benefit model of ectotherm thermoregulation has rarely been tested at climatic extremes or in laboratory experiments. We studied the thermoregulation strategy of the common lacertid lizard, *Zootoca vivipara*, an active thermoregulator with the largest natural distribution among reptiles, in the subarctic zone and under controlled laboratory conditions. Our aims were threefold. First, we investigated the thermoregulation opportunities and assessed the thermoregulation strategy of the species at the northern margin of its distribution (69°02'N). Second, we identified the thermoregulation strategy of *Z. vivipara* in a high latitude population (66°22'N), and third, we conducted laboratory experiments to study its behavioural decisions in different thermal environments. We found that even at the northern margin of *Z. vivipara*'s distribution, due to the available high (often extremely high) maximal operative temperatures, a hypothetical

thermoregulator could reach their preferred body temperature for seven hours in an average day, and thus predicted accurate thermoregulation. The operative temperature profile was quite similar, although slightly better, in the second study site, and we found that *Z. vivipara* thermoregulated accurately and effectively irrespective of sex, size or tail status. The laboratory experiments showed that as far as there was a chance to reach their preferred body temperatures, lizards thermoregulated actively and accurately irrespective of sex and gravidity, but when not, they turned into thermoconformers. Our results provide first experimental evidence for the validity of the cost-benefit model of lizard thermoregulation, but stress that the benefit of keeping the preferred body temperature in terms of optimised physiological performance outweighs the cost of behavioural thermoregulation. We conclude that *Z. vivipara* occurs in environments where the thermal habitat allows accurate thermoregulation, hence it can keep the active thermoregulation strategy.

Sperm traits of the quacking frog, *Crinia georgiana*: within and among population variation in a species with a high risk of sperm competition

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Sperm traits often show extreme variation both among and within species. Here, we report on geographic variation in size, number, motility, and longevity of sperm in the quacking frog, *Crinia georgiana*, a species where sperm competition is common occurring in around 50% of matings. We found within population variation in sperm size and sperm motility and among population variation in relative sperm number and sperm size, but not in sperm motility or survival. When we combined relative sperm number and size into one variable, and sperm motility and longevity into another (each derived from Principal Components Analysis), we found significant among population variation in these variables as well. We detected no trade-offs among various sperm traits, but considerable within- and significant among population variation in cumulative sperm quality, a combination of all four sperm traits. Our data contrast with many previous studies on sperm variation which have focused on a limited set of variables, commonly size and number (morphometry). They may have failed to explain observed variation because morphometry trades off against motility and survival. We also found a significant interaction between population origin and male size indicating among population variation in the strength of selection acting on sperm traits of males adopting different mating strategies.

Sexual selection in the common barking gecko (*Ptenopus garrulus*)

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The common barking gecko (*Ptenopus garrulus*) is a medium sized, fossorial lizard found in the arid areas of western, southern Africa. They are best known for the distinctive clicking call that they make in the summer months at dusk. We studied two aspects of sexual selection in *P. garrulus*. First, we tested whether resident male geckos aggressively respond to a calling "intruder" of a known calling frequency in this experiment we played a standard recorded call to actively calling males. The behavioral and vocal responses of the resident male were recorded and examined in the context of body size, call frequency, and throat patch size. Second, we asked whether females bred with males that called at lower frequencies. Through field observations of a focal population of geckos, we determined the number of breeding events for individual male geckos over a 2.5 month period. We discuss the features of males that successfully bred with females in comparison with a wider pool of unmated males.

Sensory ecology in caecilians

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Structure and function of sense organs in caecilians are adapted to the underground habitat. Vision seems to be unnecessary in a lightless environment. However, all species studied so far, possess eyes that show a great structural variety (cf. Wake, 1985 Zoomorphol. 105). In *Ichthyophis* it could be shown that eyes are functioning and guide at least negative phototaxis (Himstedt, 1995 Zoology 99). These caecilians live near the surface and lie in ambush for prey at their tunnel entrance during nighttime. Vision may prevent emergence in daylight. The circadian rhythm of the locomotor activity is controlled not only by the eyes but additionally by the pineal organ. Immunohistochemical studies demonstrated that visual pigments are present not only in rather well differentiated eyes like in *Ichthyophis* or *Typhlonectes* but also in quite rudimentary eyes like in *Boulengerula* or *Herpele*. Prey detection is guided mainly by olfaction. *Ichthyophis* is able to localize prey by chemical cues only, quite precisely (Himstedt and Simon, 1995 Herpetol.J. 5). In these experiments caecilians moved faster and on a more direct path towards prey than did the newt *Triturus alpestris*. The function of the caecilian tentacles is still unclear. The presumption that this organ supports chemoreception could not be verified by our experiments. *Ichthyophis* with blocked tentacles were not impeded in detecting

and localizing odour sources. These animals, however, moved slower in their tunnels and they built rather disorderly tunnel labyrinths compared to control animals. Probably the tentacles mainly guide tactile orientation within the underground tunnel systems. Ichthyophis larvae are not totally aquatic but have an amphibious mode of life, staying in moist substrate at the banks of ponds or brooks during daytime and entering the water for feeding during nighttime. Orientation in water is achieved by olfaction and by lateral line organs providing mechanoreception and electroreception.

Have introduced mammalian predators prompted behavioural changes in New Zealand lizards?

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After an 80 my history of isolation from predatory mammals, New Zealand reptiles came into contact with Pacific rats (*Rattus exulans*) when Polynesian voyagers arrived c. 1800 ya. Consequences of Pacific rat and subsequent mammalian introductions have been catastrophic for native New Zealand reptiles, as evidenced by extinctions, severe range restrictions and population declines. It is uncertain whether experience-dependent learning by native reptiles is facilitating avoidance of mammals. In order to assess behavioural consequences of mammalian predation pressure, we investigated spatial and temporal movement patterns of endemic New Zealand geckos (*Hoplodactylus* spp.) in the presence and absence of introduced Pacific rats. Geckos were located regularly by radio telemetry over a five day period on both Ohinau (Pacific rats present) and Ohinauiti (mammal-free) islands in the summer of 2004/5. Pacific rats were radio-tracked simultaneously with geckos on Ohinau Island to compare their movement patterns with those of the geckos. Preliminary data show that spatial shifts in lizard habitat use have occurred following mammalian introductions. Experience-dependent learning may act as a mechanism that enables survival of lizards in the presence of introduced mammals. However, continuing population declines suggest that, despite lizard behavioural changes, K-selected life history traits coupled with high rates of mammalian predation may leave many New Zealand lizard populations vulnerable to extinction.

Vocal sac motion: epiphenomenon or signal in anuran communication

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In anurans, vocal sac motion usually accompanies sound production used for female attraction, inter-

individual spacing, and agonistic behaviour. The conspicuousness of the vocal sac and its movement has led to the discussion about its communicative role. We examined the accumulated evidence from the literature and own observations in the light of four explanations. Vocal sac shape and motion may represent (1) a visual epiphenomenon of sound production (a) without a communicative role; (b) that can be eavesdropped by con- and heterospecifics; (2) a necessary element of a bimodal signal; or (3) a ritualized signal that may even work independently of sound. Laboratory experiments under controlled conditions of light and background noise demonstrated the detectability of the vocal sac and its influence on female behaviour. Field experiments demonstrated that vocal sac motion is necessary to release attack in phonotactically approaching males. However, body movements replacing vocal sac motion were equally successful. Vocal sac motion without concomitant sound production is known from some anurans. However, the communicative role of throat display has rarely been demonstrated. In the reported visually communicating species, the vocal sac is bright yellow, a condition shared by several diurnal and nocturnal frog species. The apparently contrasting evidence on the functional role of visual cues provided by vocal sac motion may partly reflect the confounding effect of different experimental setups and the lack of adequate controls. However, the communicative role of vocal sac motion across anuran species may well vary between explanations 1a/b to 3. Vocal sac pulsation can be viewed as a signal precursor, whose evolutionary path depends on the species ecology.

Extended reproductive seasons among southern African tortoises

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Reproductive success is fundamental to the survival of species. The diverse life histories of chelonians indicate that Natural Selection favoured more than one reproductive strategy in this group. Most chelonians have a seasonal reproductive pattern and produce their offspring during periods most favourable for the survival of both offspring and parent. In regions where climates are stable and less seasonal, chelonian females may reproduce through most of the year. Despite being exposed to large seasonal fluctuations in temperature, water and food, several tortoise taxa in southern Africa have extended reproductive seasons. Tent tortoises (*Psammobates t. tentorius*) nest over nine months, while angulate tortoises (*Chersina angulata*) produce eggs through most of the year. Both species make small clutches of eggs: tent tortoises produce one to three eggs at a time while angulate tortoises make single-egg clutches. Committing to small clutches allows females to protect critical body reserves while adjusting reproductive allocation, e.g., clutch frequency, to resource availability. Both tent tortoises and angulate

tortoises can produce one to six clutches per year. We propose that the extended reproductive season of these species is linked to their small clutch size. The extended breeding season of *P. t. tentorius* and *C. angulata* may allow females more time and opportunity to produce offspring in arid and unpredictable environments.

Prolonged development in turtles: the role of embryonic diapause and embryonic aestivation

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When environmental conditions are unsuitable for survival of the embryo, many turtles have the remarkable ability to arrest embryonic development after oviposition and extend development over vast time spans; incubation periods of one to two years have been reported. The physiological mechanisms that facilitate prolonged incubation periods are embryonic diapause and embryonic aestivation. These mechanisms synchronize development with environmental conditions optimally by reducing embryonic metabolism during unfavorable conditions. Even though, these two life history traits are present in five of the seven major clades of turtles, *Chelydra* and *Chelonia* excluded, limited knowledge is available on the effects they may have on lifetime reproductive success. Field investigations and semi-natural experiments were conducted on *Kinosternon leucostomum*, the white-cheeked mud turtle in southern Veracruz, Mexico. Seasonal and facultative expressions of both traits were identified in 143 eggs collected from 12 October 2002 to 24 April 2003. Survivorship was low with 76% of embryos surviving embryonic diapause and 69% of embryos surviving morphogenesis, thus an overall hatching success of 53%. There was a significant negative relationship between length of embryonic diapause and the date of oviposition ($r^2 = 0.438$, $F_{1,76} = 57.92$, $P < 0.000$), yet there was not a significant relationship between number of days in morphogenesis and date of oviposition ($r^2 = 0.0432$, $F_{1,76} = 3.38$, $P < 0.0697$). Methods for determining the expression of embryonic diapause and embryonic aestivation will be outlined. In addition, the need for replicating seasonal fluctuations in soil moisture and soil temperature using automated irrigation systems and digital temperature control systems will be discussed.

The use of tamoxifen to prevent egg production in a Burmese python, *Python molurus bivittatus*

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A female *Python molurus bivittatus* born in 1993, started to produce eggs yearly, from 1997 onwards without problems. In 2002 and 2003 however, she displayed problems concerning the deposition of eggs. Several (2002) or all (2003) eggs had to be surgically removed. In an attempt to stop egg-production, Tamoxifen, known for its ability to reduce oestrogenic activity in humans, was given orally in 2003. This proved to be successful: ultrasonic and radiographic examinations showed that the female had not developed any eggs. Unfortunately, the female died in 2004 due to severe bacterial pneumonia. Post mortem examinations showed totally inactive ovaria.

Sesamoid elements, foot and hand muscles: can we use them for phylogenetic hypotheses in frogs?

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Sesamoid elements, foot and hand muscles: can we use them for phylogenetic hypotheses in frogs? Sesamoid bones, foot and hand muscles in some species of ranid, leptodactylid, hylid, dendrobatid and bufonid frogs were described and explored as potential phylogenetic characters. Sesamoids discovered in frogs were: cartilago plantaris; sesamoides palmaris; fabella medialis; cartilago sesamoides; os sesamoides tarsale; metacarpal sesamoids; subarticular elements at the level of hand and feet phalanges; metatarsal sesamoids; phalanges of toe sesamoids; at the distal end of the radioulna; at the distal level of the humerus, and sesamoides ulnaris. Among this, the sesamoides ulnaris is not the same known as radial sesamoid (Olson, 2000); the fabella medialis is the same fabella (Olson, 2000), knowing only in ranids and *Hymenochirus boettgeri* before this study. We described it in species of Bufonidae (*Atelopus lozanoi* and *A. muisca*), Leptodactylidae (*Eleutherodactylus bogotensis*) and Dendrobatidae (*C. subpunctatus*). We need to explore deeper the fabella medialis and the sesamoides ulnaris, because of their recent discovery and their apparent restricted presence in frogs respectively. We need also a wider study of sesamoids examined by Olson (2000), the posterior lunula and the os tibialis anticus, recognized as putative autapomorphies in *H. boettgeri*. A few authors have carried on their research about descriptions and phylogenetic importance of frogs foot and hand muscles and the forearm, mainly in hylids, but not in leptodactylids. We described foot and hand superficial muscles in 8 leptodactylid frogs of the genus *Eleutherodactylus* of Colombia as an approach to obtain characters for phylogenetic relationships. *E. bogotensis* descriptions were obtained from Salgar (2003). For that we use as outgroups *Hyla labialis* (from Salgar, 2003) and *Atelopus muisca*. We obtained four putative synapomorphies: two from the forearm (the *m. epitrochleocubitalis* and the *m. extensor digitorum communis longus*), and two from hands (the *m.*

extensor brevis superficialis V and the *m. abd. brev* V).

The herpetology of the Suez Canal Zone: is the Suez Canal a bridge or barrier to herpetofauna?

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A herpetological survey was carried out on the west bank of the Suez Canal, covering an area of about 700 km² from Suez City at the southern terminus of the Canal to Port Said City at the northern extremity (168 km) and westward up to 8 km from the Canal. This area has a variety of habitats that includes desert, sea water and a vast green strip parallel to the Suez Canal that is fed by freshwater canals and creeks. Observations were undertaken over six axes from July 1999 to August 2004: 1) - Ismailia-Port Said highway; 2)- Ismailia-Port Said Canal Road; 3)- Ismailia-Suez highway; 4)- Ismailia-Suez Freshwater Canal Road; 5)- Ismailia-Zaqaziq Road and 6)- Ismailia-Cairo highway. This study yielded 27 herpetofaunal species: 2 amphibians: *Bufo regularis* and *Ptychadena mascareniensis*; 16 lizards: *Acanthodactylus boskianus*; *A. scutellatus*; *Chalcides ocellatus*; *Chamaeleo chamaeleon*; *Cyrtopodion scabrum*; *Hemidactylus flaviviridis*; *H. turcicus*; *Mabuya quinquetaeniata*; *Ptyodactylus hasselquistii*; *Scincus scincus*; *Sphenops sepsoides*; *Stenodactylus petrii*; *S. sthenodactylus*; *Tarentola annularis*; *Trapelus pallidus* and *Varanus griseus*; and 9 snakes: *Cerastes cerastes*; *C. vipera*; *Lytorhynchus diadema*; *Malpolon monspessulanus*; *Natrix tessellatus*; *Psammophis schokari*; *P. sibilans*; *Ramphotyphlops braminus* and *Spalerosophis diadema*. The Suez Canal acts as both bridge and barrier for herpetofauna. For instance, some forms such as; *Mabuya quinquetaeniata*, *Natrix tessellatus* and *Tarentola annularis* have moved from the Nile Delta and become common on the Suez Canal west bank are not found on the east bank. Meanwhile, some species, such as *Coluber florulentus*, *Ptychadena mascareniensis* and *Ptyodactylus hasselquistii* have moved from the west bank and other localities to Sinai through the Suez Canal.

Phylogenetic relationship among Asian toads inferred from the nucleotide sequences of mitochondrial DNA genes

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Morphometric analyses, cross experiments, and allozymatic analyses have been applied to study the speciation of *Bufo* taxa in Asia. However, none of these methods have clarified the genetic divergence between the populations and branching times of these taxa. In

this study, we sought to assess the genetic diversity and phylogenetic relationships among Asian *Bufo* taxa, mainly the *B. japonicus* subspecies group. Thirty three *Bufo* specimens consisting of 4 species and 6 subspecies were analyzed. Nucleotide sequences were determined in 7 mitochondrial DNA gene of these specimens. Phylogenetic analyses based on the sequences supported monophyly of the entire *B. japonicus* subspecies group and *B. bufo*. After *B. bufo* initially diverged in this clade, the *B. japonicus* subspecies group diverged into two clades: one consisting of three *B. japonicus* subspecies from China, Taiwan, and the Miyako islands, and the other consisting of all *B. japonicus* subspecies from the Japanese mainland. The mainland clade was subdivided into two subclades that clearly corresponded to eastern populations and western ones. Furthermore, in both subclades, the phylogenetic relationships between populations closely matched the physical distances on maps. Our results did not closely match the taxonomic grouping, however, only one subspecies from the mainland, *B. japonicus torrenticola*, formed a monophyletic clade. The estimated divergence time between the mainland and China-Taiwan-Miyako groups was approximately 6.5 Ma, while that between the eastern and western groups from the Japanese mainland was approximately 5.0 Ma. According to the established paleontologic timelines, the Japanese mainland and Eurasian continent were still continuous at those times. This suggests that the isolation of Japanese *Bufo* subspecies from those of the continent may have preceded the continental division. It also hints that a paleogeographic event (expansion of a lake area) was one of the factors behind the genetic divergence between the eastern and western groups.

Comparisons of social behaviors between diurnal and nocturnal geckos of Madagascar

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Although most geckos are nocturnal, there exist several diurnal genera that are presumably derived from nocturnal ancestors. This makes geckos ideal animals to investigate the evolutionary shift of ecological traits accompanying the change of life styles from nocturnal to diurnal. However, quantitative information on social behavior of geckos is quite limited. Based on the assumption that diurnal activity had induced to evolve behavioral traits depending on the visual modality, I examined social behaviors of a diurnal gecko (*Phelsuma madagascariensis kochi*) and a nocturnal, phylogenetically related species (*Blaesodactylus antongilensis*) at Ankarafantsika National Park in Madagascar. Both species are arboreal and similar in size, and phylogenetically related. Staged encounter experiments (male-male, female-female, and male-female) were conducted in each species at

Ankarafantsika National Park in Madagascar to compare behaviors between the species. In addition, to investigate responses to a visual image of a conspecific individual, I observed behavior of a gecko against its own reflection in the mirror, which was put 1, 2, or 3 m apart from the tested individual. *Phelsuma madagascariensis kochi* showed head wag, hand up (lifting of fore limbs), arch back, and call, whereas *B. antongilensis* did not show these behaviors. Head wag and call were performed only by males, and hand up was observed only in females after males showed head wag. Social behaviors, such as approach, thrash tail, bite, and flee were exhibited in both species. Both geckos reacted to their mirror images even at a distance of 3 m. *Phelsuma madagascariensis kochi* tended to continue agonistic behaviors against its mirror image while approaching in front of the mirror, whereas most *B. antongilensis* did not show such a behavior. These results indicate that the diurnal gecko has more various social behaviors and more strongly depends on the visual modality than the nocturnal species.

Assessing sampling availability in desert tortoises (*Gopherus agassizii*)

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Methods for monitoring desert tortoises (*Gopherus agassizii*) are subject to contentious debates due to high variability in the precision and accuracy of density estimates. This variability leads to imprecise and potentially inaccurate estimates of population status and trends. Distance sampling has been used to calculate densities of desert tortoises from randomly placed line transects. However, distance sampling (and alternative approaches to calculate density) requires precise estimates of the availability of tortoises to be sampled (G0). G0 is currently estimated by monitoring radio-telemetered animals (focal animals) though out the sampling season. The sizes of these focal populations are too small to provide precise estimates of the availability of tortoises to be censused. We are investigating a method for modeling tortoise activity from data (relative humidity, temperature and light intensity) collected by small dataloggers affixed to focal animals. These data are used to model observed tortoise activity by classifying them as in the open, under vegetation, and in burrows. These analyses predict that animals inside a burrow (both visible and not) can be distinguished from animals in more exposed microhabitats (open, vegetation, and in the burrow mouth). Additionally, we show how tortoise activity can be modeled from live and predicted observations as a function of a suite of climatic variables using artificial neural networks and other clustering algorithms. We propose that this method may lead to a more cost effective means of estimating sampling availability.

The ongoing invasion of African clawed frogs (*Xenopus laevis*) in Chile: current status

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We review the existing data on the African clawed frog in Chile (*Xenopus laevis*, Pipidae) and report new and alarming information on its distribution, provide physical data on water courses and bodies that hold populations of this frog, report observations on its diet, on mass migration overland, and on predation by native birds. Our findings reveal that: (a) the spread of the invasion is currently covering four of the thirteen regions of Chile; (b) clawed frogs are found at higher densities in artificial water bodies (ponds and dams and irrigation canals) rather than in natural lagoons or streams or rivers; (c) there is no evidence of predation on native anurans, but rather on their own larvae; and (d) they face predation from native birds. Causes of concern include (a) that African clawed frogs in Chile reach both lower and higher altitudes than formerly estimated, and (b) that they are able to migrate overland to colonize other water bodies. They are spreading at a rate of 3.1 to 3.9 km/yr in an optimistic scenario, and at a rate of 4.4 to 5.4 km/yr in a pessimistic one. The most troubling aspects of the African clawed frog invasion in Chile involve: (a) their unaided spread through central Chilean agricultural areas, using irrigation canals and overland migration; (b) the type of interactions that they may be establishing with native anurans (are they competitors, predators, habitat modifiers, disease vectors, or all things together?). As a precautionary action, we propose that the pet trade of African clawed frogs in Chile should be banned.

Turtles, tomography, and tree topology: an integrative approach to primary homology assessment in the Testudine braincase

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Characters of cranial arteries and their associated canals have played a prominent role in turtle systematics, and have been invoked and afforded considerable weight in hypotheses advanced about several fundamental groupings within Testudines. Size and branching pattern of the major branches of the internal carotid artery, along with the canals and foramina in the braincase through which these branches travel, have previously been qualitatively documented and described using destructive techniques such as dissection and sectioning of skull material. We have employed High-Resolution X-Ray Computed Tomography (CT) as one of several approaches to reappraisal of arterial canals and foramina. We present evidence for a new interpretation

of canals and foramina in the turtle braincase based on this re-appraisal, and present a new interpretation of primary homology among internal carotid branches that also attempts to transcend the constraints of nominalism. Conclusions drawn from the study of canals and foramina on the one hand, and arterial branching patterns, on the other, differ in a number of key points. Different tree topologies are favoured depending upon interpretation of the primitive pattern and the location along branches of character state changes. We present evidence for a possible sister-group relationship between Kinosternidae and Testudinoidea, contra the traditional interpretation of a Kinosternidae – Trionychidae sister-group relationship. Further, we present evidence for a sister-group relationship between the Bataguridae and Testudinidae, which together form the sister-group to the Emydidae. An attempt to integrate canal and artery information reveals three disparate, autapomorphic patterns and results in a failure to resolve the trichotomy linking Trionychidae, Kinosternidae, and Testudinoidea. Our assessment reinforces the need to take an integrative approach to the formulation of phylogenetic hypotheses and the study of primary homology.

A contribution to the natural history of *Siphonops annulatus* (Amphibia, Gymnophiona, Caeciliidae)

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The South of the Brazilian State of Bahia is rich in cacao plantations, localized in the Atlantic Rainforest. These plantations are considered very conservative ecologically because the original forest has to be preserved during planting to give shade to the cacao trees. They maintain a diverse and abundant herpetofauna. A large population of *Siphonops annulatus*, the most cosmopolitan caecilian species in South America, is found in this region mainly when revolving the litter, digging the soil or undoing decomposing logs and casqueiros (piles of cacao shells). During the climax of the rainy season (July/August) specimens were observed on the surface at the side of roads, or swimming in irrigation canals inside the plantations after heavy rain. During reproductive season (December/March) females are found coiled around the eggs or the young (around 6-15 individuals) in small galleries built either inside decomposing logs or directly in the earth. The young are born in January/February and remain in close association with the mother, frequently crawling over the female's skin. Just after birth the young do not have pigmentation and, at first glance can be confused with earthworms. Despite the apparent lack of external sexual dimorphism, the skin of females is much lighter and more opaque than that of males during the whole period of maternal care (eggs and young). During this period, the female seems not to feed and the young

were never observed feeding on any kind of food. Clutches maintained in captivity showed a fast gain of mass while the mother lost weight. These observations led to the suspicion that the female feeds its young with the whitish skin secretion. The female skin changes may also be related to the emission of aggregational pheromones, since when the young are taken away from the female, they rapidly return to its care.

Sequential mating and paternity in the common newt (*Triturus vulgaris*)

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Recent studies on sexual selection face the opposing ideas that females should either favour the best-quality males (good gene hypothesis), or the individually best-matching males (genetic compatibility hypothesis). Studies on the European smooth newt (*Triturus vulgaris*) were among the first to convincingly show that multiply mating females trade up their mating partners by sequentially becoming more choosy with regards to male ornamentation, but due to internal fertilisations the genetic mating system of *T. vulgaris* remained so far elusive. In the present study, we used genetic markers (AFLPs, Amplified Fragment Length Polymorphism) to determine the paternity of offspring produced in experimental *T. vulgaris* matings. In order to discern sperm precedence (first or second male advantage) from potential effects of mate compatibility, we sequentially mated a single female with two males, followed by repeating the same procedure in reverse male order after assumed female sperm depletion. Sperm mixing was evident in all mating trials, but no clear pattern of sperm precedence was apparent. However, regardless of mating order, there was a tendency for a specific male to sire the majority of offspring. The results suggest that trading up for good and compatible genes are not mutually exclusive strategies to maximise female reproductive success. The study adds to our current knowledge on genetic mating systems of urodeles, and should provide a further baseline for investigations on the evolution of reproductive strategies.

CITES & crocodylian conservation – perceived or real relationship?

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CITES establishes a framework for regulating international trade in species of wild plants and animals, and, inter alia, comprises three appendices to achieve this objective. Since CITES came into force in 1975, all species of crocodylian have been included in either Appendix I, where commercial international trade is PROHIBITED (except from registered captive

breeding), or Appendix II, where commercial trade is PERMITTED if provisions in the Convention are met. The inclusion of all crocodylians in the Appendices did not mean all were endangered or even threatened by trade. It is difficult to distinguish the species of origin of some species in trade, and the Convention provides for Appendix II listing based on "look-a-like" considerations. The extent to which CITES has contributed to the conservation of crocodylians and other wildlife species included in its appendices is not always readily apparent. All case histories involve complex interplays between intrinsic and extrinsic variables with no guarantee that a specific goal will be met. Nevertheless, advocates of CITES frequently offer crocodylians as an example of how the Convention can have a positive influence on the conservation of a species without compromising its role as an economically important natural renewable resource. My presentation examines the different ways in which the provisions of CITES have been interpreted and applied to crocodylians, the role and influence of external forces on that application, and with the benefit of hindsight, whether CITES has indeed contributed to crocodylian conservation.

Ecology of freshwater turtles in Loagan Bunut, a peat swamp lake in Sarawak, Borneo

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Borneo is home to a high diversity of freshwater turtle species. Unfortunately, all species, as indeed in the rest of Asia, are threatened, being overcollected for food, as pets, for traditional medicine. No life stage is spared: eggs are collected, as are juveniles and adults. Most of the freshwater turtle species known from Borneo have not been studied at length and little is known about the ecology of even the most common species in Sarawak, Malaysian Borneo. We studied the ecology of the freshwater turtle community within Loagan Bunut National Park, a proposed Ramsar Site. Species present include *Amyda cartilaginea*, *Cuora amboinensis*, *Cyclernys dentata*, *Heosemys spinosa*, and *Notochelys platynota*. Basic information, such as species diversity, population size and structure, habitat use, local distribution, variation in colour patterns, morphometrics (including lengths and weights), reproductive condition, parasites, and injuries, were recorded. Stomach contents and faeces are collected in order to characterise diets of individual species, as well as to investigate the presence of sexual, seasonal, or ontogenetic differences in diets. Radiography was used to determine reproductive condition. The local use and levels of exploitation were also recorded. Berawan tribesmen, experienced in turtle hunting, were involved as field technicians. These data are a contribution to a long-term monitoring program of

Loagan Bunut, while providing life history data critical for effective management and conservation of freshwater turtles in the region.

Flexibility in the timing of parturition: the key to viviparity in lizards?

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Viviparous squamates exhibit a complete spectrum of embryonic nutritional modes, from lecithotrophy to a level of placentotrophy comparable to that found in eutherian mammals. But why do so many species retain a significant degree of lecithotrophy? From our model genera, *Pseudemoia* and *Niveoscincus*, there is strong evidence that placentotrophy first evolved as a facultative mechanism enabling mothers to supplement an adequate yolk supply, and to provide flexibility in the timing of parturition. Our research suggests that the capacity to ensure that young are born into the most benign environment possible provides a powerful rationale for the evolution of placentotrophy. We have exploited the range of reproductive strategies and placental complexity available in *Niveoscincus* and *Pseudemoia* to test our hypotheses experimentally using two avenues of approach: assessment of placental contributions to embryonic development; and manipulations of the gestational environment to determine the ability to defer birth in unfavourable conditions and implications for offspring fitness. In all species tested, the placenta is able to transfer precursors for protein (leucine) and lipid (oleic acid) into embryonic compartments. Transfer of leucine indicates that placental nutrition is important to embryonic development but that contribution varies between species. We have demonstrated that oleic acid is transferred into embryonic fat bodies, supporting our hypothesis that facultative placentotrophy enhances neonatal fitness through providing fat reserves utilized if birth is deferred. Deferral experiments indicate that *N. ocellatus*, with moderate placentotrophy, is less able to defer birth than the primarily lecithotrophic *N. metallicus*. *Niveoscincus microlepidotus* is an alpine species with a protracted gestation: embryos are fully developed in autumn but remain in utero for another 7 months. Embryos delivered experimentally in autumn have significantly larger dry mass and fat bodies than neonates born at in spring: thus deferral over winter represents a trade-off between offspring fitness and survival after birth

Patterns of morphological change of *Podarcis bocagei* and *P. carbonelli* in sympatry

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Podarcis bocagei and *P. carbonelli* (Sauria: Lacertidae) are two species endemic to the W Iberian Peninsula. They were considered conspecific, *P. carbonelli* being defined as a subspecies of *P. bocagei* until 2002, when it was elevated to the species level. Both species overlap in a restricted area in the NW coast of Portugal, where they coexist in strict syntopy. We studied their morphology in that area and compared it to two close allopatric populations, in order to detect possible effects of sympatry. No size differences were detected between the sympatric and allopatric populations of each species. However, interesting variation patterns were observed for some meristic characters, as well as for the degree of sexual dimorphism. Examination of overall morphological distance between the species gave contrary results in the two sexes. Application of geometric morphometrics revealed a clear shape variation between sympatric and allopatric populations. Although the two species maintained their identities in sympatry, some of the variation patterns point to hybridisation, while others suggest character displacement. Further research on other aspects of the species biology is required in order to explain the patterns observed.

Nest homing behaviour and maternal care of the Taiwanese tree frog, *Chirixalus eiffingeri* (Anura: Rhacophoridae)

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The nest homing behavior of female Taiwanese tree frogs (*Chirixalus eiffingeri*) seeking to feed their tadpoles was studied through a series of manipulative experiments at the Experimental Forest of National Taiwan University at Chitou from 2000 to 2003. Replacing a female's tadpoles with non-kin tadpoles, and replacing her bamboo stump with one of similar external morphology or of a different height did not affect the homing of female frogs. Displacing bamboo stumps by 1 m did not significantly affect female homing, but displacing bamboo stumps by 3 m did. Bamboo stump location is critical to homing by female frogs. When the bamboo stump containing a female's tadpoles was displaced 1 m and a new bamboo stump with tadpoles was put in its place, some females fed the tadpoles in the displaced stump but others fed tadpoles in the new stump at the original location. Clearly, the females has confused spatially about the location of their nests. However, in other experiment

where tadpoles that were placed in a stump adjacent to a tadpole-occupied stump were not fed. These results suggest that female tree frogs use bamboo stumps near the tadpole-occupied nest as cues or landmarks for homing. Furthermore, although addition of bamboo stumps disturbed the spatial map of females, after a female frog returned to a bamboo stump and fed its tadpoles, she seemed to form a new spatial map. Overall, the results of our studies suggest that visual cues are crucial to nest homing of *C. eiffingeri* females to feed their offspring. Females *C. eiffingeri* have good spatial orientation abilities and their homing mechanism is a form of map-based orientation.

Declines in Urodeles: non-existent or understudied?

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Global declines in amphibians have been observed since the 1970s, and reports of these events have spurred significant research efforts to determine their causes and extents. Salamanders and frogs co-occur in the Nearctic, Neotropical, Palearctic, and Indomalayan biogeographic realms. Presently within these realms, the Global Amphibian Assessment has classified 32% of anurans as globally threatened, compared with 43% of urodeles. A preliminary review of the literature (n=134) on amphibian declines from these regions revealed that 78% of papers focused on anurans compared with 22% on salamanders. Reasons for the apparent discrepancy in the level of research effort being applied to each group may stem from a series of factors including: (1) the total number of species within each order in these regions (anurans = 3863; urodeles = 541); (2) efficiency and economy of sampling methods for each group; (3) ease of long-term monitoring of populations of anurans and urodeles; and (4) that many of the catastrophic declines have occurred in anurans thereby spawning further research. Habitat loss remains the most widespread threat to amphibians, affecting approximately 50% of the species in each group, and impacts of other factors implicated in declines, such as disease and pollution, are reported to affect a similar proportion of species in each group. Despite this, aspects of the life histories of each group may predispose one or the other to a more significant impact from a particular perturbation. Given the minimal effort up to this point applied to detecting declines in urodeles, relative to anurans, it is premature to determine whether the chronic and catastrophic declines observed in anuran populations are also occurring in urodele populations. Yet it is clear that the level of inquiry into declines in urodeles should be increased.

The snake family Psammophiidae – systematics, phylogenetics and phylogeography of an African radiation

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The snake family Psammophiidae (formerly subfamily Psammophiinae) is a well-defined monophyletic group distributed throughout Africa, on Madagascar, and entering Europe, the Near East and southern Asia. Psammophiids are of great ecological importance as predators, being among the most abundant snakes in a wide variety of habitats. However, little is known of their evolutionary relationships, and the type genus (*Psammophis*) is one of the largest and most taxonomically problematic African snake genera. This paper combines DNA sequence data from one nuclear and two mitochondrial genes to reconstruct psammophiid phylogenetic relationships, and to improve characterization of species boundaries. Areas of endemism were derived from analysis of distribution data, and used in conjunction with phylogenetic results to investigate spatiotemporal biogeography. The family probably has an Oligocene or early Miocene origin in northeastern Africa, with most generic level cladogenesis completed by the mid Miocene. *Rhamphiophis* and *Malpolon* group together forming the most basal psammophiid clade, followed by *Psammophis*, *Psammophylax*, and a terminal *Hemirhagerhis* – *Mimophis* grouping. There have been three independent incursions into the near East and southern Asia, one involving *Malpolon* (which is also the only extant psammophiid to have invaded Europe), and two involving *Psammophis*. An isolated Miocene dispersal across the Mozambique Channel gave rise to *Mimophis* on Madagascar. *Rhamphiophis* is polyphyletic, with *R. acutus* sister to *Psammophylax*. *Dromophis* is a synonym of *Psammophis*, nested deeply within the latter as sister to the *P. "sibilans"* species complex. Within this complex (which forms the terminal *Psammophis* clade) there is no support for a distinction between *P. p. phillipsi* and *P. mossambicus*, but *P. phillipsi occidentalis* appears to be a valid species closely related to *P. brevirostris*. This research contributes substantially to resolution of psammophiid taxonomy and phylogenetics, and provides a continental scale understanding of the biogeography of one of Africa's most important snake families.

Diversification of elapid snakes

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The front fanged "elapids" comprise one of the two major radiations of venomous snakes. The Family is highly morphologically diverse with some 61 genera and over 300 species distributed in the Americas,

Africa, Asia, Australo-Papuan region, and the Pacific and Indian Oceans. The group comprises some very well known animals including virtually all of Australia's diverse venomous snake radiation, Afro-Asian cobras, American and Asian coral snakes and the sea snakes. I will present the results of three major projects, at three taxonomic levels, concerning the evolution and diversification of elapid snakes. First I will present the results of a large scale molecular phylogeny project that aimed to elucidate the relationships among the major clades, including the origin of sea snakes, provide phylogenetic resolution within two of the major clades, determine the origins and affinities of the radiation and discriminate between alternative biogeographic hypotheses. Second, I will present the results of a major study on true sea snakes that demonstrates that the one of the major groups of sea snakes represents a rapidly diverged adaptive radiation. Finally, I will present the results of an intra-specific phylogeography project that aimed to test hypotheses concerning the evolution of body size. The highly venomous Australian Tiger snakes (genus *Notechis*) represent a well-known and extreme example of insular body size variation and are of special interest because there are multiple populations of dwarfs and giants and the age of the islands and thus the age of the tiger snake populations are known from detailed sea level studies. We demonstrate that populations of island dwarfs and giants have evolved five times independently and that these body size shifts evolved extremely rapidly. I will discuss all of this work within a broader context of how molecular phylogenies can be used to test evolutionary hypotheses.

Measuring movement and microhabitat in the field independent of an observer

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Development of a small, light weight and robust activity logger carried 'onboard' an animal allows continuous long-term records of the number of strides taken, body temperature and incident light level on the dorsal surface of the tail. These data enable lizard activity patterns, behaviour and microhabitat use to be determined for a cryptic and stealthy animal in the absence of an observer. In our study the logger stored recordings every two minutes for 15 days, allowing bias due to observer presence to be reduced, or quantified and corrected for when behavioural observations are made. In the sleepy lizard (*Tiliqua rugosa*) stride frequency is highly correlated with distance moved when standardised by individual hind limb length. As lizards modulate stride frequency to adjust their speed a predictive model was developed to determine distance moved in the field from stride counts. Continuous records of locomotor activity across two 9-month activity periods (August 2002 - April 2003 and August 2003 - April 2004) have shown that in sleepy

lizards foraging strategies changed with season and differed between years both within and between genders. During drought periods when the main food source (flowers) of this mainly herbivorous lizard was absent both genders entered into extended periods of inactivity interspersed with intermittent periods of low activity. Wide foraging with extended periods of movement was evident both during and following rain when transient food and water sources became available, and during the normal spring growth period. In spring males switched to a time-maximisation strategy, being active for a greater period each day and travelling further than females, with low gains in body mass relative to their level of activity. Females continued with an energy maximisation strategy, with a markedly higher gain in body mass relative to levels of activity.

Effects of the sandaphos (Organophosphate) and Cypermethron (Synthetic Pyrethroid) on Cholinesterase activity in liver and kidney of skittering frog (*Rana cyanophlyctis*)

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In Pakistan twenty nine species of amphibians have been recorded, including eighteen species of frog. In this study, skittering frog (*Rana cyanophlyctis*) was exposed to sandaphos (organophosphate) and cypermethrin (synthetic pyrethroid) in the laboratory experiments. Two different concentrations i.e. 5% and 10% were used and cholinesterase activity was observed in liver and kidney of *Rana cyanophlyctis*. Under the treatment of sandaphos it was decreased upto 41.28 and 51.46 % in liver and 4.43 and 22.85 % in kidney respectively. While under the effect of cypermethrin, it was decreased upto 24.46 and 26.34 % c3 in liver and 21.46 and 26.63 in kidney, respectively.

Amphibian research and monitoring initiative: an interdisciplinary approach to the study of amphibian populations in the United States

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The Amphibian Research and Monitoring Initiative (ARMI) is a national science program designed to monitor trends in amphibian populations in the United States and investigate likely causes for their decline. Currently in its fifth year, ARMI is based on a tiered approach to research and monitoring with three different levels of geographic scale and intensity. The broadest level includes an extensive network of

population surveys, atlas programs, and investigations, often involving trained volunteers in monitoring local amphibian populations. At a second and more advanced level, scientists and natural resource managers monitor amphibian populations at a limited number of sites in each region of the country. At the third and most advanced level, herpetologists conduct intensive monitoring at "index sites" to develop baseline data useful at all levels. In addition, seven regionally-based science teams investigate a wide range of natural and anthropogenic factors to develop a better understanding of how these factors individually and collectively impact amphibian populations. ARMI Regional Science Teams include specialists from the fields of biology, hydrology, environmental toxicology, and geography. The interdisciplinary composition of these teams allows them to develop a more complete perspective on the interactions between amphibians and their aquatic and terrestrial environments. The ultimate goal of the ARMI program is to improve the understanding of amphibian populations so that natural resource managers have the information needed to conduct effective amphibian conservation. To help achieve this goal, ARMI maintains web-based data resources, mapping tools, and analytical resources. A Steering Committee with members from the U.S. government, State governments, academic community, and non-governmental organizations provides oversight. ARMI provides an excellent example of interdisciplinary science in action.

The ontogeny of the posterior portion of the otoccipital region of the neural endocranium in prehatching *Alligator mississippiensis*

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In the Stage 6 (skull length - 22 mm) of *Alligator mississippiensis*, in which the endochondral ossification of the otoccipital region of the neural endocranium is still not observable, two osseous laminae are present at the external wall of the posterior portion of the neural endocranium: the anterior lamina arises from the basal plate in the level of the posterior margin of the subcapsular process; the posterior lamina from that part of the pila occipitalis which forms the posterior margin of the jugular foramen. During ontogeny, both laminae ossify in membrane, fuse together, grow laterodorsally and fuse with the lateral wall of the lateral semicircular canal and the parotic crest. This lamina forms a new, secondary wall enclosing the posterior section of the otic capsule and forms the lateral margin of the large external jugular foramen. Both laminae have not been recorded previously in crocodylians and are absent in all other Recent reptiles. From the functional point of view, the fused lamina (i) participates at the formation of the dorsal margin of the external jugular foramen; (ii) forms the floor of the Eustachian

tube; and (iii) encloses the posterior extension of the tympanic cavity. The fused lamina topologically corresponds to the cartilago metotica of birds, however, both structures have different ontogeny.

Herpetofauna and microhabitat associations at Buckhorn and Sicily Island Hills Wildlife Management Areas in Northeast Louisiana, USA

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Buckhorn (BWMA) and Sicily Island Hills Wildlife Management Areas (SIHWMA) are two state-owned properties in northeast Louisiana, with approximately 35 km distance between them. Buckhorn is a bottomland hardwood forest site in the Mississippi Alluvial Plain Ecoregion. Sicily Island Hills represents an isolated mixed pine and hardwood forest with a great amount of topographic relief on the easternmost edge of the Western Gulf Coastal Plain Ecoregion. Several 500-meter transects were marked at each area, and visual encounter surveys (VES), coverboard surveys, and drift fence surveys were conducted along them. In addition, anuran call surveys, turtle trapping and spotting scope surveys were carried out within the WMAs at other points. Surveys conducted from April 2003 through November 2004 (excluding anuran call surveys) resulted in a sample size of 2291 individuals and a richness of 44 species at BWMA, and of 586 individuals and 38 species at SIHWMA. Sorensen's similarity coefficient comparing the two areas is 0.73, indicating that many of the same species are present in both WMAs. The degree of association with particular microhabitat features was particularly strong in several species. Green Anoles (*Anolis carolinensis*) were captured during VES most often on the fronds of the Dwarf Palmetto (*Sabal minor*) at BWMA (anole captures on palmetto/total anole captures = 0.72). Green Treefrogs (*Hyla cinerea*) were also commonly found on palmetto fronds (# green treefrogs on palmetto/total # green treefrogs captured = 0.71). At SIHWMA, Little Brown Skinks (*Scincella lateralis*) primarily utilized the leaf litter of hardwood trees (skinks captured in leaf litter/total skinks captured = 0.91), whereas all Dwarf Salamanders (*Eurycea quadridigitata*) at SIHWMA were found inside large fallen pine or hardwood logs.

Body size effect on egg size in eublepharid geckos (Squamata: Eublepharidae), lizards with invariant clutch size: negative allometry for egg size in ectotherms is not universal

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In taxonomically widespread groups of ectotherms, within a single clutch, smaller species lay a smaller

number of relatively larger eggs than the larger species. Many hypotheses explaining both the interspecific negative allometry in egg size and egg size-number trade-off postulate the existence of an upper limit to the egg size of the larger species. Specifically, in lizards, large eggs of the large species could have too long duration of the incubation, or they could be too large to pass through the pelvic opening, which is presumptively mechanistically constrained in larger species. Alternatively, negative allometry could be a result of the ecological or physiological limits affecting eggs of the smaller species. Under the "upper limit" hypotheses, females of larger species are forced to divide total investment of a given clutch into more eggs, but they are allowed to do it under the latter hypotheses. Contrary to the "lower limit" hypotheses, hypotheses based on the existence of an upper limit always predict negative egg size allometry even in animals with invariant clutch size, where naturally there is no egg size-number trade-off. We studied egg size allometry in the lizards of the family Eublepharidae. Eublepharids are a monophyletic group of primitive geckos with large variance in body size and an invariant number of two eggs per clutch. We found an isometric relationship between egg size and female size, and thus disproved the upper limit hypotheses.

Assessment of reproductive cycles and nesting frequencies in freshwater turtle populations by ultrasound scanning and endoscopy

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The proportion of females reproducing per year and the number and the temporal distribution of the egg clutches they lay are important parameters in freshwater turtle ecology. However, with the notable exception of some intensive long-term studies of a few species in temperate regions, this information is often not accurately assessed in turtle studies with limited time frames. Observation of nesting females and/or radiographic screening of gravidity during the reproductive season offers snap shot information if a particular female is nesting or carries shelled oviductal eggs at a particular time, but does not provide a complete picture of the reproductive cycles and clutch frequencies in a population: it cannot be assessed if females which are not observed to nest or to carry shelled oviductal eggs are simply at another reproductive stage or if they are not reproductively active. The only non-lethal techniques that provide this information in population studies are ultrasound scanning and endoscopy. Ultrasound scanning enables the detection, measuring and counting of vitellogenic ovarian follicles and oviductal eggs in all stages of shell secretion. Endoscopy does not allow the measuring and counting of follicles and eggs but, through the observation of ovulation scars, allows the retrospective

assessment if a female already oviposited in a given reproductive season, and to some degree how many clutches. Endoscopy is the only non-lethal technique to study male reproductive cycles. Apart from the direct observation of the testes (size, color and turgescence give indications of the spermatogenetic stage) and of the reproductive tract (sperm storage in the epididymis) it is possible to collect testis biopsies for histological determination of spermatogenesis. I present examples of these techniques for Western Australian and Malagasy freshwater turtles. Results include variable patterns of vitellogenesis and spermatogenesis and the fact that low intensity nesting can be much more extended than the previously assumed nesting seasons.

From theory to practice in temperature dependent sex determination: sex ratios in captive breeding and head starting projects of threatened chelonians in Madagascar, Mauritius and Malaysia

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Temperature dependent sex determination has important implications for tortoises and turtle conservation programmes involving captive breeding or nest translocation and head-starting. The standard scientific method to establish sex ratios of hatchlings is to sacrifice them for histological examination of their gonads. The dilemma is that this technique is generally not permissible in conservation programmes, where the assessment of sex ratios is imperative. Many tortoise and turtle species take many years or decades to mature. External sexual dimorphism may take as long to develop. Thus, conservation programmes often operate for a long time without knowing the sex ratio they produce and often release into the wild. Unfortunately no non-invasive technique presently allows the accurate sexing of juvenile chelonians. I used endoscopy to sex juvenile *Geochelone yniphora* and *Erymnochelys madagascariensis* in the breeding and head-starting programme of the Durrell Wildlife conservation Trust in Madagascar; to sex juvenile *Geochelone gigantea* at the breeding programme of the La Vanille crocodile and Tortoise Park in Mauritius; and to sex juvenile *Batagur baska* for the Malaysian Fisheries Department and the University College of Science and Technology Malaysia. I successfully sexed turtles as small as 60g, but found that gonads and reproductive tracts are better differentiated and the sex is easier to determine in larger juveniles. Intersex conditions do occur in small tortoises and turtles, but three "intersex" *G. gigantea* which I re-examined four years later had all turned into females. Biased sex ratios from nests constructed by captive mothers demonstrate that the limited nest site choice in captivity does not guarantee that this "natural" incubation provides balanced sex ratios

A review of the first long-term ecological study on a caecilian amphibian

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Fundamental information on the ecology of caecilians is needed for well-founded conservation assessments as well as comparative analyses of vertebrate biology. We present data gathered over more than 20 years on *Ichthyophis* cf. *kohtaoensis* (Ichthyophiidae) from northeastern Thailand. *Ichthyophis* cf. *kohtaoensis* is oviparous: females guard egg clutches in terrestrial chambers and hatched larvae are aquatic until metamorphosis. Our studies were carried out from 1981 to 2004 in the Mekong valley (Khemmerat District, Ubon Ratchathani Province). The study site is located in the seasonal tropics (marked rainy and dry seasons). Sixteen visits were made in the rainy season (June to September) and five in the dry season (November to February). Density was estimated by timed digging and by quadrat sampling. Densities were low (mean 0.025 individuals/m², range 0.009-0.059) and showed little variation between the years. Abundance and macro- and microhabitat use vary across the seasons. Reproduction in *I. cf. kohtaoensis* is strongly seasonal. Egg clutches were recorded only in the rainy season, and aquatic larvae found only towards the end of the rainy season and the dry season. Dietary studies demonstrate that this species is a generalist carnivore throughout its life history. This body of work on a single species demonstrates the feasibility of studying caecilian ecology in at least some situations. The results are informative with respect to the design of future monitoring programs of caecilian populations with similar ecologies.

Reproductive biology of caecilians (Amphibia: Gymnophiona): past, present & future

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In contrast to most frogs and salamanders, the majority of caecilian species have severed their reproductive ties with the aquatic environment in favour of terrestrial reproduction. Describing and understanding the reproductive diversity of caecilians is crucial for interpretations of amphibian reproductive biology as a whole, as well as having significance for understanding the evolution of tetrapod terrestriality and the origin of amniotes I will summarise results of a new, extensive review of the published literature on caecilian life history and reproductive biology. I will describe the variety of caecilian reproduction and its classification into modes, including diverse forms of oviparity and viviparity. Currently, the reproductive mode for less than one third of the 172 currently known species can be inferred. There are reliable, detailed life history observations for some of these, but for many the

inference of reproductive mode is weaker, sometimes being supported from data on phylogenetic relationships. In many instances, life history observations cannot be attributed to particular taxa with any confidence because of unstable taxonomy and lack of voucher material. The majority of caecilian species for which assessments are made are oviparous, with only about one quarter exhibiting one form or another of viviparity. Quantitative data on various reproductive parameters such as clutch size and total length of hatchlings are available only for very few species. Data for these taxa, covering a variety of reproductive modes, are assembled into life history tables. This review represents a platform that is being built on with the addition of new data. Some of these data extend observations for particular species, some represents the first evidence of reproductive mode for other species, and these and additional data are being generated to address specific questions in the evolutionary reproductive biology of caecilians.

Footprints in the sand: independent reduction of subdigital lamellae in the Namib-Kalahari ground geckos

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Colopus, *Chondrodactylus*, and *Palmatogecko* are ground-dwelling gekkonids that occupy sandy substrates in arid southwest Africa. Though identifiable components of Africa's *Pachydactylus* Group radiation, the ground geckos' precise phylogenetic affinities remain elusive. These three genera have been considered closely related, united by a suite of burrowing specializations that include reduction or loss of subdigital lamellae (pads). However, independent evolution of pad reduction offers an alternative hypothesis for their terrestrial condition and successful exploitation of Namib-Kalahari sands. We present a molecular phylogeny for the *Pachydactylus* Group based on mitochondrial (cytb, 12S and 16S rRNA) and nuclear (RAG-1) gene sequences. Bayesian and parsimony analyses consistently placed all three ground-dwelling genera within *Pachydactylus*. *Chondrodactylus* is sister taxon to a large-bodied, basal clade whereas *Colopus* and *Palmatogecko* each fall within separate, small-bodied clades. Strong support for these distinct lineages, together with significantly different alternative topologies, suggests pad reduction has occurred independently three times in the southern *Pachydactylus* Group.

A microanatomical and histological study of the paired fin skeleton of the Devonian sarcopterygian *Eusthenopteron* and the conquest of land by vertebrates

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The Devonian sarcopterygian *Eusthenopteron foordi* is one of the closest relatives of tetrapods that possessed paired fins and it has played a major role in the discussions of scenarios of the conquest of land by vertebrates. Early studies suggested that its environment dried periodically and that *Eusthenopteron* had to crawl on land to seek deeper bodies of water, and that this behavior triggered the conquest of land by vertebrates. However, recent studies suggest that this sarcopterygian lived in a lagoonal marine environment unaffected by droughts, and this suggests that it did not have to venture on land. Sections of fore and hind limbs of *Eusthenopteron foordi* show a thin cortical compacta and an extensive and relatively loose medullary spongiosa. Most long bones have no free medullary cavity. The structure of the long fin bones, which looks fragile, seems to be incompatible with extensive use of the fins in terrestrial locomotion, and a comparison with comparable sections of extant taxa also suggests that *Eusthenopteron* was a fully aquatic animal. Thus, the new data are congruent with recent paleoecological interpretations of the environment in which *E. foordi* lived and of the aquatic lifestyle of Devonian stegocephalians. Thus, the image of *E. foordi* or similar early sarcopterygians dragging themselves on dry ground is probably not accurate, and the tetrapod limb is an exaptation (a preadaptation) rather than an adaptation to life on land.

The otic region of the Carboniferous temnospondyl *Iberospondylus schultzei*, the middle ear of temnospondyls, and the evolution of hearing in early tetrapods

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Until recently, most paleontologists believed that lissamphibians derived from temnospondyls, and that the tympanic middle ear present in anurans was derived from a similar structure in temnospondyls. Thus, the ability to hear high-frequency air-borne sounds was thought to have appeared in stem-amphibians in the late Carboniferous or the early Permian, about 300 MY ago. This implied that the tympanum and associated structures had disappeared in apodans and urodeles. New data from the otic region of the Carboniferous temnospondyl *Iberospondylus schultzei* show that this taxon did not possess a tympanum; instead, a bony septum closed the otic notch, thus separating the stapes from the area where other authors placed the hypothetical tympanum. A review of the evidence shows that the widely held idea that many temnospondyls possessed a tympanum is unlikely; the stapes of this group is always more massive than that of similarly-sized extant tetrapods that possess a tympanum, and a fusion between the stapedial footplate and the neurocranium is incompatible with the function of a typical tympanic middle ear. Other arguments presented to support the presence of a tympanum in temnospondyls also appear

to be invalid. Furthermore, recent analyses show that temnospondyls are probably stem-tetrapods, and that lissamphibians are derived from "lepospondyls", that did not possess a tympanum. Thus, stem-amphibians probably never had a tympanum, and the absence of this structure in apodans and urodeles is primitive, rather than resulting from a loss. The tympanum of anurans originated more recently than previously believed, perhaps as late as in the Triassic, about 220 MY ago.

To see or not to see: the effect of habitat light on the evolution of signal design and visual-system function in allopatric populations of the lizard *Anolis cristatellus*

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Divergence in communication systems among populations, particularly in signals used for courtship and/or as species recognition has been suggested to play a key role in the evolution of reproductive isolation. However, the mechanisms that favor divergence in communication systems are poorly understood. The Sensory Drive Hypothesis states that natural selection favors adaptations of the sensory system and/or signal design to achieve signal efficacy in a particular environment. I tested this prediction using four allopatric populations of the lizard *Anolis cristatellus*, from two distinct environments (i.e., mesic and xeric conditions). For each population we measured habitat light characteristics and quantified signal design by measuring the spectral and total reflectance and transmittance of the dewlap (a colorful throat fan used in signaling). I used these data to measure signal detectability of each dewlap in each habitat, based on an empirically-based model of signal detection probability. I found that populations from mesic and xeric conditions occupy two distinct habitats with respect to light intensity and spectral quality, and that dewlap design has diverged between populations in a way that increases signal detectability in each habitat. The major difference in dewlap design was in total reflectance and transmittance, making dewlaps from xeric habitats darker and dewlaps from mesic habitats brighter. Furthermore, dewlap detection decreased significantly when a dewlap from a xeric habitat is detected under the spectral conditions of a mesic habitat. The converse is true for a dewlap from a mesic habitat. I propose that sensory drive has promoted adaptations of dewlap design to distinct ecological conditions and discuss how natural selection can promote early stages of reproductive isolation between populations of *A. cristatellus* as a by-product of adaptations of the dewlap design to distinct habitat light conditions.

Frog pond communities from southeastern Australia show stable community structures

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Many pond breeding anurans have been demonstrated to possess a metapopulation structure characterised by a mix of essentially permanent and relatively transient breeding populations. Each population is at risk of extinction and studies have found up to 25% of may disappear in any year, but are replaced by new populations. Our experience in New South Wales suggests that communities at small (<30m diameter), permanent ponds rarely change. To test this, we surveyed six species at 36 ponds in central NSW yearly from 2001 to 2005. In 2004 we surveyed also the same species at 28 northern NSW ponds searched 11 years previously. In both areas, all species present in the initial surveys remained present in 2005, even though mean counts for any of the species were less than 15 males per pond/per year. 2002-2003 were drought years with poor survey success and a species went undetected at a pond on 27 occasions, but all returned when the drought broke. Frog communities in both areas have been very stable and unchanged communities at some ponds can be traced back to the 1970s. We found no evidence for local population extinctions, although sources and sinks of actual reproductive success may still exist. Our study ponds are permanent and offer stable, uniform breeding environments with no fish predators, which may explain the stable frog communities. This information is important for the monitoring and management of frog species in this region as extinctions are unlikely to represent natural events.

Phylogenetic diversity of East African caecilians

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It is only very recently that DNA sequence data has informed questions of caecilian diversity, particularly phylogeny and the detection of species limits. Based on several years of field and laboratory work, I will provide an outline of the diversity of caecilians of East Africa, exclusive of Ethiopia, in order to provide an up-to date assessment of species limits and distribution. Preliminary analyses of mtDNA sequence data and morphology for three caecilian genera (*Boulengerula*, *Schistometopum*, and *Scolecormorphus*) indicate a gross underestimation of lineage diversity that potentially corresponds to previously undetected species. The increased diversity is unevenly distributed, occurring primarily in forms associated with the montane element. For example, species of

Scolecophorus are interpreted as having small distribution ranges, restricted to one or two fragmented mountains of the Eastern Arc. Sampling of almost all known populations of this genus has revealed high genetic diversity that indicates a potential 200% increase in numbers of species. The diversity of the caecilian coastal fauna is less clear because it is poorly sampled. Preliminary results indicate that although coastal species are possibly more widely distributed than montane forms, an increase in sampling might reveal previously undetected lineages. However, any increase in described species is likely to be less dramatic than for the montane region, which is indicative of the biogeographic patterns repeated in other groups in the region. Furthermore, molecular clock estimations suggest a substantial period of isolation between all lineages, particularly between species distributed in the Eastern Arc forests, a region rich in endemics and 'archaic' lineages.

Larval morphology of reed frogs, *Hyperolius kivuensis* and *H. viridiflavus*, from western Kenya (Anura: Hyperoliidae)

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The Afrotropical reed frogs, genus *Hyperolius* Rapp, include about 120 described taxa. For less than 20 *Hyperolius* species detailed descriptions of the larvae are available. During field surveys in western Kenya, we found adults and tadpoles of five syntopic reed frog species. No description is available for the tadpoles of these species. Our samples, collected in the field between 16 March and 5 April 2003 in the Kakamega Forest, consisted of broad series of larval *H. kivuensis* Ahl and *H. viridiflavus* (Duméril and Bibron). The larvae were reared and different developmental stages were fixed and stored in 4 % formaldehyde. Body measurements were taken according to the primary landmarks. The generalized *Hyperolius* tadpoles are uniform in external morphology. The differences in size, body proportions and life colors between the *Hyperolius* species are too poor to enable proper diagnosis and clear decisions for systematic purposes. The tadpole morphology may provide useful characters for species diagnosis and for assessment of phylogenetic relationships. The oral disc morphology especially the labial tooth rows and the labial teeth of the two species were compared. For the description of the buccopharyngeal structures 50 specimens of Gosner stages 28, 32 and 36 from each species were dissected under the binocular. Buccal roof and buccal floor were separated by inserting the irisectomy scissors into the corner of the mouth and cutting back horizontally. For scanning electron microscopy (SEM) 12 specimens each were processed.

Does gravidity influence maternal thermoregulation in an oviparous reptile?

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Viviparity has evolved over 100 independent times in squamates, presumably because it enhances the female's ability to regulate the thermal conditions of the developing embryos. The importance of embryonic developmental temperature is reflected by the fact that many viviparous species maintain a higher and more precise body temperature when pregnant. Since oviparous squamates generally retain their egg in utero until embryonic development is one fourth complete, gravid females may also show critical alterations in thermoregulation similar to those of viviparous species. Therefore, we examined an oviparous python, *Antaresia childreni*, to determine the extent to which development occurs prior to oviposition and whether gravidity induced thermoregulatory changes. We found that the embryonic stage at oviposition was very advanced (stage 35) compared to other oviparous species. Second, we detected a significant influence of reproductive status on thermoregulation. Gravid females maintained higher and less variable body temperatures than non-reproducing females. Additionally, mean daily body temperature accounted for over 60% of the variance observed in the duration of days between post-ovulatory shedding and oviposition, with higher mean temperature resulting in earlier oviposition date. These results underline the importance of thermal control of early embryonic development and the potential thermal benefits of embryonic retention regardless of reproductive mode.

The inadequacy of standard conservation management approaches to the disappearances and declines of amphibians. A role for assisted reproductive technologies

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Species extinction is unique among major anthropogenic changes because it is irreversible. It is now accepted amongst biologists that the amphibia are experiencing a major world-wide extinction crisis. Substantial range contractions, population reductions and extinctions have been reported on different continents, with major crises experienced particularly in Central America and Australia. The reasons for these declines, which only became apparent from about 1980 are still poorly understood and controversial, although recent evidence implicates a fungal disease. Other environmental factors such as global warming, UV-B radiation via ozone depletion, and pesticides/herbicides are also postulated to have played a role. The ideal strategy for the long-term protection of biological diversity is the preservation of natural communities in

the wild. However, in situ preservation is not a viable option in the current circumstances where species disappeared from pristine areas. Moreover, some of the factors implicated are beyond human control. In such a case it is likely that the only way to save susceptible species from extinction is to maintain individuals in artificial conditions until the causal agent is confirmed and means of mitigation identified. It is simply not acceptable to repeat the approaches adopted in the 1980s-90s that involved monitoring declines and searching for the cause, because species disappeared while the search for the causal agent was underway. We have investigated the role of "genome banking" as an insurance against extinction and the loss of population genetic diversity. We have successfully developed methods to; collect amphibian gametes without death of donors, cryopreserve sperm, conduct in vitro fertilization and intra-cytoplasmic sperm injection. Further technologies need to be investigated and adapted including (i) cryopreservation of diploid totipotent stem cells, (ii) nuclear transfer, and (iii) androgenesis using cryopreserved gametes.

Developing and testing predictive niche models for five lizard species in Southern California, USA

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A common difficulty in producing conservation plans for species of concern is lack of adequate information about species' distributions and factors controlling those distributions. We developed and tested the validity of predictive niche models for five lizard species: the coast horned lizard (*Phrynosoma coronatum*), granite spiny lizard (*Sceloporus orcutti*), southern sagebrush lizard (*S. graciosus vandenburgianus*), orange-throated whiptail (*Cnemidophorus hyperythrus*) and coastal western whiptail (*C. tigris stejnegeri*) in Western Riverside County, California. We created a community model by combining data for all species except *S. graciosus*, which primarily occupies higher elevations. We used Geographical Information Systems (GIS) to quantitatively summarize a series of environmental variables thought to influence each species' distribution and calculated the multivariate mean of these variables. We then generated a Habitat Similarity Index (HSI) using the Mahalanobis D2 statistic and used the HSI to identify locations within the study area that share the same multivariate configuration of variables as those locations known to be occupied. Analysis of validation survey data revealed that HSIs for the *C. hyperythrus* model ($p < 0.01$) and community model ($p < 0.05$) significantly correlate with species detection/non-detection. Variables that seem most closely associated with *C. hyperythrus*' distribution are precipitation, elevation, maximum July temperature and amounts of scrub, chaparral and exotic grass vegetation. Variables that seem most closely

associated with the community distribution are elevation, precipitation and amounts of scrub and chaparral vegetation. Validation data did not reveal significant correlations between HSIs and species detection/non-detection for the *P. coronatum*, *S. orcutti*, *S. graciosus* or *C. tigris* models, although small sample sizes hindered the power of some of these analyses.

Life history and seasonality of a Kenyan caecilian

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Life histories of amphibians are frequently regarded as the model complex life history for vertebrates. However, only the most basic information exists for caecilians. *Boulengerula taitanus* is a terrestrial caecilian commonly found in agricultural settings of the Taita Hills, Kenya. During twelve monthly visits, 246 caecilians were collected by digging into soil. Caecilians were captured on every visit, although increased searching time and low capture numbers coincided when soils were dry. Data on condition (M L-3) defines three ontogenic stages, for which growth can be approximately followed over the sampling period through frequency histograms. Juveniles (< 140 mm) appear to become subadults (< 240 mm) around a year after hatching, while subadults mature into adults (> 240 mm) after a further year. Adult males are significantly longer than females. Mating occurs in the soil prior to egg laying at the beginning of the short rains. Females construct a chamber before laying eggs ($= 5$), and are found attending eggs during incubation, and after hatching. Juveniles make up the smallest proportion of the population (maximum is 24% in April and May). Specimens resulting from regular monthly collections can be used for a wide range of studies, especially those relating to seasonality. We use this life history data to propose several testable ecological hypotheses that could help to open up the dark world of subterranean herpetology.

Trophic transfer of cadmium in *Podarcis carbonelli* - a model lizard for ecotoxicology

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In parallel with the highly publicised global decline of amphibians is a comparable, or possibly even more advanced decline in reptile numbers around the globe [1]. In contrast to the consequent interest in amphibian toxicology, reptile ecotoxicology has received scant attention, and is predominated by field surveys for accumulated residues. Laboratory based manipulations with reptiles remain scarce [2]. This study presents data on metal accumulation in a European lacertid lizard (*Podarcis carbonelli* Pérez-Mellado, 1981). Adult lizards maintained under controlled laboratory conditions were fed live crickets

contaminated with cadmium (~ 0.5 µg Cd per cricket). The crickets had previously accumulated Cd by feeding on Cd-contaminated lettuce. The inclusion of ¹⁰⁹Cd as a radioactive tracer, allowed for accurate, non-destructive measurement of Cd contamination within individual crickets and lizard faeces at weekly intervals over the course of the study, thereby providing a time course evaluation of Cd assimilation. Preliminary data at the time of writing indicated that lizards assimilated approximately 50% of the Cd available within each cricket. Data will be presented on Cd assimilation as a function of Cd speciation and the implications for metal bioavailability in toxicity studies and in trophic food chains.

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CITES: conservation issues of the live herp trade

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Worldwide, the trade in live reptiles and amphibians has become an important segment of the trade in CITES species. Both trade volumes and species diversity are reflecting the high demand e.g. for the pet trade in Europe and the United States. The paper provides an overview on the live herp trade in CITES species with particular reference to the situation in the European Community and discusses its conservation implications.

Does grassland management negatively impact conservation of herpetofauna in South Africa?

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Habitat structure plays an important part in determining reptile and amphibian diversity for any given area. Since grassland management practices have a direct influence on habitat structure, it follows that management policy is likely to have a direct, but as yet, unmeasured influence on the reptile and amphibian populations in South African grasslands. We measured the species richness of herpetofauna at 10 sites at Suikerbosrand Nature Reserve, South Africa. This nature reserve represents one of the most important remnants of natural highveld grasslands and the history of management blocks within the reserve has been well documented over the last 30 years. Although the initial design of our study was aimed at detecting effects due to burn history, we found that species richness was best explained by a model that included ground cover, grass height, and habitat type ($R^2 = 0.97$). Once these effects were removed we showed that fire had little residual influence on species richness. In general,

species richness was strongly positively correlated with an increase in the structure of the habitat, suggesting that the amount of cover directly or indirectly improves herpetofaunal richness. The most obvious direct effect of increased cover is a decrease in the risk of predation since reptiles and amphibians are more easily able to avoid detection. Indirect effects include a better food supply and improved thermoregulatory opportunities. Grassland management practices in Suikerbosrand include controlled burns and manipulation of large mammal stocking densities. Since high stocking densities of ungulates lead to modifications of habitat structure through grazing, a recent move by management of Suikerbosrand to increase stocking densities of ungulates is likely to have a negative impact on the conservation of the herpetofauna in the reserve.

The life of the semi-aquatic *Varanus mertensi* (Reptilia: Varanidae)

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We report for the first time the daily and long-term spatial movements of the semi-aquatic monitor, *Varanus mertensi* (Reptilia: Varanidae) based on a 2-year field study in the Kimberley region of tropical northwest Western Australia. We also report on detailed observations of active radio-tagged individuals observed throughout their daily activity pattern. Daily activity areas of this monitor lizard encompass the aquatic zone and nearby terrestrial riparian vegetation bordering watercourses. Individuals utilize the majority of the aquatic environment available to them during their active day, hence daily activity areas closely resemble the shape of waterbodies used. Observations indicate that individuals concentrate their foraging whilst swimming along the benthos or wading along the "bank/water interface" of waterbodies in search of their dominant prey, freshwater crabs. Basking sites used during an active day are usually located on the edge of waterways. Long-term movements of *V. mertensi* are similarly linked to the path of watercourses inhabited with few relocations recorded away from water. Occasionally individuals were found to seasonally relocate between watercourses and several individuals were identified moving between the same watercourses at similar times during consecutive years. These movements may result from diminished prey resources in vacated areas. Some individuals displayed extended periods of inactivity, with animals remaining burrowed at various sites during the cooler dry season. Inactivity of individuals in burrows did not correlate with absence of water at these sites but may also be linked with low prey resources during dry season months.

Heating and cooling rates of leopard tortoises (*Geochelone pardalis*) under experimental and natural conditions

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It would be advantageous for an ectotherm to retard the rate of heat uptake under warm conditions and retard the rate of heat loss under cool conditions, to maximise operating body temperatures. Seasonal heating and cooling rates of Leopard tortoises (*Geochelone pardalis*) were investigated in the laboratory and in the wild to determine if Leopard tortoises could maximise their operational activity periods. Experimental heating and cooling rates were measured in six adult, three juvenile and seven hatchling Leopard tortoises between 5 and 30 °C using cloacal body temperatures, and comparisons made with models. Heating and cooling rates of adult free-ranging Leopard tortoises in the Nama-Karoo were collected using *Thermocron iButtons*TM. Heating rates were faster than cooling rates for all age classes and decreased with increasing body mass. When corrected for body mass, cooling and heating rates differed by a factor of ten between each age class. Tortoise models had considerably faster heating and cooling rates than live tortoises. Leopard tortoises had significantly lower cooling rate in winter than in summer and a significantly lower heating rate in summer than in winter. Free-ranging Leopard tortoises cooled down slower and heated up faster than captive tortoises under experimental conditions. Heating and cooling rates of Leopard tortoises were dependant not only on body mass, but on the surface area-to-volume ratio of an individual tortoise. Leopard tortoises were able to physiologically adjust their heating and cooling rates under experimental conditions, and when compared with inert models. Free-ranging Leopard tortoises used physiology and behaviour to further retard heat gain to minimize the risk of overheating in summer and retard heat loss to maximize operative activity time. Leopard tortoises can alter their rates of heat exchange both behaviourally and physiologically to maximize the time available for activity under any conditions.

Are amphibians good biological indicators?

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Human activities over years often mean threat for the environment at various intensities and scales. Assessing extent of the damages, anticipation of possible consequences, assumptions used in environmental decision-making and policies exhibited the need of indicators able to give synthesised information on complex interactions between human

activities and environment. There is a large scientific literature on biological indicators and in e.g. the case of ecological indicators, advances often follow the conceptual understanding of ecosystem functioning. The aim of this presentation is to use the question "are amphibians good biological indicators?" to illustrate the complex and sometime overlapping definitions of biological indicators. An indicator is a person or thing that measures something (Webster's New World Dictionary, 1995). Biological indicators aim to measure biological processes, and ecological indicators can be defined as measurable characteristics of the structure (e.g. genetic, population, habitat, and landscape pattern), composition (e.g., genes, species, population, communities, and landscape types) or function (genetic, demographic/life histories, ecosystem, and landscape disturbance processes) of ecological systems (Niemi & McDonald, 2004). Amphibians, as widespread species in the world and ecosystems, can play the role of ecological indicator i.e. to access the condition of the environment (early-warning system) or to diagnose the cause of environmental change. We will try to illustrate these concepts and definitions with amphibian studies such as bioindicator (presence-absence of species, species richness or diversity, relative abundance of guilds) in response to pollutants or landscape change (e.g. fragmentation), bioaccumulators (non-target effects of xenobiotics evaluated using mortality as the end point) or measurement of biomarkers (e.g. cellular and enzymatic activities, developmental asymmetry, genetic local adaptation) which can provide data on the potential adverse impacts of e.g. contaminants in both aquatic and terrestrial habitats. Finally, amphibians could have their place in the indexes of ecological and environmental integrity which have been recently introduced and still discuss.

Ecology, ecography and the size of caeciliid caecilians

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The causes of geographic variation in morphological traits, including body size, are not well understood. For intraspecific variation, known ecological factors include spatial heterogeneity, climatic variability and habitat quality. Bergmann's rule predicts that intraspecific body size increases with increasing latitudinal distance from the equator or at higher elevations. Although this has been shown to apply generally to several vertebrate groups of endotherms, the trend is less clear for amphibians. Similarly, the influence of habitat change on faunal assemblages in the forested tropics is well documented for some vertebrate communities; but amphibians appear to be underutilized despite being reputedly good indicators of otherwise cryptic or synergistic habitat changes. Many amphibians express strong phenotypic plasticity making determination of the cause of intraspecific morphological differences

difficult. In this study, data from three species of subterranean caeciliid caecilians are used to explore the effects of altitude and habitat on morphological features; in particular size as expressed by total length. Results, presented together with supporting morphological and environmental data, give an important insight into the population biology of caecilians.

Evolutionary ecology and molecular systematics of the Australian agamid lizards (Amphibolurinae)

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Australia is home to more than 70 species of agamid lizards, known as the Amphibolurinae. There are a wide range of ecological and morphological forms, such as the arid-zone lizard *Moloch horridus* and the southern mountain dragon *Tympanocryptis diemensis*. Morphological analyses have shown that this group is an adaptive radiation, with a significantly greater diversity of form compared to other agamid groups and previous molecular work indicates that the Amphibolurinae diversified within Australia at least 50 million years ago. Thus, the Amphibolurinae provide a unique opportunity to study the evolutionary patterns of ecological and morphological diversity at a continental level. However, current systematic uncertainties are impeding these efforts, particularly in the genera *Tympanocryptis*, *Ctenophorus* and *Diporaphora*. We have undertaken a study to resolve these using mitochondrial and nuclear DNA sequencing. Currently, we have sequenced over 200 samples, including 115 species and subspecies. We will be presenting results that indicate taxonomic revision of the Amphibolurinae in needed.

Morphology, locomotor performance and foraging mode

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The predicted morphological and performance consequences of foraging mode are well described. However, relatively few studies have explicitly tested these predictions. For example, almost no information is available about the morphological differences between ambush predators and active foraging species. Whether these groups of species exhibit differences in body or limb proportions is largely unexplored. Evidence for locomotor performance differences between ambush and active foraging species is equivocal. Some studies have shown that ambush foraging species are faster, but active foraging species have greater stamina. However, a recent study failed to demonstrate performance differences

between foraging modes. In this paper, we address two questions. First, are ambush predators morphologically distinct from widely foraging predators? Theory predicts that the latter should have a streamlined body form with long tails. Second, because mode of prey acquisition may require greater speed rather than stamina, is maximum velocity greater in ambush predators? Conversely, we expect widely foraging predators to have high endurance capacity. We recorded morphological data on 330 species of lizards using museum specimens. We used published sources on locomotor performance to obtain data on maximum velocity for 148 species and endurance capacity for 69 species. Our statistical analyses were based on the actual species values and controlling for the effects of phylogeny. A canonical variate analysis of the morphological data revealed active foraging species to be relatively more streamlined with longer femora and hind feet than ambush predators. Ambush predators had wider bodies, with a longer radii and crus, and longer digits on the hand. Furthermore, ambush predators were significantly faster than active foraging species, after controlling for body size. This pattern was consistent across clades and within families. Ambush predators had low endurance capacities compared to active foraging species, which is consistent with previous studies. Both maximum velocity and endurance capacity were significantly and positively correlated with moves-per-minute. Our analysis confirms the prediction that foraging mode influences numerous phenotypic attributes of lizards. Furthermore, evolutionary shifts in foraging mode were accompanied by changes in morphology and performance, suggesting that the observed patterns are not the result of other selective factors.

New insights in caecilian mesonephric nephron design

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Within the caecilian life cycle two kidney generations are present and functional. The pronephros is the functional kidney in larvae, whereas the more complicated mesonephros becomes the functional kidney in the adult. Caecilian kidneys are often viewed as being almost representative of the ancestral vertebrate kidney and studies on these kidneys are therefore often used in discussions on vertebrate kidney evolution. Recently, we published a detailed study on the morphology and ultrastructure of the mesonephric kidney in the caeciliid caecilian *Geotrypetes seraphini*. Nephrons were reconstructed and the cellular characteristics of different nephron segments described. This presentation will focus on similarities and differences in caecilian mesonephric nephron design. The caecilian mesonephric nephron is composed of a Malpighian corpuscle and a renal tubule, which can be divided into six distinct sections: ciliated neck segment, proximal tubule, ciliated

intermediate segment, early distal tubule, late distal tubule and finally the collecting tubule, which opens into collecting ducts that lead the urine to the Wolffian duct. Variation among caecilians in mesonephric nephron design includes differences in renal tubule segmentation and ultrastructure, Malpighian corpuscle size and nephron-coelom connections. Nephron structures in caecilians will be compared with the structure of nephrons in other amphibians and the evolutionary origin of the amphibian nephron is discussed.

Caecilian eyes: a morphological and molecular perspective

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Vernacular names in several languages suggest that some 'caecilians', 'Blindwuehlen' or 'cobra-cegas' are blind, reflecting the facts that that eyes are typically small and are sometimes obscured by skin or even bone in some *Gymnophiona*. Early studies of morphology showed caecilian eyes to be somewhat rudimentary and it is now clear that there is extensive variation in the degree of morphological rudimentation of the eyes within the group. Somewhat contradictory reports in the literature indicate a need for some re-evaluation of basic observations to better characterise the morphological data and to extend observations to currently unsampled genera or species. Even the most rudimentary eyes probably retain the basic function of distinguishing light and dark, but it is unknown how visual function has been affected by the morphological rudimentation. Phylogenetic studies of character data from the visual system suggest that morphological rudimentation of the eye has occurred independently in several lineages, presumably accompanying parallel shifts in ecology associated with increased burrowing. Because several genes, particularly opsins, are known to contribute to vision, caecilians provide an opportunity to examine convergent and correlated evolution of the visual system within the group at both morphological and molecular levels. I summarise the interpretation of morphological characters of the visual system in the light of caecilian phylogeny, and describe recent work characterising opsin genes of caecilians. A direct measurement of opsin function revealed a spectral shift in the maximum wavelength of light that is absorbed by rods of the 'basal' caecilian *Rhinatrema bivittatum* compared to other *Amphibia* that can be related to changes in the amino acid sequence of the rod opsin.

Two step decision making for ambushing by a Japanese pitviper, *Trimeresurus okinavensis*

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Trimeresurus okinavensis is a typical sit-and-wait predator, distributed in Ryukyu Archipelago, Japan. In the northern mountains of Okinawa Island, the snake aggregates to breeding sites of two species of frogs, which explosively breed in a few days of winter at restricted areas of the mountain stream. Our previous survey revealed that a number of snakes appeared at the frog breeding sites only in winter and that few snakes were observed along the stream in other time of the year. Here, we conducted a radio-telemetric study to examine the moving range of the snake over a year. We also made census along the stream during the frog breeding season to investigate daily appearance and ambushing site selection of the snake in a finer topographic scale. The radio-telemetric study indicated that snakes move away from the frog breeding sites to the deep forests early spring and return to the breeding sites late fall. The census survey revealed that most snakes ambush in water at the breeding peak of the frogs, whereas they tend to sit-and-wait on the bank beside the brook after the peak. A high correlation between the number of ambushing snakes at a night and that of frogs indicates that the snake emerges and ambushes only at nights when activity of the frogs is high. These census data suggest that the snake performs micro-scale adjustment to maximize the probability to encounter frogs. Collectively, our results indicate that *T. okinavensis* has two steps of decision making for ambushing. One is a large scale step that involves seasonal adjustment of ambushing area, that is, visiting streams from forests in winter. The other is a small scale step that corresponds to daily adjustment of appearance and microhabitat selection for ambushing frogs (water vs. bank).

Spines versus speed in cordylid lizards: the armadillo lizard, *Cordylus cataphractus*, as an extreme case

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Being rockdwelling heliothermic baskers, cordylid lizards have to deal with multiple predators, with contrasting demands on morphology. To escape avian predation, cordylids need to be fast to reach the safety of their crevices during attacks. To avoid being eaten by terrestrial predators, more often than not, they need to be armoured to some degree. Heavy armour will, however, compromise sprinting ability and increase vulnerability towards avian predators. Behavioral and/or other morphological adjustments will be required to compensate for loss of speed in heavily armoured cordylids or lack of armour in cordylids with high sprinting abilities. For example, in cordylids the degree of body armature is inversely correlated with distance run from a predator, heavily armoured species always entering crevices after fleeing short distances. Thus heavily armoured cordylids stay close to their crevices during general maintenance behaviour to compensate

for the loss of speed and resultant greater vulnerability to avian predators. The armadillo lizard, *Cordylus cataphractus*, is a heavily armoured, group-living species that regularly goes on foraging excursions to feed at termite foraging ports considerable distances away from the crevice. Predation by terrestrial predators during these excursions must have been the main driving force in the evolution of heavy armour and the tail-biting antipredator behaviour displayed by this species. Heavy armour makes this lizard sluggish. In order to lower the impact of avian predators, against which speed is required as an escape strategy, individuals stay close to the crevice during general maintenance behaviour. It is suggested that living in groups further alleviates avian predation impact in that individuals in a group may benefit from early detection of predators ('many eyes' hypothesis) and 'safety in numbers'. In *C. cataphractus*, terrestrial predation associated with termitophagy, dictates morphology, and extreme behavioral adjustments, including grouping behaviour, had to be made to compensate for increased vulnerability to avian predation.

The plasma membrane transformation as key to the evolution of viviparity

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In mammals, early pregnancy is characterised by ovarian hormone-driven changes in the uterine epithelium that prepare the epithelium for attachment with embryonic tissue. In the plasma membrane in particular, highly characteristic changes occur which collectively are referred to as "the plasma membrane transformation". It is striking that these changes in the plasma membrane of uterine epithelial cells occur in mammals regardless of the placental type that ultimately develops; in mammals the types of placentas vary greatly from epitheliochorial, where the maternal epithelium remains intact, to hemochorial, where both the maternal epithelium and the maternal blood vessels are breached by the implanting embryonic tissues. All viviparous reptiles studied so far display an epitheliochorial placenta and, while sometimes much altered by invaginating stromal blood vessels, there is no evidence that the maternal epithelium is breached. Even so, our recent electron microscopic studies have shown that the maternal epithelial cells in viviparous lizards undergo changes during early pregnancy consistent with a plasma membrane transformation, particularly loss of apical microvilli and the appearance of uterodomes, both of which are seen in mammals. We have not observed similar changes in oviparous lizards. We suggest that fundamental cell biological changes are necessitated by the close contact between maternal and foetal tissues which lead to placentation and viviparity. Changes in the plasma membrane of uterine epithelial cells that are categorised as the 'plasma membrane transformation' are thus likely to be

convergent characteristics of uterine preparation for early pregnancy across viviparous amniotes.

Caecilian skull development revisited

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A full understanding of amphibian relationships and evolution is still hampered by the limited information that is available on many aspects of caecilian biology. This pertains especially to a profound lack of ontogenetic data on the vast majority of caecilian species. The few previous studies available are often contradictory in their results and most are constrained by the limited number of ontogenetic stages observed. A further problem, especially of studies undertaken prior to the 1960s, lies in an unstable taxonomy combined with the lack of an evolutionary framework. To gain a better understanding of skeletal development in caecilians, I sampled species from four of the six recognized caecilian families and studied the development of the skull in particular. Species studied include *Ichthyophis* sp., *Uraeotyphlus* sp., *Scolecormorphus* sp., *Hypogeophis rostratus*, *Gegeneophis ramaswamii*, *Boulengerula taitanus* and *Geotrypetes seraphini*. The general morphology of the developing skull is similar in most species, with the exception of the highly divergent *Scolecormorphus*. However, many differences are readily discernible among the taxa studied. In most cases, these differences are correlated with different reproductive modes, e.g. the indirect developing *Ichthyophis* exhibits a different ossification sequence than the direct developing *Hypogeophis* and *Gegeneophis*. Within the direct developing species, differences in the degree of skull differentiation appear to be correlated with different degrees of altriciality at hatching. In comparing and interpreting these data, new hypotheses of homology for some skull elements are postulated. New data on skull development in *H. rostratus* profoundly disagree with older studies and cast doubt on previous systematic conclusions that closely link caecilians to lepospondyls.

Herbaceous composition and physical features of paths taken by pancake tortoise, *Malacochersus tornieri*, during inter-kopje displacement

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The pancake tortoise, *Malacochersus tornieri* (Siebenrock): Testudinidae has restricted range in East Africa (Kenya and Tanzania). The live international trade has been singled out to be the most significant potential threat to the species survival. Very little is known about the species ecology. Recent studies indicated that pancake tortoise out-of-crevice movement might involve crossing between distant

crevices, exposing them into predation risk due to their soft-shell, which cannot afford physical protection from ferocious mammal and raptor predators. Understanding of vegetation characteristic may be important to unveil how the species minimizes predation risks. Study was therefore conducted during the wet season in April 1998 to find out herbaceous composition of the rocky terrain pancake tortoise microhabitat and physical characteristics of the paths taken by the species when moving between crevices separated by different rock outcrops. Vegetation sampling was performed using quadrants of 1m x 1m in 30m x 30m blocks. All herbaceous plants were identified and counted in order to determine their diversity. The spool-and-line was used to track the species path taken when moving out of the crevices. The Boundary hill study site comprised of seventy different species of herbaceous plant distributed into twenty-six families. The Poaceae (22 species = 31%) had the highest species representation followed by Papilionoideae (9 species = 12%) and Compositae (5 species = 8%). Although the herbaceous layer looked dense at the top, the ground level had enough of spaces to allow pancake tortoise to freely move through. These vegetations, apart from providing food and shelter they also seem to provide safe on-transit hideouts from aerial predators, away from the safety of rock crevices. It is therefore plausible to suggest that habitat destruction, in the form of removal of this vegetation layer, as might be the case outside core-protected areas, may be one of the threat dimensions to the species survival.

The African Colubroid radiation

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We compared nuclear and mitochondrial DNA sequences from many African and Eurasian Colubroidea. A monophyletic group could be identified which contains the following taxa: Elapidae, Atractaspidinae, Aparallactinae, Lamprophiinae, Psammophiinae, Pseudoxyrhopiinae, and the enigmatic genus *Prosymna*. These taxa are predominantly Ethiopian biogeographically, and it is suggested that they represent an old African radiation. During the Tertiary elapids and psammophiines spread from Africa to Asia, while colubrids and natricines moved in opposite direction. *Grayia*, an African genus conventionally assigned to Natricines, turned out to represent a separate clade. *Pseudoxyrhopiines* and *psammophiines* colonized Madagascar by rafting. It is of great evolutionary interest that venomous glands and fangs (both opisthoglyphous and proteroglyphous) evolved multiple times. A revision of the classification of snake families is suggested.

Barking up the right tree - the use of dogs for locating cryptic reptiles

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Difficulties in locating cryptic species of reptiles can be due to a number of factors such as very low densities, aversion to traps, activity in highly restricted habitats or just elusive behaviour. There are a number of threatened cryptic lizard species in New Zealand for which true status has been difficult to assess due to a lack of appropriate survey techniques. In order to determine the status and management needs of such species, and to monitor the effects of any management, innovative detection and capture methods are urgently required. For over 30 years tracker dogs have been routinely used in New Zealand for conservation management of secretive and critically endangered bird species. During 2004 two young border terrier dogs were trained as conservation dogs targeting endemic skinks and geckos. Training involved teaching the dogs to passively indicate the presence of either a skink or gecko, whilst ignoring the presence of non-target species such as ground-dwelling birds and introduced mammals. Certification required the dogs to locate at least 75% of lizards that had been hidden in a forested area. The effectiveness of this technique was assessed by testing the encounter rate by "lizard dogs" against traditional manual search and capture techniques for a range of cryptic taxa.

TSD in *Tuatara*: nesting ecology and global warming

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Tuatara (Order Sphenodontia) are medium sized reptiles with the rare type 1b (female-male) pattern of sex determination. The two extant species, *Sphenodon punctatus* and *S. guntheri* are restricted to offshore islands of New Zealand, many of which are <10 ha in area. The disjunct nature of the distribution, pattern of sex determination where males are produced from warmer incubation temperatures, and generally small population sizes leave tuatara vulnerable to stochastic events. In addition, female tuatara lay eggs every 2-5 years, and the only extant population of *S. guntheri* comprises 60% males. We investigate whether sex ratios of tuatara populations are likely to become male-biased due to global warming by estimating hatchling sex ratios from nest temperature data and monitoring plasticity of female nesting behaviour with respect to environmental cues. We present nest characteristics and estimated hatchling sex ratios in the context of weather data from three seasons of nesting on Stephens Island (*S. punctatus*). In general, female tuatara build nests with similar characteristics in

rookeries that vary in aspect and soil type, and across seasons. The variability in nest locations and seasons ensures both sexes are produced in this relatively large tuatara population. Preliminary analysis of female nesting behaviour indicates that they return to the same rookeries over successive years. More data are required to establish whether individuals construct similar nests each time they nest, and thus whether they manipulate micro-site nest choice, depth, or timing of nesting based on environmental cues.

Are Red-Eared Sliders Reproducing in Singapore?

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The Red-Eared Sliders (*Trachemys scripta elegans*), originally native to Florida, U.S.A., is the only species legally imported to be kept as pets in Singapore. Populations of the sliders have been living in the water bodies of Singapore for more than 20 years. This ongoing study, aimed at investigating the reproduction of these terrapins, is being carried out at two different sites: one with more natural surroundings and where nesting behaviour has previously been observed, while the second site was at a man-made reservoir with less suitable areas for nesting. Male and female terrapins were collected at monthly intervals and the development of gonads was scored. Developing follicles and sometimes, shelled eggs were found within the females, but it was not synchronous among the females. While the equatorial climate is not within the slider's natural range, they are commonly found in many South Asian countries including Thailand, Hong Kong and Taiwan. Together with the intentional release of the terrapins by the public, the successful reproduction and establishment of Red-eared Sliders here could pose a serious problem, both for park management as well as to the populations of native terrapins such as the Malayan Box Terrapin (*Cuora amboinensis*) and the Black Marsh Terrapin (*Siebenrockiella crassicollis*).

Population and demography of the red-eared slider terrapin in Singapore

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The Red-eared Slider (*Trachemys scripta elegans*) has been recorded in Singapore waters from before the 1980s. Although not native to the region and originally from Florida, U.S.A., these sliders have become very common in local water bodies. It is still unclear if these large numbers are due to their ability to breed outside of their natural range, or if it is due to the continual release of the terrapins by humans. This study looks at the population size and structure of Red-eared Slider populations from a number of sites of different size, public accessibility and type of surroundings. Although

smaller in size, the publicly accessible water bodies had a higher concentration of sliders than the nature reserves and in all sites, the sex ratio was biased towards females. Other species of chelonians, some native, some alien and some of questionable status were also recorded. In the course of the study, individuals of native terrapins such as the Malayan Box Terrapin (*Cuora amboinensis*) as well as the Black Marsh Terrapin (*Siebenrockiella crassicollis*) were recorded within the nature reserves of Singapore, both of which are classified as "vulnerable" in the IUCN red list of threatened species.

Cameroon chameleons with special reference to species of international pet trade

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The collection of chameleons for the international pet trade is a growing issue in Cameroon whereas, little is known of their distribution and population biology. This work provides some preliminary data of the collection and exportation of chameleons in Cameroon between 2001 and 2003 based on field observations and discussions with local collectors. About 15 species and sub species of chameleons occur in Cameroon with the most heavily collected for the international pet trade found in the western forested part of Cameroon, particularly the southwest province. The most commonly traded species are: *Chameleo montium*, *C. pfefferi*, *C. wiedersheimi*, *C. quadricornis*, *C. oweni*, *C. cristatus* and *Rhampholeon spectrum*. The first four are mountain endemic and there are indications that the population of *C. quadricornis* has dropped around the Manengouba mountain. Interviews with local collectors indicate a post capture mortality rate of 25% in villages and attend a rate of 40% with export expatriates based in Cameroon during exportations due to poor conditions in over stocked cages. These animals are sold locally at \$2.5 each and attend prizes of \$90 to \$150 in Europe and America resulting to an increasing demand locally. Mountain endemic species were recently recorded around the chain of hills forming the boundary between the southwest and the northwest and need special attention for conservation as no collection has been noticed here. Chameleon collection contributes to the income stream of a number of people based in villages of the southwest Cameroon and ensuring the sustainability of collection will ensure long-term benefit.

Phylogeography and demography of Guianan harlequin toads (*Atelopus*): Diversification within a refuge

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We investigated the genetic structure of populations of Guianan harlequin toads (genus *Atelopus*) and their evolutionary affinities to extra-Guianan congeners. Phylogenetic analysis of mitochondrial cytochrome b (cyt b) and NADH dehydrogenase subunit 2 (ND2) gene sequences produced well supported clades largely corresponding to the four recognized taxa in the Guianas (*A. spumarius hoogmoedi*, *A. s. barbotini*, *A. franciscus*, and *A. flavescens*). Our findings suggest that the Guianan *Atelopus spumarius* represent a distinct evolutionary lineage that merit distinction from Amazonian conspecifics, and that the status of *A. flavescens* and *A. franciscus* is somewhat less clear. Approximately 69% of all genetic variation is accounted for by differences between these four recognized taxa. Coalescent based estimates of gene flow between taxa suggest that these lineages are largely isolated from one another with the exception of *A. franciscus*, which appears to be dispersing into the regions inhabited by (and hybridizing with) *A. flavescens* to the north and *A. s. barbotini* to the south. Asymmetric rates of migration between populations and significant divergence within such close proximity suggests that though the region inhabited by these taxa is almost entirely undisturbed, significant habitat heterogeneity has resulted in the diversification of *Atelopus* in the Guianan Shield.

More than one way to lay an egg: oviposition behaviour of the European newts, *Triturus vulgaris* and *T. cristatus*, on a range of substrates

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Female *Triturus* newts typically lay their eggs on broad-leaved macrophyte species. Little is known about oviposition substrate selectivity in newts and lists of 'preferred' plants for egg-laying are often based on anecdotal information. There is some evidence that females are selective about substrate but to fully understand the mechanisms of selectivity we needed to detail precisely how a female newt interacts with a substrate. Detailed behavioural observations of the oviposition sequence were recorded for female smooth and great crested newts on three different substrate materials (chosen for their structural differences and for ecological reasons). Watercress is a typical broad-leaved species on which all three British newts known to lay eggs; polythene strips, a neutral/inert material used for translocation/mitigation ponds; and *Crassula helmsii*, an alien invasive species with small, narrow, rigid leaves and a potential threat to newt populations. The two newt species differed significantly in key

elements of the oviposition sequence and handling of the substrates. Total number of eggs laid on each substrate over the test period differed significantly and differences in latency to hatching of eggs were also found. These findings are of important behavioural ecology and conservation interest.

Amphibians of Delta State, Nigeria

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A survey of amphibians of Delta State, Nigeria, an area prone to environmental pollution due to oil exploration was done between December 1998 and December 2000. The amphibians were categorised into four families of Anura order - Hyperoliidae, Ranidae, Pipidae and Bufonidae, twelve genera and forty species. The family Hyperoliidae had the highest species number of twenty-two in three genera; Ranidae had fourteen in six genera; Pipidae had two in two genera while Bufonidae had one genus and two species. The highest diversity of eighteen species was recorded at Otor-Udu, an area free from oil exploration presently. Seasonal variations were recorded in the collections. Due to problems of identification, eighteen species were only identified to the generic level while three are yet to be identified.

GSD and sex allocation in reptiles: an overlooked gold mine?

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Reptiles have become one of the most commonly used models for assessing adaptive evolution of temperature-dependent sex determination. Far less appreciated is, however, their usefulness for studies of sex specific genetic effects, most often due to sex-linked genes, and its potential role in driving the evolution of sex allocation tactics. Results from work on other taxa are substantial, but conflicting. In *Drosophila*, the Y-chromosome can be a hot spot for accumulation of mutations that contribute to male reproductive success, whereas in man, the Y-chromosome is evolutionarily self-destructing due to gene loss at a rapid rate. These are hard questions to study at an ultimate level. Many reptile species, however, may be the optimal models, from a mechanistic level under controlled lab conditions, to selection scenarios in the wild. To exemplify this, I report on work (with colleagues) on the Swedish sand lizard (*Lacerta agilis*). Our results show that offspring in crossings between males and females from two different sampling regions have 300 % higher malformation frequency and ten percent lower hatching success, with an increased risk of having inviable offspring at production of daughters. This is most likely because detrimental paternal alleles

on the Z chromosome are always expressed in the heterogametic sex (females are ZW, males ZZ). There are good reasons for predicting that similar, although less pronounced, effects should also occur within populations. Specifically, daughters should primarily be produced when mating with partners of high genetic quality with a minimal risk of expressing detrimental paternal alleles. This turned out to be the case. When females mate with genetically superior males, exhibiting high MHC Class I polymorphism, offspring sex ratios are biased towards daughters. Thus, reptiles may provide a key taxon for studies of sex-specific genetic pathologies and their effects on sex allocation evolution

Lizards as a model to study mechanisms of visual evolution and development

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Most lizards have excellent vision. Recent research in our group has shown that lizards are ideal research subjects for many aspects of visual function and development. In the talk, this will be shown for three aspects of visual function. (1) Visual optics. Research on chameleons revealed an unusual optical design of the eye with a lens of negative power. The unusual visual optics were functionally related to the specialized mode of prey capture in these lizards and helped to understand the principles of optical design in vertebrate eyes in general. Accordingly, we found similar trends in completely unrelated vertebrates (teleosts). (2) Evolution of binocular vision. Binocular image fuse is a prerequisite to achieve three-dimensional spatial vision (stereopsis). It can only be maintained if both eyes are moved in strong coherence. Chameleons are famous for their independent eye movements and seem to be far away from the requirements of stereopsis. A detailed study of eye movements, however, revealed that these lizards in fact switch between two modes of eye movements: both eyes are either moved completely independent from each other or, in the other case, in a coupled mode in which saccades are initiated simultaneously in the two eyes. This unique feature can be used to study evolutionary principals of binocular coordination in vertebrates (3) Neuronal development. Lizards as "cold-blooded" animals offer the advantage of to study neuronal tissues in an in vitro assay over days. We used this technique to study the development of a uniform population of retinal ganglion cells that projects to the accessory optic system in the brain. As will be shown in the talk, these cells provide an ideal model to study post-embryonal mechanisms of dendritic regulation and differentiation in the growing eye.

Metapopulation structure, nest-site fidelity, and conservation genetics of the Amazon river turtle *Podocnemis expansa* (Chelonia; Podocnemidae)

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The Amazon river turtle *Podocnemis expansa* is widely distributed across the Amazon, Orinoco, and Essequibo river basins in South America, and has served as an important source of protein to river peoples since pre-colonial times. Although once common, life history traits of *P. expansa* - large size, high fecundity, colonial nesting behavior, and potential long-distance movements between feeding and nesting areas - have made this species especially vulnerable to over-exploitation, and populations have been severely reduced or extirpated in many areas throughout the range. Freshwater species with large geographic ranges and potentially high vagility may or may not display genetically structured populations, depending on migration patterns within and between river basins, and nest-site fidelity of both sexes; when such species are in decline, it is important to evaluate population structure to implement conservation measures at appropriate spatial scales. This study reports on a range-wide evaluation of metapopulation structure and gene flow, based on 453 samples collected from 17 nesting beaches in Brazil, Colombia, Peru (representing the Amazon drainage), and Venezuela (the Orinoco basin); this sampling design permit analyses at a range of geographic scales. We use 9 microsatellite loci and 1343 bp of the mitochondrial control region, to discriminate between male- and female-mediated gene flow. Both data sets are analyzed by a variety of methods to gain from different properties of the data, and to avoid bias from the underlying assumptions of any single method. Nuclear loci reveal the distinctness of some river systems (Orinoco, Araguaia, Pimenteiras-Guapore), while mtDNA suggested restricted gene flow at least in the eastern part of the Amazon basin (the Araguaia sub-basin is clearly differentiated from all others). Most populations show genetic signatures for recent demographic bottlenecks, and we explore the conservation implications of these results, as well as the potential for forensic ID of some populations.

Conservation management of a threatened burrowing frog species

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The giant burrowing frog is a threatened forest dependent species from south-eastern Australia. Managing this frog in timber production areas is a

priority, but the information to do so has been poor. We undertook a comprehensive study of the biology species based around radio-tracking 33 individuals between December, 2001 and April 2004. Individuals spent a greater than 99% of the time more than 50m from the breeding sites. Males were on average significantly closer to the breeding site than females ($p=0.0270$). Individuals all showed specific, apparently non-overlapping home ranges (mean 307 m²) and burrowed an average of only 10 cm below the ground. Fire and compaction by vehicles during logging operations appeared the greatest threats to an individual's survival. Testing prescribed burns indicated that temperatures at depths greater than 5 cm are unlikely to represent a major threat. However, assessments of depth and area disturbed by logging machinery suggest that this may be a significant threat. We suggest that conservation is best achieved through the protection of core sites from logging disturbances.

The influence of fragmentation and selective logging on reptile communities in a Western Madagascar dry forest

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Madagascar is one of the world's most important biodiversity hotspots and faces tremendous habitat destruction. While most public awareness focus on the destruction of rainforests, southern and western Madagascar's dry forests face equal or even higher destruction rates. Ecological demands of the highly endemic reptile fauna remain largely unknown. However knowledge of mechanisms structuring reptile community composition in pristine and altered forests might be crucial to predict and eventually prevent biodiversity loss. We conducted a four-month field study on reptile community composition in Kirindy forest, Madagascar's largest remaining area of highly seasonal western dry deciduous forest. To investigate reptile assemblages we established a total of 31 plots (25 x 25 m each) during the 2003 rainy season. Habitats ranged from pristine to selectively logged and fragmented forests. Reptiles were searched visually during day and night (total of 365 man/hours). In addition we compiled trapping data, using pitfall (1824 trap/days) and funnel traps (1041 trap/days) to complete species inventory lists. Study sites differed in their habitat characteristics. We used a total of 21 habitat variables to investigate patterns of reptile species occurrence, association, and abundance (32 reptile species recorded). Using different ordination methods, we identified several important habitat parameters (e.g. leaf litter thickness, stem density) that predicted reptile community composition. All results are discussed in the context of recent threats and conservation efforts in the Kirindy forest (Menabe region).

Morphology, mtDNA and subspecies in *Lacerta perspicillata*

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Lacerta perspicillata (Duméril and Bibron, 1839) is a small lacertid endemic to NW Africa. It is distributed along NW Morocco to N Algeria, and has also been introduced in Menorca (Balearic Islands, Spain). The systematics of this species appears complex. An early alpha-taxonomy study described three different subspecies, *L. p. perspicillata*, *L. p. chabanaudi* and *L. p. pellegrini*, based on external characters although doubts have been expressed as to their validity. A preliminary mtDNA study showed that the subspecies designations did not correspond to haplotype groupings, and suggested that *L. perspicillata* was a species complex. We carried out a detailed analysis of both morphology and mtDNA in *L. perspicillata* from five different localities of Morocco and one in Menorca representing all subspecies. Our goals were to test the validity of the current subspecies based on colour pattern and morphology, and to assess the concordance between morphological differentiation and mtDNA lineages. Multivariate analyses were carried out on seven body measurements, two scalation characters and seven colour pattern variables. The relatively rapid-evolving ND4 region of the mtDNA was amplified and then sequenced for a subsample of individuals. A restriction endonuclease was applied to the ND4 fragment to assign the remaining individuals to clades. The morphological differentiation was generally concordant with the subspecies designations, although some additional differentiation was also detected (e.g., individuals from Oukaimeden). The existence of two highly divergent mtDNA clades was confirmed: one included *L. perspicillata* from Menorca as well as individuals assigned to *L. p. chabanaudi* from a site in N. Morocco (Taza) at which *L. p. pellegrini* was also present. The other clade included individuals from all three subspecies. This similarity showed no evidence of monophyly of subspecies previously described, except for *L. p. pellegrini* (from Taza population and the Caves of Chiker). We discuss possible explanations of the observed patterns including mtDNA introgression and ecophenotypic convergence.

The problem of modality

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Many authors have recognized two basic modes of foraging, commonly called "sit-and-wait" (SW) or "sedentary" and "widely foraging" (WF) or "active". This dichotomous view posits that the two strategies are highly distinct and characterized by a suite of differences, such as locomotor performance,

thermoregulatory behavior, morphology, and sensory capabilities. Many of the lizard species first studied appear to fit this model quite well, lending it support, predictive power, and early acceptance. However, not all species fit the model. Moreover, since the terms SW and WF were not originally quantitatively defined, some confusion has emerged and some species have been assigned to different modes by different authors reporting similar behaviors. Alternative views have been proposed over the years to better account for the growing amount of data. These include trimodality and a continuum of foraging modes. Recent examinations of large datasets, using both traditional approaches and phylogenetic analyses, support a view of common foraging parameters as continuous, rather than bimodal. However, the bimodal view remains conceptually attractive and frequently assumed. I will discuss the ongoing debate regarding the presence or absence of modality in foraging behavior, particularly in light of phylogenetic analyses showing that lizard foraging behavior is often conservative.

Moving to be seen: signal design in an Australian agamid lizard *Amphibolurus muricatus*

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Movement-based animal signals are ubiquitous. They are used in a variety of contexts including opponent assessment, female mate-choice, pursuit deterrence and alarm signaling. Lizards have proved to be very useful model systems for understanding the design and function of this class of signals, particularly in the context of opponent assessment. As demonstrated in other signaling modalities, a detailed understanding of signal structure provides important groundwork for explorations into signal design, and further insight into other aspects of the animal's ecology. Using the territorial display of a native Australian agamid lizard (*Amphibolurus muricatus*) as a model system, I have combined analyses of signal structure with playback experiments to identify the likely constraints that have shaped the design of this signal. The display typically begins with a tail-flick and is followed by four distinct motor patterns delivered in an obligatory sequence. As effective communication requires efficient detection, I concentrate on understanding why the tail-flick motor pattern is used as a putative alerting component rather than any of the other motor patterns. Structural conspicuousness of all but one motor pattern is illustrated through quantitative analyses of lizard displays and background plant movement at the same distance, suggesting that conspicuousness alone is not sufficient to explain fully the design of this signal. A series of playback experiments incorporating 3D animations were conducted to identify the relative importance of various signal attributes on the probability of detection including the speed of movement, as well as the duration and 'active space' of the signal. Results are

discussed in terms of a trade-off between signal efficacy and cost to the signaler.

Adders in the African landscape: site fidelity and seasonal movement

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Wherever they are found snakes are seldom randomly distributed throughout a landscape, even where the general habitat appears to be uniform. Widespread species such as the European Adder, *Vipera berus*, are often described as habitat generalists, but field studies have shown that even this abundant species exhibits specific habitat requirements. Concealment and thermoregulation are key component parts of a snake's lifestyle, and this is reflected in the nature of the topography, vegetation structure and microclimate of the habitat. In temperate regions it is well known that snakes can often be found in notable aggregations at winter dens, which represent a high degree of site fidelity where such sites can be described as traditional. Typical examples are the rattlesnakes, *Crotalus horridus* and *C. viridis*, and also the European Adder. These, and other species, may occupy different habitat types during the annual activity cycle. Movement may be linked to mate-searching, foraging and feeding, or both. In more dynamic habitats movement may be a result of population shifts due to negative influences, such as fire, flooding or human disturbance. A long term study of the European Adder has shown that population structure consists of a number of sub-populations within a general population, and that individual snakes show a high degree of site fidelity. Currently, there is little knowledge as to how African Adders are distributed over a given area. Initial field studies have shown that a number of species of *Bitis* exhibit a degree of site fidelity. Female Gaboon Adders, *B.gabonica*, in KwaZulu-Natal were found to be remarkably sedentary and occupied the same localised area for at least two years. Small groups of Berg Adders, *Bitis atropos*, were found in the Kwazulu-Natal Drakensberg, and a number of individuals were recaptured at the same location the following year.

Impacts of introduced herpetofauna species on the Northern U.S. Virgin Islands

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Island ecosystems are highly sensitive to the impacts of introduced species. Non-native invasive snakes, lizards, and amphibians can introduce diseases into native populations, and have other deleterious effects through predation, competition, and habitat manipulation. The U.S. Virgin Islands are situated on the Puerto Rican Bank in the Caribbean Sea and have

a long history of human impacts and species introductions. Two species, the Green Iguana (*Iguana iguana*) and the Red-legged Tortoise (*Geochelone carbonaria*) were historically introduced and have become naturalized with little apparent impact to the local ecosystem. Recent years, however, have seen the introduction of several highly invasive species that have proved to have severe impacts when introduced elsewhere, specifically the Cuban Treefrog (*Osteopilus septentrionalis*), Cane Toad (*Bufo marinus*), and the Red-eared Slider (*Trachemys scripta*). Here we report on the distribution of exotic reptiles and amphibians across the islands of St. John, St. Thomas, and outlying cays; identify potential routes of introduction and dispersal; and discuss the implications of the introductions on the native species of herpetofauna.

A phylogeny for *Dendroaspis* (Elapidae), according to mitochondrial DNA and toxin amino acid sequence data

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Mambas are among the most notorious and widely known venomous snakes. However, at the scientific level, research interest in these snakes has been almost entirely focused on venom toxins, with little or no attempt to elucidate their phylogeny. Here we present the first comprehensive mitochondrial phylogeny for *Dendroaspis* using fragments of the cytochrome b and NADH dehydrogenase subunit 4 genes. The topology of the mtDNA is congruent with the species tree extracted from a 3-finger toxin gene tree, using gene tree parsimony, although support for the latter is weak due to limited toxin sample size. The four species exist as strongly supported monophyletic lineages in the tree, with *D. angusticeps* as a sister taxon to *D. polylepis* in one clade, and *D. jamesoni* with *D. viridis* in a second clade. The subspecies *D. j. kaimosae* and *D. j. jamesoni* form each other's sister lineages, but the low pairwise divergence between them (2.2-2.8%) suggests these lineages are not sufficiently differentiated to warrant recognition as separate species. Divergence (1.6-2.4%) was also very low in *D. polylepis* over a wide geographical range, from South Africa through to Kenya. In contrast, unexpectedly high levels of divergence (5.2%) were noted in *D. angusticeps* from Tanzania and Mozambique. These results are interesting since geographic variation has previously been noted in *D. polylepis*, but never in *D. angusticeps*, and suggest that multiple cryptic lineages might exist within *D. angusticeps*.

Amphibian diversity in Eastern Tanzania: a study in complexity

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The amphibian fauna of eastern Tanzania illustrates the complexities of estimating biodiversity. "Diversity" is usually taken to be synonymous with species richness, which begs the question of what may be understood by the term "species" in the first place. There is both the theoretical difficulty of definition, and the practical difficulty of diagnosis caused by clinal and other variation. An example is given of clinal variation in the case of *Arthroleptis affinis*. Diversity is not an absolute measure, being dependent, among other factors, on choice of the geographical extent and the ecological complexity of areas under investigation; this complicates the comparison of diversity values taken from different areas. These complexities are illustrated by an ongoing attempt to estimate amphibian diversity on the Eastern Arc mountain chain in Tanzania and on the adjoining coastal lowland. Most amphibian species in this region occur on the coastal lowlands and are widely distributed, extending at least north or south of Tanzania and west to the inland plateau. Diversity along the length of the lowlands shows complexity, with a fragmentation of species ranges according to available breeding sites, and the presence of a Sahelian element in the extreme north. Marked species turnover from lowland to upland is shown on the Eastern Arc slopes, with some taxonomic differences suggesting a long-standing divergence between montane and lowland faunas, characterised respectively by cool temperate relicts and lowland tropical generalists. On the Eastern Arc chain, taxonomic changes associated with rising altitude are far greater than changes associated with latitudinal distance, as is shown by a comparison of the fauna of the isolated East Usambara, Uluguru and Udzungwa mountains with the lowland fauna. Despite over a century of investigation, it can be expected that the current perception of geographical and taxonomic diversity shown by amphibians populating eastern Tanzania is still an underestimation of what may turn out to exist.

Phylogenetic relationships within Xantusiidae: using trees to address evolutionary questions at multiple levels

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The lizard family Xantusiidae contains three genera confined to North America, including *Cricosaura* (single species in Cuba), *Lepidophyma* (~18 species in Central America), and *Xantusia* (~10-12 species in southwestern North America). Phylogenetic placement

of this family is one of the most intriguing (and refractory) questions in the study of squamate evolution. Results of several prior analyses have recovered at least six different sister group relationships for the Xantusiidae within Squamata, but all previous studies have been based on limited taxon and population sampling within the family. Limited sampling may confound the ability of phylogenetic algorithms to accurately reconstruct ancestral character states, making the clade hard to resolve in the context of squamate evolution. Resolution of relationships within Xantusiidae, based on extensive sampling, should overcome these limitations and allow researchers to answer fundamental questions about the early radiations of ancestral character states among squamates. Moreover, a well-resolved hypothesis of relationships will allow a rigorous test of the hypothesis of a possible non-hybrid origin for the unisexual taxa (e.g., *Lepidophyma reticulatum*, and southern populations of *L. flavimaculatum*). The Xantusiidae also represent a model system with which to investigate adaptive radiation and the geography of speciation in response to invasion of distinctive rock crevice and tree trunk ecological niches. To explore relationships within Xantusiidae, we are collecting several classes of molecular markers, including more than 3kb of sequence data from multiple mitochondrial and nuclear markers. Our preliminary data include more than 130 individuals spanning virtually all currently recognized species of xantusiid and a diverse sampling of basal Scleroglossans. Our datasets were analyzed both separately and in combination with Parsimony, Maximum Likelihood, and Bayesian methods. We present phylogenetic relationships of this family, and discuss its placement among extant squamates.

Elevated corticosterone concentration affects thermoregulatory behavior and raises metabolic rate in the New Zealand common gecko, *Hoplodactylus maculatus*

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Previous research suggests interrelationships between plasma corticosterone (CORT) concentration and thermoregulation in reptiles (e.g. positive correlation between CORT concentration and field body temperature (Tb) in the New Zealand common gecko, *Hoplodactylus maculatus*). Here, we tested the hypothesis that elevated CORT affects thermoregulatory behavior so as to increase Tb. We implanted CORT (0.5 mg dose) or placebo pellets into non-pregnant female geckos, and measured Tb of animals in their home cages 5 and 19 days later. Additionally, we measured Tb in a thermal gradient (range = 12-37 °C) over an 18 hr period (0800, 1400, 2000, 0200 hrs), 6-7 days after surgery. Beginning 6 days later, we measured rates of resting oxygen consumption at 10 and 25 °C. Basking frequency of

experimental geckos in their home cages was significantly higher than that of placebo geckos. Body temperatures of experimental animals in their home cages were significantly higher than those of placebo animals on Day 5, but not Day 19. Repeated measures ANOVA indicated a significant effect of time, but not treatment or a treatment * time interaction on Tb selected in the thermal gradient. At one time period (0800 hrs), Tb of experimental animals was significantly higher than Tb of placebo animals. We found significant effects of temperature and treatment on rates of oxygen consumption. Animals at 25 °C and those with CORT implants consumed oxygen at significantly higher rates than animals at 10 °C and those with placebo implants. Thus, there appears to be a metabolic cost associated with elevated CORT in this species. Interactions between CORT and Tb may be of broad significance in terrestrial ectotherms, and variation in CORT levels should be considered as a variable in future studies of thermoregulatory behavior.

Amphibian and reptile road kills: importance, frequency, mitigation measures

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The importance of road kill has been recognised at the end of the 20th century with many animal groups. As fragmentation due to transport infrastructure is rapidly growing in many parts of the world, this topic is getting more and more into the focus of conservation-oriented investigations. Decline, local disappearance, unequal sex ratio, growing genetical distance in the vicinity of busy roads and changing behaviour such as avoidance are some of the effects, which have been recorded in connection with roads. Amphibians proved to be the most frequently run over vertebrates on roads in different continents even if their proportion is often underestimated due to low detectibility caused by low retention time and small size in comparison with the other taxa. The relative frequency of amphibian road kill often reaches 90%, while reptile road kill remains under 10%. Under arid conditions or at special crossing sites, however, reptiles, such as female terrapins during egg-laying migration, their hatchlings on the way to the freshwater habitat or aquatic snakes during their migration to find hibernation sites, also die in large numbers. The frequency of amphibian and reptile road kill was reasonably lowered at a number of sites with mitigation measures of different design usually consisting of fences and tunnels. Besides providing corridors, large constructions, such as game bridges also function as habitats e.g. for lizards. The use of mitigation measures by amphibians and reptiles is needed to study further, as well as efforts should be made to construct more passages or alter existing structures in the future to lower habitat fragmentation along transportation infrastructure.

Bigger boys at the top during breeding: influence of size, sex and reproductive phase on perching behaviour in tropical rock lizard, *Psammophilus dorsalis*

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Perching behaviour was studied in a population of rock lizard, *Psammophilus dorsalis* in the field (Hampi, Karnataka, India) in relation to sex, body size and reproductive phase. Adult lizards (n=14 males and 16 females) were captured and marked by toe clipping during November 2001. They were observed at intervals (n=10 times) over next 18 months encompassing post-breeding (December-early March), recrudescence (late March-April) and breeding (May-October) phases. In the post-breeding phase, males perched at significantly lower height. They started occupying higher perches during recrudescence phase reaching their highest points in breeding phase compared to the post-breeding perches. Females also exhibited similar pattern but they moved within a narrow range of heights. The males occupied higher perches than females at all times. However, the males exhibited greater among individual variation in their perch heights unlike the females. Interestingly, among the males, bigger individuals perched at greater heights compared to smaller ones in both recrudescence and breeding phases. No such trend was evident during the post-breeding period when the perch heights overlapped regardless of their sizes. In females, unlike males, there was no size specific perch selection in any phase of the reproductive cycle. These patterns clearly suggest that reproductive activity is an important factor determining differential perch utilization between sexes, males selecting higher perches possibly for territory defense and advertising their presence to conspecifics. Further, size specific perch selection in males prior to and during breeding period suggests that size via-a-vis age, and reproductive experiences may also influence perch height in males.

Placental transfer of nutrients during gestation and ultrastructure of the placenta in *Mabuya mabouya*

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New World skinks of *Mabuya* genus exhibit the most specialized allantoplacenta among squamates (type IV), and the greatest degree of placentotrophy known in Reptilia. They ovulate microlecithal eggs (1-2 mm) that lack of fatty yolk platelets; thus, it is suggested that virtually all of the nutrients for embryonic development are obtained by placental means. To test this inference we quantified the net uptake of nutrients during gestation of *Mabuya mabouya* and study the ultrastructure of placental tissues related to the histotrophic transfer of nutrients. There is a significant net uptake of water, ions (calcium, potassium, sodium, magnesium), lipids, nitrogen (an index of protein), and dry matter during development. The observed cytological features of the uterine and extraembryonic membranes during the sequence of placental development (bilaminar yolk sac placenta; chorioplacenta; allantoplacenta) show that all placentas are highly specialized for nutrient absorption from early developmental stages. However, at the last stages of gestation, when allantoplacenta is developed, the transference of nutrients to the embryo is highest, correlated with the greatest specialization for histotrophy (placentome, paraplacentome, chorionic areolae, and absorptive plaques). Also, there are respiratory segments at the abembryonic hemisphere. They are sites with attenuate epithelial cells and close vascular apposition. The interhemal diffusion distance is minimal; however, neither the chorionic epithelium nor the uterine epithelium undergoes erosion during development. Correlations between ultrastructural placental features and net uptake of nutrients, and comparative analyses with other matrotrophic scincid species, other viviparous and oviparous lizards, and therian mammals permit to generate hypotheses that relate function and structure. In the evolution of placentotrophy in New World *Mabuya* the relative reduction in the contribution of lecithotrophic nutrients to the embryo is related to the drastic reduction of the egg size, an obligatory placentotrophy from early developmental stages and the highest placental complexity known in Reptilia.

Phylogeography of the *Eremias persica* complex of the Iranian plateau

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The lacertid genus *Eremias* (sensu stricto) Fitzinger, 1834, as a palearctic clade, encompasses 5 subgenera and about 32 species (Szczerback, 1974, Anderson 1999). It has a wide distribution range. Various species of this genus are distributed from southern Europe to the Iranian plateau and eastward in to the central and northern Asia as far east as Mongolia and Korea (Szczerbak 1974, Arnold 1986, Anderson 1999). However the knowledge of the Iranian plateau

Eremias is, to a great extent, anecdotal and there are still large gaps in available material from various parts of the plateau (N.Rastegar Pouyani and G.Nilson 1997). The Persian racerunner *Eremias persica* Blanford, 1875 is a widespread Iranian species of the typical subgenus *Eremias*, inhabiting quite different biotopes in a large territory from lowlands and open plains of the southeast of the plateau up to highlands of the northwest with more than 2800m elevation. As a part of our long term study on phylogeography of Iranian lacertid lizards, the whole mitochondrial cytochrome b gene (1143 bp) from 152 different individuals from 10 different populations which originate from the whole of the Iranian plateau were sequenced and analyzed, as well as in each individual up to 40 external morphological characters were measured and analyzed. Different populations of *Eremias persica* display notable levels of genetical and morphological variability, although there is a high degree of congruence between the morphotypes and the genetical variability but few exceptions are identified. Hypotheses to explain genetic variation and the causes for some discrepancies between data sets, as well as subspecies differentiation and phylogeographic hypotheses will be discussed.

A new form of *Trapelus* (Sauria: Agamidae) from Southern Iran

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The ground-dwelling gamid lizards of the genus *Trapelus* Cuvier, 1816 are currently recognized by 10-14 species distributed from north Africa into the Middle East region and as far east as eastern Kazakhstan and western China. At least four species of this genus occur on the Iranian Plateau as follows: *Trapelus agilis* (Olivier), *T. ruderatus* (Blanford) (=the Traditional *T. persicus*), *T. lessonae* (De Filippi), and *T. megalonyx* Gunther. Based on extensive and long-lasting study and field work in various regions of the Iranian Plateau, a new form belonging to the genus *Trapelus* Cuvier, 1816 is discovered. From morphological (multivariate statistical analysis) and preliminary molecular (mitochondrial DNA sequencing) perspectives, this new form (which is awaiting a new taxonomic name) is intermediate between *Trapelus agilis* on the one hand, and *T. ruderatus* (= the Traditional *T. persicus*) on the other. The new form of *Trapelus* was recorded during a long-term field work in southern regions of the Iranian Plateau in Fars Province. From geographical point of view, the range of the new mentioned form of *Trapelus* is located between the ranges of *Trapelus agilis* in the east and *T. ruderatus* (= the Traditional *T. persicus*) in the west. Based on all the available evidence, the newly discovered form is either the result of hybridization between the two above-mentioned species of *Trapelus*, or a new and distinctive species.

Both alternatives are feasible. Furthermore, taxonomy and distribution of the Iranian Plateau species of *Trapelus* are discussed and distribution maps for all these species are provided.

Ranging behaviour in the smooth snake, *Coronella austriaca* Laurenti

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The ranging behaviour of individual smooth snakes *Coronella austriaca*, was studied using capture-recapture of PIT-tagged animals, as part of an ongoing individual based study of a population of smooth snakes in southern England (1993-present). Although a small number of individuals, mainly males, moved widely within the study area, most did not, and demonstrated a high level of site fidelity to small areas of heathland both within and between years. Analysis of the monthly mean distances moved by individuals showed that adult males ranged significantly greater distances ($\approx 65\text{m}$) than adult females, sub-adult males and sub-adult females ($\approx 35\text{m}$), in all months except May, when mating occurs. Although the distances moved by males were shortest in small individuals and longest in large individuals, there was a trend for a step increase in the amount of ranging behaviour at a body size equivalent to the onset of sexual maturity. No similar size related correlation was found in females. The overall range size of 110 individuals was analysed using Cluster analysis (Ranges6 software). A highly significant difference ($P = 0.013$) was found between the mean range size of adults males (0.1285 ha, SD = 0.1667 ha, $n = 27$) and sub-adult males and all females (0.0649 ha, SD = 0.0912 ha, $n = 83$). Data will also be presented (currently under analysis) showing the relationship between individual male and female breeding success and ranging behaviour/range size.

Ecology and conservation of endemic *Boa constrictor* in the Cayos Cochinos, Honduras

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Insular snakes are increasingly held up as model systems for investigations of evolutionary shifts and/or plasticity in body size, and their typically high densities may offer high returns on sampling effort relative to mainland populations. Some insular snakes are of conservation concern because their often unique appearances and divergent body sizes make them highly desirable in the pet trade. During July-September 2004, we initiated a long-term study of insular-endemic *Boa constrictor* in the Cayos Cochinos, an archipelago off the north coast of Honduras. Due to their small size and attractive pattern, these snakes

were heavily exploited for the pet trade during the 1980's, and we estimate that >10 boas/ha were removed from the islands during this time. Fieldwork was primarily pursued on Cayo Menor (the smaller of the two main islands in the archipelago, which is protected as a biological reserve), with additional sampling on Cayo Mejor (the largest island, with a permanent human population). We captured 84 *B. constrictor* during our fieldwork on Cayo Menor, with snout-vent lengths ranging from 64cm to 205cm. Low capture rates on Cayo Mejor suggest that this population has been depleted by exploitation for the pet trade. Results of a radiotelemetric study of four boas indicate that snakes are highly arboreal and make extensive use of tree cavities as refugia. Most boas were captured in oak hill forest, and only one boa contained a prey item. Overall, our results suggest that these boas largely subsist on migratory passerine birds in the spring and fall, and that the summer months represent a period of low prey availability and moderate water stress. Continuing arrests of snake smugglers indicate that exploitation of these boas continues, and that Cayo Menor may be the only sanctuary for this unique population in the long term.

Habitat use and hibernaculum characterization of neonate Blanding's turtles: A multi-generational radio-telemetry study in Minnesota, USA

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The ecologies of the juvenile life stage of many turtle species are poorly understood, despite the importance of this life stage in chelonians. Young turtles often display different habitat use and behavior compared to adults, and techniques used to study a turtle species may therefore be biased against detection of juveniles. The ecology of adult Blanding's turtles, *Emydoidea blandingii*, has been well-documented, but most studies have encountered very few hatchlings and little is known about their habitat use, behavior, or abundance. The Blanding's turtle is a declining species; therefore it is critical to understand and include the ecological requirements of all life stages in conservation efforts. We used radio-telemetry to identify nesting sites and track neonates from nest emergence to hibernaculum entrance. Adult female Blanding's turtles from a population in Scott County, Minnesota, U.S.A. were radio-tracked intensively throughout the 2004 nesting season to locate nests. All females nested after dark, and many nested in grasslands far from trails or roads, making it extremely unlikely that their nests would have been detected in the absence of radio-tracking. Immediately following nest completion, wire cages were erected around nests to exclude predators and trap hatchlings upon nest emergence. Neonates from nests in various habitat types were fitted with radio transmitters immediately following nest emergence, and were radio-tracked for three weeks. Neonates

traveled in a fairly straight line from their nest site, and traveled for 2-15 days before entering a hibernaculum. The number of days a neonate traveled before entering hibernation was correlated with the date of nest emergence; neonates that emerged later traveled for fewer days before entering hibernation. Neonates preparing to hibernate buried themselves in moist soil in various habitat types, including tallgrass prairie, mesic grassland, and emergent wetland edges.

Climate change affects leatherback reproductive schedule and population viability

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Leatherback turtles nesting on the Pacific coast of Costa Rica have been tagged since 1993 to allow identification of individuals every time they come to nest. In late 1997 to mid 1998 there was a major shift in Pacific Ocean climate from warm El Niño conditions to cool La Niña conditions that resulted in a dramatic increase in oceanic productivity. In the nesting seasons of 1999/2000 and 2000/01 many more turtles nested than had been expected, more turtles remigrated from a previous nesting season than in other years, and the reproductive schedule of individual turtles was changed following the transition from El Niño to La Niña conditions. The results indicate that turtles benefited from increased oceanic productivity to regain reproductive condition more quickly so that they remigrated sooner. Modelling of the data shows that the survival rates required for viability of the population are lower in La Niña conditions and higher in El Niño conditions and that climate has a major influence on leatherbacks in the Pacific. This is the first reported instance of data that shows the effect of climate-driven variation of oceanic conditions on specific individual marine animals that changes their reproductive schedule and population viability.

The impact of pesticides on amphibian communities

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Growing concerns over amphibian declines have caused biologists to work on identifying the causes. In some cases the causes are obvious while in other cases they are more enigmatic. Pesticides appear to be playing a role in at least some declines and our knowledge of pesticide effects on amphibians is still in its infancy. In this talk, I present results from the past five years of work in which we have been examining the impacts of pesticides on amphibians under both laboratory and mesocosm conditions and ranging from single-species toxicology experiments to whole-community ecotoxicology experiments. It is clear from

this work that pesticides can affect amphibians through a wide variety of direct and indirect pathways, many of which are only observable when tested in a whole-community context. These data suggest that pesticides indeed can have substantial direct and indirect effects on amphibians that can lead to both negative and positive effects on amphibian populations.

Temperature-dependent sex determination in a viviparous lizard: what role do hormones play in sex determination?

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The discovery of temperature-dependent sex determination in the Australian viviparous lizard, *Eulamprus tympanum* presented an outstanding opportunity to relate the hormonal environment of the developing embryo with incubation temperature and investigate changes in maternal circulating hormones throughout gestation. Incubation temperature has been demonstrated to affect sex steroid hormones in the yolks of some oviparous reptiles with TSD that play a role in sexual differentiation and determination, but nothing is known about the hormonal environment experienced by developing embryos in the viviparous lizard *E. tympanum*. We collected yolk at several stages throughout development from females maintained at either a predominantly male producing temperature (30°C) or at a mix sex producing temperature (20°C). Blood was also collected from females to measure circulating maternal hormone levels throughout gestation. The embryos were staged and the yolk and plasma frozen until assay. Measurement of androstenedione, dihydrotestosterone, estradiol and testosterone in both yolk and plasma samples was accomplished by extraction, followed by column separation, and individual hormone fractions were quantified via RIA to determine any temperature effects and correlations between yolk and circulating maternal plasma.

Developmental patterns of Mesozoic pipid frogs and problem of Pipidae-Palaeobatrachidae relationships

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Except for *Vieraella* and *Notobatrachus* from the Early and Late Jurassic, respectively (representing the earliest anuran fossil record in Gondwana), and *Baurubatrachus* from the Late Cretaceous of Brazil, all

other Mesozoic anurans from southern hemisphere bear distinct pipoid features. Besides fossil record represented by adults, several series of pipoid tadpoles were found in the Lower and Upper Cretaceous strata of Israel and South Africa (*Shomronella*, *Thoraciliacus*, undescribed pipid from Stompoor), covering to various degree their larval and metamorphic development. These developmental series were compared with *Palaeobatrachus* tadpoles from the Late Oligocene of the Czech Republic which are the most representative series of fossil tadpoles ever found. Based on larval and adult anatomy, Pipidae and Palaeobatrachidae are generally considered closely related to each other but this view is doubted by some anatomical, biostratigraphical and palaeogeographical facts. The most important anatomical difference is the shape of vertebral centrum (procoelous in *Palaeobatrachus*, opisthocoelous in all Pipidae). However, close examination of developing vertebral centra in *Shomronella* revealed that although it ultimately developed in the opisthocoelous shape, it passed a stage from which it could potentially evolve in a procoelous condition. This may support an idea of a common origin of pipid and palaeobatrachid lineages. Another interesting feature is that early pipoid tadpoles have their ribs provided with uncinat process, which is generally considered a discoglossoid feature. This is why it may be supposed that early larvae of Cretaceous pipids (illustrated by *Shomronella*) and early larvae of Mesozoic discoglossoids (not preserved as fossils, but their anatomy may be inferred from adults) bore similar anatomical features. Later, during the Cainozoic, some of these characters could be maintained in one lineage (e.g., uncinat ribs in discoglossids), whereas they could be lost in the other.

Unusual features of the head anatomy in the discoglossid frog *Barbourula*

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Barbourula is a very poorly investigated discoglossid anuran which occurs in the Philippine Islands (*Barbourula busuangensis*) and Borneo (*Barbourula kalimantanensis*). Its development is unknown. Available information on its skeletal morphology is based on several dry skeletons, cleared and stained skeletons, and radiographs (Clarke 1987). Therefore we decided to investigate the head anatomy of 5 years old individual by means of the serial histological sections from which a computer-aided reconstruction of the skull was produced. The study revealed several peculiar features previously unreported not only in the Anura but in all modern Amphibia. The most remarkable is a pair of muscles stretching above the skull roof from the level of the nasals, along the frontoparietals, up to the otic region. Although these muscles are well developed, their function remains obscure. Another pair of muscles is stretched antero-

posteriorly underneath the otic section of the braincase. The anterior part of the braincase inserts between the nasal capsules, so the olfactory canals are directed laterally, similar to praemetamorphic larvae of *Ascapbus*. The skull is remarkably hypoossified, although the investigated specimen was undoubtedly an adult. We also investigated detailed anatomy of the middle ear; although the tympanal system is covered by skin it is complete (in contrast to *Bombina* to which *Barbourula* is supposedly closely related). We believe these new anatomical data on *Barbourula* may contribute to clarify its phylogenetic position.

Frog species richness and composition in coastal Brazilian restinga habitats

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We studied the species richness and composition of frogs in ten restinga habitats (sand dune environments dominated by herbaceous and shrubby vegetation) along approximately 2000 km of coast of three Brazilian States: Rio de Janeiro (Grumari, Maricá, Massambaba, Jurubatiba and Grussaí), Espírito Santo (Praia das Neves and Setiba) and Bahia (Prado and Trancoso). All areas were surveyed under similar sampling effort in the wet season to eliminate differences among areas due to seasonal effects. At each area, the survey involved a total of 80 h of search (20 man/hours), using transects with active search in the different microhabitats available and by dissecting 200 bromeliads. We found 28 frog species belonging to the families Hylidae, Microhylidae, Leptodactylidae and Bufonidae. The richest restinga was Praia das Neves, where we found 13 frog species, followed by Grussaí and Trancoso in which 8 species were found. The commonest frog species in the restingas was *Scinax alter* (found in eight restingas), followed by *Aparasphenodon brunoi* (seven areas). The frog fauna along restinga habitats was significantly nested (matrix community temperature = 26,13°; $p=0.00705$) with Praia das Neves being the most hospitable area for the frogs. Our data shows that richness and composition of frog communities tend to vary consistently in restingas along eastern Brazilian coast. Also, frog faunas in restinga areas occur in a nested pattern in which the current frog assemblage of each area partially seems to represent a nested subset of the original assemblage. This, in part, probably results from the intensive fragmentation of restinga habitats. Our data also showed that the most hospitable restinga was Praia das Neves and this area must be protected as a conservation unit. Probably, many frog species may have been lost in some studied areas as a result of the extensive degradation under which restinga habitats presently are.

Diversity of reptiles in the Comoro islands: a phylogeographic analysis

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After the separation of Madagascar from Africa, the volcanic chain of islands situated between was formed, during the Miocene to the late Pleistocene, and has been colonized by the flora and fauna of both Africa and Madagascar, which were already differentiated. We examined some groups of reptiles from the Comoros, using analysis of DNA sequences, and including samples from Madagascar and Africa for more widespread taxa. Our aim was to study the relationships and level of differentiation between the populations from different islands and from the mainland and also to assess the direction and number of colonization events. This would help to clarify their taxonomy, identify possible recent introductions and enable conservation plans to be established. We analyzed the variation within chameleons of the genus *Furcifer*, *Cryptoblepharus* skinks, and *Hemidactylus* geckos. Both species of *Furcifer* seem to have independently colonized the Comoros, from Madagascar, and also the presence of *Cryptoblepharus* in these islands is explained by at least two colonization events, one of them from Madagascar, with a third one, also from Madagascar, giving rise to the African populations. Concerning the *Hemidactylus*, the Comoro islands are inhabited by the same three species that occur on Madagascar, *H. mercatorius*, *H. platycephalus* and *H. frenatus* and by a fourth one, *H. brooki*. Although *H. platycephalus* is by far the most abundant species on these islands, and its presence may be due to a natural colonization from Africa. *H. mercatorius* is the species that exhibits more genetic variation, pointing to a natural and ancient colonization of at least one of the islands, Mayotte, from Madagascar. Apparently introduced individuals of *H. mercatorius* from Western-Central Madagascar were also detected, that can have serious conservation implications. *H. frenatus* and *H. brooki* are the least abundant species in the Comoros: individuals from *H. frenatus* are closely related to the Malagasy ones and *H. brooki* occurs at least in Moheli and Anjouan, with individuals from the Mascarenes islands being the most closely related to them.

West African amphibian diversity: much higher than predicted

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Whereas the West African amphibian fauna was thought to be well known until the late 80s of the last century, more recent investigations dramatically

changed this view. More detailed investigations revealed taxonomic difficulties in almost all groups of frogs. Numerous species new to science have been discovered since the early 1990s and many more species still await description. This is especially true for the western part of the Upper Guinean rainforest that, concerning amphibian diversity, therewith ranks as one of Africa's "hottest" hotspots. The talk focuses on these new findings and their taxonomic, zoogeographic and conservation implications.

Latitudinal variation in sex ratio in a turtle with TSD

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The diamondback terrapin is an emydid turtle with a broad geographic range and Type II TSD. Populations on the eastern seaboard of the United States range from Massachusetts to Florida. Throughout this range, the onset of nesting varies from late May to early April in low latitudes to mid June in higher latitudes. We collected terrapin eggs from populations in South Carolina, Maryland, and Rhode Island during the summer of 2004. We incubated these eggs at three temperatures (27.0, 28.5, and 30.0 C) that span the pivotal temperature for the Maryland population. Sex will be determined for these individuals at the completion of a grow-out study. We will compare the threshold range among these populations to determine if populations at higher latitudes compensate for cooler incubation temperatures by decreasing the threshold temperature. Although the currently observed seasonal shift in the nesting season is potentially a behavioral mechanism to compensate for latitudinal variation in incubation conditions, we cannot rule out that this shift is due to thermal constraints on the physiological processes involved in the production of eggs.

All these data and what do we do now: analysis of mark-recapture data

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Most field studies of imperiled populations use standard mark-recapture techniques to enumerate basic population parameters. These data determine statistics such as population size, survivorship rates, and other age or size-specific population parameters used for management and conservation decisions. Although a variety of techniques can estimate the statistics of interest directly, other population processes or biases from capture methods can influence the estimate. MARK is an analytical software program written specifically for the analysis of mark-recapture data. Parameter estimates can improve with the estimation of capture probabilities and other population processes available that can be estimated through the many

options in MARK. I will illustrate the use of MARK with a long-term mark-recapture data set of the diamondback terrapin, *Malaclemys terrapin*.

Why does *Chytridiomycosis* drive some frog populations to extinction and not others? The effects of interspecific variation in host behaviour

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Amphibian populations around the world have declined or become extinct in recent decades, and many of these declines have been attributed to the amphibian disease chytridiomycosis. However, while some species appear to have been severely affected by the disease, other, sympatric species remain unaffected. For species that have declined, mortality events occur more often in the dry/cool season. As the thermal and hydric environments experienced by frogs can have a large influence on their susceptibility to chytridiomycosis, some interspecific differences in the effects of the disease may be explained by variation in microenvironmental use among frog species. This study examined the microenvironments selected in the field by *Litoria nannotis*, which has experienced large and long-lasting population declines, and *Litoria genimaculata*, which declined to a lesser extent and then recovered. Frogs of each species were tracked in North Queensland rainforests, and their three-dimensional location and temperature were recorded several times a day. Thermal and hydric models were also placed in sites representative of those chosen by each species. *Litoria nannotis* was largely restricted to the stream environment, moving significantly smaller distances overall, and remaining significantly closer to the stream in terms of both elevation and horizontal distance, compared to *L. genimaculata*. *Litoria nannotis* also had a lower average temperature compared to *L. genimaculata*. Thermal and hydric models revealed that microenvironments typical of *L. nannotis* had higher humidity and lower temperature than those environments typical of *L. genimaculata*. Frog behaviour also varied significantly with season. In the dry/cool season, both species moved less often, moved shorter distances, were cooler and were more often in contact with other frogs than during the wet/warm season. Interspecific and seasonal differences in frog behaviour may indeed determine disease susceptibility, with declining frogs and frogs in the dry/cool season behaving in manners more conducive to the development of chytridiomycosis.

Integrative functional morphology of the gekkotan and polychrotid subdigital

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Climbing employing subdigital adhesive pads in gekkotan and polychrotid lizards has been the subject of intrigue and study for centuries. Many hypotheses have been advanced to explain the mechanism of adhesion, and recently this phenomenon has been investigated at the level of individual setae. The ability to isolate, manipulate and record adhesive forces from individual setae has provided new insights not only into the mechanism of attachment, but also into the physical orientation of these structures necessary to establish attachment, maximize adhesive force, and effect subsequent release. This, in turn, has enabled reassessment of the overall morphology and mode of operation of the adhesive system in its entirety. Digital hyperextension has often been noted as a behavioral characteristic associated with the deployment of the gekkotan adhesive system. This is now understandable in the context of setal attachment and release kinematics, and in the context of the evolution of this pattern of digital movement from the primitive pattern of saurian digital kinematics. The perpendicular and parallel preloads associated with setal attachment are now reconcilable with other morphological aspects of the gekkotan and polychrotid adhesive system, and the common morphological patterns of independently evolved versions of this type of adhesive system reciprocally illuminate what is necessary and sufficient for its deployment. Future investigations of the integrated adhesive system will help to further elucidate the interdependence of its structural and functional components, and the roles of stages preceding geometric configurations of epidermal outgrowths capable of exploiting adhesion via van der Waals molecular bonding.

Effects of conservation efforts on the leatherback turtle (*Dermochelys coriacea*) population nesting at Parque Nacional Marino Las Baulas, Costa Rica

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The leatherback turtle (*Dermochelys coriacea*) is critically endangered due to declines of reproducing females at nesting beaches worldwide. The largest remaining population of Pacific leatherback turtles is at Parque Marino Las Baulas in Guanacaste Province, Costa Rica. The number of leatherback turtles nesting at Las Baulas has declined precipitously in the last 15 years. Mortality rates of adults have been 15% to 20% for various annual cohorts during this time. Estimated juvenile and subadult mortality rates in the ocean were double the rates of a stable population. The proportion of hatchlings produced from eggs laid increased since

the Park was established as a result of our conservation practices. Although the decrease in number of nesting females has caused an overall decline in the production of hatchlings, the rate of hatchling production was much greater than expected without protection efforts. There were approximately the same number of hatchlings produced at Las Baulas in 1998-2003, with 68 to 188 nesting females under the current conservation regime, as there were in 1988-1989 with 1500 nesting females and no Park. In 1999 and 2000 the 246 and 417 nesting females produced two to three times the number of hatchlings that were produced in 1988 and 1989. Female leatherback turtles have a high level of exchange between nesting beaches within Las Baulas. Thus, protection of all nesting beaches within the Park is critical for the survival of the population. Despite current conservation efforts the population at Las Baulas is still threatened by mortality at sea and development on and behind the nesting beaches.

Girls will be boys and boys will be girls: investigating the TSD-GSD continuum in reptiles

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An increasing body of evidence suggests that there is a common underlying mechanism of sex differentiation in reptiles and that because of that commonality, variations in sex determination mechanisms may be effected at several points in the sexual differentiation pathway. Therefore, we argue that genetic and environmental sex-determination in reptiles should be seen as a continuum of states represented by species whose sex is determined primarily by genotype, species where genetic and environmental mechanisms coexist and interact in lesser or greater measure to bring about sex phenotypes, and species where sex is determined primarily by the temperature of incubation. Such a continuum suggests that transitions between GSD and TSD mechanisms in reptiles may require only relatively small changes at the molecular level and that environmental and genetic influences on sex determination may co-occur frequently in nature. We are seeing evidence of such co-occurrence in *Bassiana duperryii* and *Emys orbicularis*, and from our own studies of *Pogona vitticeps*. In such cases, it should be possible to find molecular markers that segregate with genotypic sex in species with TSD that have an underlying genetic sex determination mechanism. We are exploring these possibilities using a combination of incubation experiments and molecular analyses using sister taxa in which one species in the pair has GSD and the other TSD. We will present preliminary data from these experiments and discuss their implications for the exploration of hypotheses on the relative fitness of "sex reversed" individuals and selective forces likely to maintain or remove TSD.

Outbreeding depression - a problem in amphibian conservation?

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Theory suggests that there is an optimal balance between inbreeding and outbreeding that generates the highest fitness. Amphibians are facing a global decline and many amphibian populations are today small and threatened by extinction. The reasons for the decline are debated but possible reasons include habitat loss due to human activities and environmental change. Whatever the reason for the decline, small population size will inevitably lead to inbreeding, with potential for detrimental synergistic effect with the initial cause of the decline. If low viability of many amphibian populations is partly caused by inbreeding depression, one proposed conservation approach is to translocate individuals from other populations to increase the genetic variation. However, because dispersal is low in most amphibians, they could be particularly sensitive to outbreeding depression, for example, by breakdown of locally adapted gene complexes. Understanding the causes and consequences of outbreeding is therefore important for conservation of endangered species. Unfortunately, very few empirical studies of outbreeding depression have been conducted on vertebrates, especially amphibians. We review theoretical aspects of outbreeding depression and argue that it is of particular importance for amphibians. Furthermore, we present experimental evidence for outbreeding depression in larval traits in the common frog, *Rana temporaria*, and discuss potential population-specific characteristics that could underlie differences in response to outbreeding. Our experimental approach, together with molecular studies of genetic diversity, constitutes a powerful method for assessing consequences of conservation policies such as translocations.

Evolution of autopodials in pleurodire turtles: developmental, phylogenetic and morphometric aspects

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Variable materials and methods were used to document carpal and tarsal ontogeny in a comprehensive sample of pleurodire turtles, including histological sections and cleared and double stained autopodials of recently hatched and juvenile specimens representing 10 chelid and pelomedusoid species. Comparisons were made with skeletons of adult specimens after own observations in museum

collections of dry skeletons, radiographs, and data taken from the literature. There is much more morphological diversity in the manus than in the pes. Variation in autopodial skeletons includes: (1) astragalus and calcaneum are either separated or fused, (2) distal carpals 4 and 5 are fused in most chelids, (3) distal carpals 3, 4 and 5 are fused only in some *Chelodina* and *Pelomedusa* (4) central 2 exists in most but not all chelids, (5) centrals 3-4 are fused in some and separated in other species, (6) pisiform is absent in some specimens, (7) presence of accessory ossifications on the radial and/or ulnar side of the manus. Forelimb measurements were taken from more than 50 pleurodiran specimens, including 20 species within 12 genera. Examined morphometrics show that (1) chelids have lower values of the ratio radius length to metacarpal 1 length than African pelomedusids (2) chelids have lower values of the ratio fibula length to metatarsal length than pelomedusoids, (3) the chelid *Hydromedusa maximiliani* is an outlier within the chelids in many of the ratios measured and shows similar values to those characterizing pelomedusoids (4) pleurodires show different metacarpal proportions than those of the outgroup (trionychids). Some of the autopodial diversity in chelids can be summarized into discrete characters, which when analyzed together with other morphological and molecular data, provide a revised hypothesis of the phylogeny of this group.

Novel tools for assessing disease in the desert tortoise (*Gopherus agassizii*)

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Hypotheses and models of the mechanisms regulating wildlife diseases often lack the necessary tools for field tests to support or refute them. In addition, few models consider the effects of opportunistic pathogens as important influences on wildlife populations. Opportunistic pathogens are constantly present within the host population, but they only lead to disease in the presence of certain physiological and environmental conditions that may weaken the host organism to the point where its immunological resistance to infection is compromised. *Mycoplasma agassizii*, a known cause of upper respiratory tract disease (URTD) in the desert tortoise (*Gopherus agassizii*), may be an example of such an opportunistic pathogen. We are developing novel immunological tools to assess the occurrence of URTD in the threatened populations of the desert tortoise in the Mojave desert of North America. These tools include two field-adaptable agglutination tests to determine both the presence of *M. agassizii* in the respiratory tract of tortoises and the presence of *M. agassizii*-specific antibodies in tortoise blood serum. In addition, a laboratory-based ELISA test will be used to determine the titer and isotype of these antigen-specific antibodies present in the blood serum. These new tools will lead to accurate and precise data on the disease

status of Mojave populations of the desert tortoise. These data will then be used to explore environmental factors, including temperature, rainfall, anthropogenic disturbance, and other potential sources of physiological stress, which may be leading to immunosuppression, morbidity, and subsequent population declines within some populations of the desert tortoise.

Complete nucleotide sequence of the mitochondrial DNA of *Rhacophorus schlegelii* (family Rhacophoridae) and structural features of rhacophorid mtDNAs

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Mitochondrial genome structures are generally conserved in vertebrates. All 37 genes are arranged in the same relative order in almost all vertebrate species, from teleost fishes to eutherian mammals. In anurans, however, the gene arrangement of *Rana nigromaculata* (family Ranidae) mtDNA varies from that of typical vertebrates in the positions of four tRNA genes (tRNA-Leu(CUN), Thr, Pro, and Phe). The *Buergeria buergeri* (family Rhacophoridae) mtDNA has a translocation of the ND5 gene sharing the same four tRNA gene rearrangements observed in *R. nigromaculata*. In order to infer the timing and pathway of these mitochondrial genome reconstructions in the family Rhacophoridae, we determined the complete nucleotide sequence of the mtDNA from *Rhacophorus schlegelii* (family Rhacophoridae) and the partial sequences from other rhacophorid frogs (*Theioderma asperumi*, *Kurixalus eiffingeri*, *Philatus luteolus* and *Polypedates leucomystax*). As in the *B. buergeri* mtDNA, the ND5 gene was translocated in all the rhacophorid frogs investigated in this study. We thus speculate that the translocation of the ND5 gene may have occurred in a common ancestor of these rhacophorids. In addition, the complete mtDNA sequence of the *R. schlegelii* revealed the following unique features. 1) The positions of the tRNA-Thr and tRNA-Leu(CUN) genes were exchanged with those of *B. buergeri*. 2) The D-loop region was duplicated and these two regions were positioned both upstream and downstream of the ND5 gene. These features were also found in the *Polypedates leucomystax* mtDNA. This may indicate that the exchange of two tRNA genes and the duplication of the D-loop region took place in a recent lineage of these rhacophorid frogs.

Temperature dependent sex determination in the genus *Eulamprus*: a widespread character?

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Temperature dependent sex determination was recently reported in the temperate-climate, viviparous, skink, *Eulamprus tympanum*. This trait may be an adaptation to temperate climates, allowing females in cold areas to control the sex, and perhaps other characters, of their offspring. From a comparative point of view, it is interesting to determine whether this character is an adaptation unique to this species, or whether it is more widespread in the genus. We examined the sex ratios produced by females in two *Eulamprus* species, with more tropical distributions, *Eulamprus quoyii*, which occurs from temperate to tropical areas, and *E. brachysoma*, which occurs in the tropics. We exposed females of these two species from early pregnancy to heat regimes of 3, 6 or 10 hours, which they could exploit for basking, and then quantified morphology, performance and sex of offspring. We also monitored body temperatures of females throughout gestation. We found that females typically used high temperatures whenever they were available, but there was a lot of individual variation in body temperature of females during gestation. Females produced 50:50 sex ratios in all treatments, but treatments influenced the gestation period, morphology and performance of offspring of both species. Our data suggest that while incubation conditions influence many characteristics of offspring of tropical species, they do not influence gender. Perhaps TSD is an adaptation to temperate conditions.

The genus *Odontophrynus* (Anura: Leptodactylidae) in Argentina: distribution, taxonomy and phylogeny

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The semifossorial leptodactylid frogs of the genus *Odontophrynus* are geographically restricted to the latitude range of 20° to 41° east of the Andes in Argentina, Bolivia, Brazil, Paraguay and Uruguay. The centre of diversity is Argentina with a total of eight species: *O. americanus* (Dumèril & Bibron, 1841), *O. achalensis* di Tada, Barla, Martori & Ceï, 1984, *O. barrioi* Ceï, Ruiz & Becak, 1982, *O. cordobae* Martino & Sinsch, 2002, *O. lavillai* Ceï, 1985, *O. occidentalis* (Berg, 1896) and two still unnamed species inhabiting the provinces of San Luis and San Juan. The lowland species *O. americanus* and *O. occidentalis* have extensive geographical ranges, whereas the ranges of the lowland taxon *O. cordobae* and the highland taxa *O. achalensis*, *O. barrioi*, *O. lavillai*, *O. spec1* and *O. spec2* are small. Highland taxa inhabit isolated extra-Andean mountain plateaus of at least 1900masl altitude and consequently, are allopatric. Considering the existence of many unexplored highland ranges (sierras pampeanas) the diversity of the genus *Odontophrynus* is probably greater than presently known. All lowland

taxa are partially sympatric among each other and narrow contact zones may exist between *O. occidentalis* and highland taxa. Still, natural hybrids have not been detected yet suggesting complete reproductive isolation among the recognized taxa. Each species is easily diagnosable using a combination of morphological, karyological, bioacoustic and allozyme characters. Based on these characters two clades emerge within the genus *Odontophrynus*: the americanus-group including the tetraploid *O. americanus* and the diploid *O. cordobae* and *O. lavillai* and the occidentalis group including the other five species. Distinctive characters are advertisement call structure (one long pulse group versus many short pulse groups) and larval development (small, fast developing tadpoles versus large, hibernating tadpoles).

Amphibians, reptiles and the 2010 biodiversity target

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To address the challenge of biodiversity loss, the world's leaders, meeting in Johannesburg in 2002, adopted a biodiversity target: to achieve by 2010 a significant reduction in the rate of biodiversity loss at global, regional and national levels. In response, scientists have developed a series of indicators to determine whether or not the 2010 Biodiversity Target is achieved, including the Red List Index (RLI) (Butchart et al. 2004). To measure success in achieving 2010 Biodiversity Target, it is necessary to have at least three separate readings of the RLI covering three different time periods. The Global Amphibian Assessment (GAA) (IUCN, Conservation International and NatureServe 2004) provides a reading of the RLI for 2004, and Stuart et al. (2004) back-calculated the RLI for 1980. There are therefore already two RLI readings for the world's amphibians, and plans to update the GAA by 2009 mean that the requisite three readings of the RLI should be achievable. However, for reptiles this will not be possible. The Global Reptile Assessment (GRA) is just starting, and the results will not be available until 2008. Some unusual characteristics of amphibians and their recent population declines make back-calculating for this group relatively easy and defensible. However, it is unlikely that such back-calculating will be possible for reptiles. Nor will it be possible to update the GRA between 2008 and 2010. It might be possible to use reptile data to measure the achievement of the Target at regional and national levels in some parts of the world. If governments agree further biodiversity targets subsequent to 2010, and providing that the GAA and GRA develop into ongoing processes, in future it will be possible to use data on both amphibians and reptiles to measure progress in achieving the biodiversity targets set by the world's leaders.

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The influence of top predators on mesopredator assemblage composition

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Top predators tend to disappear from anthropogenically altered habitats. Understanding the effects of these disappearances is critical for conserving remaining trophic levels, because top-level predators influence assemblage structure at lower trophic levels via both direct and indirect effects. There is, however, no consensus on the size, direction, or nature of these effects, especially in terrestrial ecosystems. We studied the influence of top predator (varanid lizard) removal on scincid lizard assemblages in tropical Australia using a large-scale, manipulative experiment. An array of 8 14 x 14 m (200 m²) wire mesh enclosures, plus four unenclosed plots of the same size, have been allocated in a randomised block design to three experimental treatments: 1) control enclosures with natural varanid and skink densities, 2) varanids excluded, but skinks allowed access, 3) unenclosed plots to control for enclosure effects. Each treatment is replicated once in each of four spatial blocks. Comparisons between treatments with natural-density controls and those with varanids removed allowed us to examine the effects of varanids on the abundance and species composition of skink assemblages in the absence of predators. Results suggest that abundance of skinks is higher in enclosures than in unenclosed controls, suggesting that even in treatments with predator access, structure provided by the enclosures allows some protection from predators. In addition, enclosures excluding predators have altered species composition compared to those allowing predator access, suggesting that top predators affect the composition of the skink mesopredator assemblage.

Tail injury linked to morphological asymmetry in a polymorphic snake

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Tail loss in reptiles, including autotomy, is considered a mechanism for evading predation. The literature lists intraspecific (e.g., male competition) and interspecific (e.g., predator community structure) factors affecting tail loss frequency in lizard populations. Recent evidence shows association of tail loss with directional asymmetry (DA) in several lizard families and in some snakes. Since autotomy is rare in snakes, tail loss is usually associated with failed predation attempts on them. My study of wild populations of the polymorphic snake *Psammophis schokari*, in the coastal sands of Israel, found differences in tail loss frequencies between various color morphs at different sites. In Palmahim sands (during 1997-2004, N=216), two sympatric discrete morphs exist: rear-striped (RSM) and striped (STM), at a frequency ratio of 1:3 respectively. In the more southern Nizzanim sands (during 1997-2004, N=116), the ratio was 1:1. In Palmahim, tail injuries were nearly four times more frequent in RSM snakes than in STM snakes (23% versus 6%) and DA in supralabial counts occurred in RSM but not STM. In contrast, in Nizzanim no significant difference occurred in tail injury frequency between RSM and STM (9% and 7%, respectively) and DA was undetected. Differences in tail injury frequency indicate differential predation pressures among the morphs. These pressures vary among sites according to local conditions, such as vegetation cover, which is higher in Palmahim than in Nizzanim. Possibly RSM snakes are better camouflaged in less vegetated habitats, while STM snakes are better camouflaged in more densely vegetated habitats. The question, whether an injured tail signifies a disadvantage (more injuries = higher susceptibility to predation) or an advantage (more injuries = better survival after predation attempt) remains open. The higher injury frequency in Palmahim's RSM snakes hints that symmetry correlates with escape ability.

The survival of reptiles in the Mount Lofty ranges, South Australia

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Wildlife habitat in the Mount Lofty Ranges (MLR) to the east of the city of Adelaide has been hit hard since European settlement began in 1836. Most (over 85%) of the native vegetation has been cleared for agriculture, forestry and urban development and what remains is mostly on private land with only 23%

protected in parks. The vegetation that is left is protected from further large scale clearance but some degradation still occurs. These fragments of the native vegetation are often small, separated by agricultural land and are often infested with weeds and feral animals. The dramatic loss of plant, mammal and bird species from the MLR has been well documented but other taxa are generally not well studied. 49 reptile species have been recorded in the southern MLR where this study was based, with 21 spp in the actual study area: one terrapin (Chelidae), one gecko (Gekkoninae), two legless lizards (Pygopodinae), two dragons (Agamidae), one monitor (Varanidae), ten skinks (Scincidae) and four snakes (Elapidae). There is no evidence that any species has been lost from the area overall but some have disappeared from large parts of their former distributions and may now be represented by few individuals; e.g., the heath goanna, *Varanus rosenbergi*. This study examined the patterns of reptile occurrence in 21 native open forest remnants (*Eucalyptus obliqua* / *E. baxteri*) by using nested subset analysis in standardized sampling plots. This revealed a highly nested, non random distribution, where species richness was associated with fragment area. Canonical Correspondent Analyses and Multiple Linear Regressions were used to explore the relationship between the distribution of reptiles and a variety of environmental variables. These also suggested that fragment area is critically important. The implications of this work for the long-term survival of reptiles in the MLR are discussed.

Did embryonic responses to incubation conditions drive the evolution of reptilian reproductive modes?

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My talk will address five key questions in reptilian reproductive biology: (1) why did viviparity evolve from oviparity, (2) why is viviparity common in the tropics as well as in cold climates? (3) why hasn't the reverse transition occurred as frequently (or at all), (4) why are transitional stages (oviparity with very prolonged uterine retention of developing embryos) so rare, and (5) why do most oviparous squamates delay oviposition until so much of early embryogenesis is completed? The first question has attracted most attention. Extensive research suggests that temperature has been the most critical selective force, but reveals unsuspected complexity. For example, the variances of thermal regimes as well as mean temperatures are important, and may affect fitness via subtle modifications to hatchling phenotypes as well as more obvious effects on developmental rates and hatching success. These effects may occur in the tropics as well as in cold climates. Answers to the three latter questions are more speculative, but may involve the ability of embryos to control hydric exchange with the

surrounding environment. First, loss of the eggshell during the transition to viviparity may preclude subsequent reversals that require oviposition in relatively dry nest-sites. Second, intermediate stages of prolonged uterine retention may be precluded for the same reason: the eggshell thinning needed for gas exchange of late-stage embryos in utero is incompatible with desiccation resistance after oviposition. Third, oviposition may be delayed until the embryo has the morphological and physiological capacity to regulate its own water balance. Thus, thermal relations may explain why viviparity evolves from oviparity, whereas hydric relations explain why this has been a one-way process, and why most oviparous squamates retain eggs for about one-quarter to one-third of embryogenesis, rather than for a shorter or longer period.

Teasing apart the sexual history in *Lepidophyma*?

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Investigation into the origins of two parthenogenic *Lepidophyma* species (*L. flavimaculatum* in Costa Rica and Panama and *L. reticulatum*), using mitochondrial (cytb and 12S) and nuclear (Gapdh) markers, was consistent with a non-hybrid origin. The nuclear data supported previous morphological, karyotypic, and allozyme work showing an absence of fixed heterozygosity and of differences between unisexual and gonochoristic populations. However, we found a number of heterozygous positions in Gapdh sequences of the gonochoristic species *L. sylvaticum* in populations from San Luis Potosí, as evidenced by double peaks at up to seven nucleotide positions. To investigate this phenomenon we developed a suite of microsatellite markers from *L. flavimaculatum* that amplify across the genus. Preliminary results from nine loci demonstrate good amplification and allelic variation. All genotypes were diploid for *L. flavimaculatum*, and the absence of fixed heterozygosity is consistent with a non-hybrid origin for unisexuals in this species. However, we found instances of 3N and 4N genotypes at four loci in *L. reticulatum*, *L. sylvaticum* and *L. micropholis*, suggesting polyploidy (complete genome duplication) or gene duplication.

Parasite infection and amphibian limb deformities

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During the last decade reports of limb deformities have raised concerns regarding the fate of amphibian populations and threats to environmental health. Several hypotheses have been forwarded, but the role of infection by helminth parasites, notably the trematode *Ribeiroia ondatrae*, has received the closest attention. We evaluated the relationship between trematode infection and limb development in 50 populations in Vermont, USA. Vermont populations have experienced deformity rates of over 30% and received national attention as one of the 'epicenters' of the limb deformity phenomenon. We found no evidence for infection based limb deformities. *Ribeiroia* was never detected in our study populations and the infection intensity of other subcutaneous trematode metacercariae was unrelated to deformity status (case vs. control). The pattern of limb deformities in Vermont populations is inconsistent with patterns seen in *Ribeiroia* infection experiments but is consistent with patterns uncovered in most other natural populations. These findings suggest that chemical contaminants or other factors should receive closer attention in the search for causes of limb deformity outbreaks. Preliminary evidence from a risk analysis suggests that land use near wetlands may contribute to deformity patterns within amphibian populations.

Variation in development of the yolk sac of squamate reptiles

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The yolk sac of oviparous amniotes is an extension of the embryonic gut that envelops nutrient-rich yolk and mobilizes and transports molecules to the developing embryo. The mechanisms for nutrient mobilization are unknown for most amniote taxa, but are thought to be mediated by endodermal cells of the yolk sac splanchnopleure. Yolk sac development of squamate reptiles is unusual because extraembryonic mesoderm grows into the yolk in the abembryonic hemisphere of the egg and does not contribute to the outer wall of the yolk sac. As a result, the abembryonic yolk sac is bilaminar, i.e., consists of ectoderm and endoderm, and is not vascularized. The sheet of mesoderm that invades the yolk splits to form a cavity, the yolk cleft. The function of the yolk cleft is unknown, but it has been suggested that it contributes to the digestion of yolk. Some patterns of variation in development of the yolk cleft of oviparous squamates may reflect phylogenetic differences but other variation is associated with reproductive mode. Generally, the yolk cleft of oviparous species is eliminated prior to hatching, whereas it is retained throughout gestation in most viviparous species. Species that retain the yolk cleft have evolved independently mechanisms that retard its demise and the persistent bilaminar omphalopleure contributes embryonic tissue to a yolk sac placenta. A second major variation occurs in some

highly placentotrophic lizards with markedly small yolk masses in which the yolk cleft has been lost secondarily. These species have prominent chorioallantoic placentae.

Microevolutionary implications of genetic variation in the São Tomé caecilian *Schistometopum thomense*

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The endemic caecilian *Schistometopum thomense* (Gymnophiona: Caeciliidae) is a biogeographical enigma, as caecilians are widely considered poor dispersers; thus its presence on the oceanic island São Tomé, 225 km off the western coast of continental Africa, is intriguing. This species was originally described as three different taxa over the period 1873-1965 (Bocage 1873, Peters 1874, Taylor 1965). Subsequent literature and finally a monograph of the genus *Schistometopum* (Nussbaum and Pfrender 1998) reduced nominal confusion by removing mistaken synonymies due to sexual dimorphism and clinal morphological variation. This cline, documented by Nussbaum and Pfrender (1998), is partially characterized by an increase in dorsal brown pigmentation from north to south in populations across the island. New data will be presented on mitochondrial genetic variation as it relates to geographic distribution, individual coloration and potential evolutionary significant subunits for this species.

Natural selection on signal design in dwarf chameleons (*Bradypodion* spp.)

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There are many types of adaptive solution to the problem of trying to maximise conspicuousness to conspecific receivers without attracting predators. For instance, animals may flash a concealed colour patch or use colours that can be seen by intended receivers but not 'eaves-droppers'. Chameleons are able to use the same body region or colour patterns for both signalling and camouflage by changing colour. However, there are limits to chameleon colour change. The environment may greatly affect the degree to which individuals of different species are able to change colours (colour lability) as well as the types of colours used for signaling or camouflage through its influence on predation pressure as well as background, light and structural characteristics. Dwarf chameleons (*Bradypodion* spp.) represent a recent endemic radiation characterised by great variation in coloration, yet they are highly conserved in both their morphology and behaviour. Dwarf chameleons also inhabit diverse

habitats including rainforest, montane heath (fynbos), grassland and thorn-scrub, providing an ideal opportunity to examine natural selection on signal design. We present some preliminary comparative data on predator-specific colour change, male display coloration, female aggressive coloration and colour lability for both sexes for a selection of dwarf chameleon species from eastern South Africa. We relate this to habitat characteristics and discuss how natural selection may have influenced signal design and ultimately contributed to speciation in the genus.

Multiple paternity in the common toad (*Bufo bufo*)

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Recent studies provided several examples of multiple paternity in anurans, suggesting it is more common than previously thought. Multiple paternity may result from multiple amplexi, long-distance sperm diffusion, or post-mating clutch piracy by males. However, so far all studies focused on species that lay their eggs in clumps, giving spermatozoa almost simultaneous access to the entire egg mass. We investigated paternity in the common toad (*Bufo bufo*), a species that releases its eggs in strings during consecutive extrusions. Furthermore, the sex ratio in *B. bufo* is highly male biased, causing strong male-male competition and multiple amplexi ("mating balls"). We collected samples from naturally spawned egg strings and from egg strings spawned under experimental conditions (females exposed to either 2 or 6 males simultaneously), and used microsatellite genetic markers to determine the offsprings' paternity. The vast majority of egg strings were fertilized by a single male. In the two (out of 14) cases of polyandry one male clearly dominated in the paternity of a female amplexed by two males, and paternity was rather even across two males for a female amplexed by several males. Our results conform with population genetic evidence that the relative effective number of breeding adults in *B. bufo* is particularly low.

Dissecting the evolutionary relationships of the African chameleons – A review of the past, present, and a look at a proposed future.

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The phylogeny of the Chamaeleonidae of KLAVER & BÖHME (1986) divided the Chamaeleonidae into six genera and two subgenera based on datasets obtained from studies on lung morphology, hemipenal structure, cranial osteology, karyotology and external morphology. That classification did not provide all the answers and even raised some problems of its own, but it did provide a robust platform from which to

continue. Although morphological datasets are still not complete for all genera, many new items of phylogenetic value have come to light prompting a formal re-appraisal of the phylogeny. Studies of the lungs of chameleons have provided the most accurate estimates of generic and supra-generic relationships. The advent of phylogenetic analyses through DNA sequencing has brought a new dimension to chameleon systematics by providing a means of assessing genetic relationships and by providing a means of estimating dates of evolutionary divergences. In general, sequence based estimates of relationship largely support estimates based on other means. A revised phylogeny based partly on new evidence provided by comparative genetics is proposed that is largely congruent with KLAVER & BÖHME hypothesis with some refinements. The subfamilial status of the Brookesiinae although not supported by readily identifiable synapomorphic features is retained. The monophyly of Rhampholeon was previously disputed and genetic analyses have provided enough evidence to subdivide Rhampholeon into two genera and three sub-genera. The subgenera *Chamaeleo* (*Chamaeleo*) and *Chamaeleo* (*Trioceros*) are elevated to full genera. Sub-groups within *Trioceros* are evaluated as possible sub-genera. The Genus *Bradypodion* sensu KLAVER & BÖHME (1986) is also found to be paraphyletic. This will be split into its representative groups. The relationship between the East African *Bradypodion*, Southern African *Bradypodion*, *Calumma* and *Furcifer* is to be reassessed in light of both lung morphology and the genetic evidence.

Impacts and future of invasive *Trachemys scripta elegans* in France

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New-born red-eared slider turtles (*Trachemys scripta elegans*) have been massively exported from the United States to European and Asian countries to be sold as pet. These juvenile turtles, when kept in good conditions, have grown and led to more inconvenience that pleasure for naive owner. Therefore, many owners, ignoring the potential consequences of their act, released their turtle in natural freshwater ecosystems. Although importation of the red-eared slider turtle is forbidden in European Union since 1997, many sliders are still kept as pets, and feral adult turtles have been detected all over France. As a part of a general project concerning invasion potentialities of slider turtles in France, some studies demonstrate both sexes production in nests incubated outdoor in semi-natural conditions. We also want to provide information on the impact on red-eared slider turtles on French freshwater ecosystems. First, we analysed the diet of adult turtles by dissecting digestive systems. We wanted 1) to know what kind of food slider turtles could eat in France, 2) to test whether the diet composition changes with turtle

age. Secondly, we compared macro-invertebrate communities of ponds submitted or not to the presence of slider turtles, after having taken account of differences in vegetation. The correlation that we found between turtle presence and macro-invertebrate community composition suggests an effect, direct or indirect, of turtles on invertebrate communities. Finally, we model a semi-natural French freshwater ecosystem as a tool for long-time predictions.

HoxA10 in the viviparous lizard *Eulamprus tympanum* and the oviparous lizard *Lampropholis guichenoti*

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The evolution of a uterus that is receptive to blastocyst implantation has occurred over a hundred times in the squamate reptiles. This indicates that the transition of uterine structure to support viviparity has relied on a relatively small number of genes and proteins. The multiple origins of viviparity in squamates provide an excellent model in which to study the origin of viviparity. HoxA10 is a gene that has been highly conserved in vertebrate evolution and is involved in uterine receptivity in mice. To begin an investigation on the genes and proteins that are responsible for the evolution of blastocyst receptivity in the uterus in lizards, we compared HoxA10 expression in the uteri of one viviparous lizard *E. tympanum* and one oviparous lizard *L. guichenoti*. HoxA10 was detected in 21 out of 23 *L. guichenoti* samples tested and was mainly present as a doublet of bands of molecular weight 64 and 59 kDa. In *E. tympanum*, HoxA10 was detected in 23 out of 34 samples, often as a doublet of 63 and 59 kDa. The samples of uterus from *L. guichenoti* were divided into 3 groups, 1) vitellogenic, 2) carrying shelled eggs, or 3) recently oviposited. There was no statistical difference in HoxA10 expression between any of these groups. *Eulamprus tympanum* samples were divided into 3 groups 1) vitellogenic, 2) pregnant or 3) postpartum. There was no statistical difference in HoxA10 expression between any of these groups. Thus, the presence of HoxA10 is not exclusive to viviparous uteri but this does not rule out the possibility that the gene may function in uterine receptivity. The amount of HoxA10 expressed appears not to change with reproductive status in either lizard, but controls on HoxA10s biological activity at various times in the reproductive cycle are yet to be explored.

Goanna shape: effects of size and phylogeny

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Shape in lizards can be associated with preferred habitat, performance traits, life-history patterns, behaviour and microhabitat use. Shape is also influenced by body size and inherited characteristics. The objectives of this study were to examine whether there is a strong relationship between variations in size-free body shape of Australian goannas and choice of habitat, and to look at the extent to which variations in shape could be accounted for by phylogeny. Various linear body dimensions were measured for 26 species of Australian goannas to characterise body shape. Australian goannas are not morphologically conservative and vary appreciably in body size. We removed the effects of size using a variation of PCA developed by Sommers (1986, 1989) and used phylogenetic auto-correlation (Rohlf 2001) to account for phylogenetic effects. Australian goannas can be placed in four groups in morphometric space: those that retreat to oblique rock crevices, those that retreat to burrows in the ground, those that retreat to spaces in rocks or trees, and those that inhabit the outside of trees. We will briefly discuss the influence of body size and phylogeny on body shape.

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Rehabilitation index for evaluating the success of rehabilitated disturbed areas using reptile assemblages as a bio-indicator

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We will describe a Rehabilitation Index for measuring the extent to which rehabilitated mining sites and waste dumps in Australia have developed into near natural, self-sustaining, functional ecosystem similar to that in the adjacent undisturbed areas using the reptile assemblage as the bio-indicator. The rehabilitation index uses a series of quantifiable parameters (diversity, taxonomic and trophic groups) for comparing reptile assemblages in rehabilitated areas with that in an adjacent undisturbed area. Each of these parameters is subdivided into a number of sub-parameters (e.g. diversity is divided into log series diversity, evenness, similarity and species richness). A Rehabilitation Index target score is defined. This target score represents the level at which rehabilitation interventions are no longer required, and given time, the rehabilitated site will eventually develop into a self-sustaining, functional ecosystem that resembles the adjacent undisturbed area. Results from this study

provide a useful tool for mine site environmental officers in planning their disturbed site rehabilitation programs and seeking a return of rehabilitation bonds from government. We will present data to demonstrate the usefulness of the Index and to support its robustness based on four years of field sampling in the Goldfields of Western Australia. This Rehabilitation Index provides mining companies with a quantifiable measure of rehabilitation progress in developing sustainable and functional ecosystems. It has the potential to be used for other applications (e.g. measuring degradation in pastoral areas due to over grazing, or the impact of feral animals on ecosystems such as the cane toad (*Bufo marinus*) in the Kimberley area of Australia.

Testing the role of visual cues in speciation

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Classically, speciation in sexual vertebrates is thought to occur primarily through differentiation in geographic isolation (i.e., geographic or allopatric speciation). However, the current debate on speciation recognizes that in situ natural selection for current conditions and sexual selection may have an important role in speciation. Molecular genetic studies of two lizard models (Canary Island Gallotia and Lesser Antillean Anolis) have contributed to this debate and even suggest that selection (in the broad sense) is more important in determining patterns of gene flow than substantial differentiation in geographic isolation. The colour pattern and hue of sexual selection markings are implicated in both of the above cases, but several problems occur when trying to link sexual colouration with the process of speciation. These problems include 1) using objective and mathematically sound methods of comparing hue among populations, 2) running experiments to reveal the behavioural basis of how sexual colouration can impact the extent of interbreeding (e.g., assortative mating), and 3) finding and applying genetic and associated methods that can effectively demonstrate the reduced interbreeding and its evolutionary product. This presentation discusses these problems with lizard examples.

Species diversity of *Xenopus*: an update

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While most laboratory studies involving *Xenopus* have employed a single species, *X. laevis*, there is now increasing interest in other representatives including *X. tropicalis* (whose genome lacks the complexities of the polyploid species) and certain higher polyploids (which illustrate these complexities of polyploidy). These 'other species' in the genus have major interest for

evolutionary biology and potential for future laboratory research. The number of described species rose from 6 at the start of the 1970s to 17 by the mid 1990s but there have been no formal descriptions in the past 10 years. However, recognition of further diversity has continued and new approaches (especially molecular studies) have incorporated data on a series of presently-undescribed species. In addition, on-going studies record new species that are entirely unstudied, found especially in museum collections. These developments contribute to a picture of steadily increasing species diversity within extant *Xenopus*. This paper reviews the current knowledge of diversity and highlights foci of undescribed new species endemic to the highlands of Central and East Africa. Morphological characters distinguishing the new species are subtle, but it is typical of already-known species that relative phenotypic uniformity actually conceals major genetic differences including the remarkable allopolyploid series (with $2n = 20, 40, 36, 72$ and 108 chromosomes). In some cases, the external characters of the new species exhibit combinations of features diagnostic of pre-existing species; this may further emphasise the role of hybridisation in speciation. Future studies now require fieldwork in areas pinpointed by the museum collections (especially from the 1950s and 1960s). However, in several cases, the localities are in regions of recent human conflict and major habitat destruction. The fate of certain of these species, during the 50 years since their collection, remains unknown. So, collection of live material for comprehensive analysis (including molecular characteristics) may now be difficult, but should be an urgent priority.

Evolution of vocal communication in the Xenopodinae

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The Xenopodinae, totally aquatic frogs native to sub-Saharan Africa, express a complex repertoire of under water songs. The best studied species is *Xenopus laevis* in which males use six song types: three of these are directed solely to other males while three are directed to both sexes. Females produce only two call types, a receptive and an unreceptive call, both of which are directed only to males. The extent of polyploidization in the genus is exceptional; all but one species are polyploid and ploidy levels reach dodecaploidy ($12N$). The Xenopodinae contain over 20 known species most of which arose by allopolyploidization. To determine how vocal communication has evolved in the Xenopodinae, we have analyzed the intra- and inter-sexual song types produced by every known species. Vocal characters were mapped to a molecular phylogeny (Evans et al., 2004). Males in every species use an advertisement call and these vary from temporally simple to complex.

We examined a number of call features- advertisement call complexity, repertoire size, presence of male directed calls, and presence of female calls- to determine evolutionary trajectories and relation to ploidy. Female unreceptive calls are present only in more derived species. We find that there is no relation between ploidy and any feature examined. Advertisement calls did not evolve from simple to complex (or vice versa). Male directed calls are universal suggesting that male/male communication may be ancestral to female directed calls.

The dwarfs of Africa: taxonomy, distribution and diversity of dwarf chameleons (*Bradypodion sensu lato*)

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The taxonomic and evolutionary relationships within the dwarf chameleons (*Bradypodion*) have long been controversial. Presently, the taxonomy of the 15 recognised South African species is based primarily on morphological characters. In addition, 9 East African species were transferred from *Chamaeleo* to *Bradypodion* on the basis that they lacked morphological characters linking them to *Chamaeleo*. This resulted in *Bradypodion* becoming a grab-bag of species unallocated elsewhere, and further confused the taxonomy of the genus. Through mitochondrial DNA sequencing, it has become apparent that such an expanded *Bradypodion* is paraphyletic. The South African *Bradypodion* form a monophyletic group exclusive of all East African species. The East African species are distributed in three clades, which are divergent from all other clades of chameleons. Sequence divergences between these clades are comparable with that between chameleon genera. There is no obvious phylogeographic pattern associated with the clades, aside from 'B'. *mlanjense*, which forms a separate clade and is known only from southern Malawi. The remainder of the species form two distinct clades that are distributed in montane forests across Rwanda, Kenya and Tanzania. These results confirm that the East African species should be removed from *Bradypodion*. The genetic differences are large enough to possibly assign the East African species to several new genera, but a full complementary morphological analysis with nuclear DNA markers should be carried out to establish the validity of new genera.

Vaccination against habu (*Trimeresurus flavoviridis*) venom carried out in Amami Islands, Japan for 33 years

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Habu (*Trimeresurus flavoviridis*) is a large crotaline snake and causes many severe bites in Amami and Okinawa Islands, Japan. To reduce the severe cases vaccination against habu venom started on 1970 by Sawai and others. Habu venom toxoid was first prepared using dehydrothioctic acid, later by formalin. The crude venom was used in first trials, then several methods were tried. And finally two haemorrhagic components, HRI and HRII were detoxified and used for vaccination. Vaccination ceased on 2002 due to several reasons. Here I review the vaccination in Amami Islands during 33 years.

Using null models to evaluate thermoregulation in large reptiles

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Hertz et al. (1993) presented protocols for evaluating thermoregulation in reptiles. Their approach employs comparisons of thermoregulatory performance with null models of the body temperatures achievable in particular environments. Their approach assesses the precision, accuracy, and effectiveness of thermoregulation, and they suggest means to assess the ecological impact of thermoregulation on performance measures for individuals. The approach requires measuring, or calculating, operative temperatures as a means to create null models of achievable body temperatures. However, large reptiles have significant thermal inertia and this means that operative temperatures are really not necessarily achievable body temperatures. The operative temperature is the body temperature that a reptile would achieve, if the real animal had no mass. However, for large reptiles the achievable body temperature is simultaneously a function of the operative temperature, the heat capacitance of the animal, physiological adaptations for controlling heat gain and loss, and the thermal history of the animal. Christian and Weavers attempted a mechanistic evaluation of thermoregulation in large Varanid lizards, and in this presentation we have refined their approach to use models to understand the mechanistic relationships among the variables that determine achievable body temperatures in large reptiles that incorporate the necessary variables to calculate achievable body temperatures for large reptiles in a manner that allows calculation of null models and application of the Hertz et al.

Ecological significance of body size and skin resistance to terrestriality in frogs

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Many amphibians evaporate water freely across their skin. This creates a challenge to thermoregulation: how to simultaneously regulate water and temperature balances, when thermoregulatory behaviors may simply result in changes in water loss rates, rather than changes in temperature. The apparent conflict between predictions based on the physics of heat exchange, and observations of apparently thermoregulatory behavior has resulted in a debate for many years. It is likely that frogs with extreme resistance to water loss have the capacity to thermoregulate and be partially emancipated from the need to find free water, and therefore have the means to become arboreal. Controlling rates of desiccation in frogs appears to be accomplished by three mechanisms: (1) having cutaneous resistance to water vapor transport (e.g. *Litoria bicolor*), (2) having a large body size which effectively reduces the surface area to volume ratio, and thus, reduces the rate dehydration (e.g. *L. caerulea*), and (3) behavioral or ecological selection of wet environments (such as rainforests or streambanks; e.g. *Platymantis vitiensis*). We have developed biophysical models to calculate water loss in frogs in relation to cutaneous resistance to water vapor loss and body size, and the simulations from this modeling shows that it is possible to achieve the same resistance to loss of hydration level by having a high cutaneous resistance, or by having large body size. This is consistent with the hypothesis that there is more than one means by which the ability to avoid desiccation can evolve, thereby providing potential for thermoregulation. We have constructed a relatedness tree of the Hylid frogs in Australia and we have found that arboreality has evolved more than once in the evolutionary history of Australian Hylid frogs. Additionally, it is clear from the relatedness analysis that the trait of arboreality has been achieved in different ways in different clades.

Scientific assessment of the recovery plan for the Mojave desert tortoise

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The Desert Tortoise Recovery Plan Assessment Committee (DTRPAC) was appointed by the U.S. Fish and Wildlife Service (USFWS) in 2003 and charged with carrying out a scientific assessment of the Desert Tortoise Recovery Plan published in 1994. The

assessment committee consisted of credentialed academic and agency scientists with expertise in ecology, tortoise biology, conservation biology, geography and GIS technologies, scientific ethics and philosophy of science, and other. The committee concluded that recovery depends upon a substantially greater understanding of tortoise behavior, genetics, disease transmission, and demography. Desert tortoises face an array of threats, which act simultaneously and synergistically. The far-reaching implications of this concept were not fully appreciated in the original Recovery Plan. Multiple, simultaneous threats are particularly insidious to formulating recovery actions because it is possible that potential gains made in tortoise numbers through one action can be lost when potentially "saved" tortoises perish or fail to reproduce due to a different threat not alleviated by the management action. The synergism of multiple threats refers to the biological fact that effects from one threat can be magnified when the threat co-occurs with another threat. The original Recovery Plan does not fully appreciate that threats to tortoises can act in this non-additive way. The interaction between disease and climate may be one of those novel threats, which appear to act differently from disease or climate acting singly. This interaction may partially explain why population crashes occur more frequently in the West Mojave Desert where rainfall naturally occurs less frequently.

Disruption of reproductive and thyroid endocrine systems in frogs by estrogenic pollutants and UV-B radiation: implications for population decline

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Many amphibian populations worldwide are in decline. In some regions, it is obvious that habitat destruction and road mortalities have devastating effects. However, many populations inhabiting what appear to be pristine aquatic environments have been in decline or have been extirpated. There is evidence to suggest that increasing UV-B radiation due to the thinning ozone layer and endocrine disrupting chemicals (EDCs) may be linked to these declines. Our work has shown that estrogenic pollutants (octylphenol, OP- a metabolite of industrial surfactant) and ethinylestradiol (EE2; from contraceptives found in sewage effluents) and UV-B radiation can disrupt brain development and metamorphosis in the Leopard frog. Chronic exposure (12h/day) to sublethal UV-B (approximating ambient springtime levels) during development blocked development at Gosner stage 34 (toe development stage). Combined treatment with OP induced abnormalities (i.e, spinal curvature, abdominal edema). Exposures to environmentally relevant concentrations of EE2 induce intersex male (testes with oocytes)

tadpoles and such effects occur when tadpoles are exposed during specific periods of sexual development. Our data indicate that UV-B radiation and estrogenic chemicals can upset metamorphosis and sexual development. We speculate that delayed metamorphosis and altered sex ratios could be a contributing factor to amphibian declines. This hypothesis awaits rigorous testing under both laboratory and field conditions. Supported by the Canadian Network of Toxicology Centres, Environment Canada, and NSERC.

A closer look at the phylogeography of moss frogs

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The Cape Floristic Region is well known as a global hotspot of floral biodiversity. Less well known is that this area also has very high levels of amphibian endemism. The moss frogs, genus *Arthroleptella*, are an example of one such endemic genus. This study presents some initial findings of a phylogeographic study on moss frogs, based on advertisement calls, morphology, and DNA sequences. Variation in these characters at a fine spatial scale in the Cape Fold Mountains indicates a complex phylogenetic situation. At least one undescribed allopatric species has been discovered. These results provide an insight into the modes of speciation in this genus.

Genetic structure in remnant populations of adder (*Vipera berus*)

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The adder (*Vipera berus*) possesses a large distribution area, but is threatened in most European countries and particularly in some regions. In the Jura Mountains (located between Switzerland and France), this species is isolated and limited to about 46 locations, of which some are composed by a couple of animals. The genetic structure was assessed by using microsatellite markers in 10 populations in the Jura Mountains (probably the most important). Results show that the adders are not much mobile, and distances higher than 2-3 Km are enough to isolate populations.

Responses of reptile assemblages to seasonal management burning for weed control in tropical savannas of northern Australia

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Fire is an important disturbance medium structuring communities, and is increasingly used as a land management tool throughout tropical savannas. The type of fire regime implemented in an area can affect faunal assemblages by altering habitat structure. In tropical savannas, the season when a fire occurs may influence reptile composition post-fire. This project examined the impacts of seasonal management burning along creek lines for weed control on reptile assemblages in grazed tropical savannas of northern Australia. Reptile species abundance and assemblage structure were compared amongst replicate experimental treatments (unburnt control, wet season burnt & dry season burnt) at two time intervals to examine the short-term (6-12 months post-fire) and medium-term (2-3 years post-fire) impacts of seasonal burning. Species responses were correlated to environmental variables to determine habitat preferences in relation to fire treatment. Total reptile abundance and community structure did not vary between treatments in the short-term, but individual species responded differentially to fire treatments. The skink *Carlia munda*, favoured dry season burnt treatments, while *Cryptoblepharus virgatus* preferred the unburnt controls. The medium-term impacts showed lower total reptile abundances in the dry season burnt treatments compared to the unburnt controls. One species in particular, *Heteronotia binoei*, appeared to be fire-sensitive and showed a strong preference for unburnt habitat. Dry season burning typically removes large amounts of understorey vegetation, altering microhabitat structure and reptiles may be responding to a reduced level of microhabitat complexity. The results reveal the impacts of seasonal weed management burning along creeks and highlight the importance of appropriate fire management strategies to conserve faunal assemblages.

Molecular evidence for phylogenetic reassignment in some African Ranoid frogs

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The large number of Africa endemic species and genera of the Ranoidae are characterized by incompletely clarified phylogenetic relationships. We present three cases where molecular markers provide phylogenetic information that augments and sometimes greatly differs from the current morphological phylogenetic hypotheses. A phylogeny based on the single-copy nuclear Rag-1 gene revealed unexpected placement of the brevipitine frogs (rain frogs or reën padda), formerly assigned to the Microhylidae. They are shown to be highly divergent and are placed within the Arthroleptidae, sister to the Hemisotidae. Similarly, the genus *Leptopelis*, with over 50 species endemic to sub-Saharan Africa, is generally considered to be part of the Hyperoliidae, in the subfamily Leptopelinae. Our molecular data suggests that this genus is closer

related to the Astylosternidae and Arthroleptidae. We also provide the first molecular phylogenetic hypothesis for ranids that is almost complete at the level of subfamilies, and includes a representative sampling of 11 African endemic genera. Analysis of nuclear (rag-1, rag-2 and rhodopsin genes) and mitochondrial markers (12S and 16S ribosomal subunit genes) provide evidence for an endemic clade of African genera that thus far were assigned to up to five different subfamilies based on morphology: *Afrana*, *Cacosternum*, *Natalobatrachus*, *Pyxicephalus*, *Strongylopus*, and *Tomopterna*. This clade has its highest species diversity in southern Africa, suggesting a biogeographic connection with the Cape Floral Region. Bayesian estimates of divergence times place the initial diversification of the southern African ranid clade at about 62-85 million years ago, concurrent with the onset of the radiation of afrotherian mammals. These and other African ranids (*Conraua*, *Petropedetes*, *Phrynobatrachus*, *Ptychadena*) are placed basally within the Ranoidae with respect to the Eurasian groups, which suggests an African origin for this whole epifamily.

Herpetological surveys of Cat Tien National Park, Vietnam

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At the invitation of Cat Tien National Park in Viet Nam and the World Wildlife Fund International's Cat Tien Project, three herpetological surveys were conducted during the May-June transition between dry and wet seasons. In 2001 three collectors spent about 30 person days in the park and recorded 54 species (25 Amphibians and 29 "reptiles"). In 2002 a team of seven collectors spent another 91 person days in the park and found 68 species (26 amphibians and 42 reptiles). In 2004 six collectors spent 80 person days at Cat Tien and registered 70 species (27 amphibians and 43 reptiles). The grand total of 98 species for the three years included 1 caecilian, 34 frogs, 5 turtles, 26 lizards, and 32 snakes. Numbers of species first confirmed for Cat Tien or added to the park list were 12, 13, and 8 in successive visits. Species saturation curves did not level off with either number of sampling periods or person hours; so new surveys should discover more species.

Fossil footprints of a bipedal reptile from South Africa

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Vertebrates appeared on land in the Late Devonian. Footprints are known in the Northern Hemisphere from the Carboniferous to the present day, and Monographs date back to before Darwin's Origin of Species. The Northern continents lay on the Equator during the Carboniferous, while the Southern continents were near the South Pole, and hence there are no southern Tetrapod footprint records. In Southern Africa there are no non-mammalian footprints recorded after the Early Jurassic, when much of the subcontinent was covered by lava, up to 4½ kilometres thick. In Africa only 10 Permian terrestrial footprint sites have been reported, all in Southern Africa, and all discovered since 1980, and 10 Cretaceous sites, all in Africa north of the Equator. World-wide no fossil footprints of non-mammalian hoppers have been reported and gained acceptance. A provable finding in Southern Africa would hence be noteworthy. Fossil footprints of two bipedal hoppers from South Africa are illustrated.

Anura as prey of the spotted eagle owl in the Western Cape, South Africa

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Bones of Anura formed a high proportion of material found at roosts of Spotted Eagle Owls (*Bubo africanus*) in the Tokai pine plantations on the Cape Peninsula, Western Cape, South Africa. Pine needles replaced the indigestible hair or feathers of prey in the pellets, making them less coherent, so that individual pellets were often not distinguishable. The anuran bones were derived mainly from Short-Headed "Rain" Frogs (*Breviceps*: Brevicipitidae). There were some Platannas (*Xenopus*: Pipidae), and a few ranids, including of the Ranidae, *Afrana fuscigula* and probably *Strongylopus grayii*. No bufonids were found. Individual pellets from other sites in the area often had no anurans, but when Anura were present in several instances they made up about half the bulk of the bones, the vast majority from *Breviceps*. Bufonidae and Pipidae were not found in them, while the few ranids found included *Ilia* of the Burrowing Ranid Frog, *Tomopterna delalandii*. The potential of owl pellets for the study of the distribution, present and past, of anurans, and for the study and teaching of functional anatomies in a group of vertebrates, is noted.

CITES and the conservation of tortoises and freshwater turtles

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CITES is the only treaty to have jurisdiction over international trade in animal and plant species at actual

or potential risk of extinction because of such trade; it is therefore of great conservation value. A substantial number of turtle species, including all tortoises and all marine turtles as well as a variety of freshwater turtles, have been included in the CITES Appendices in the 3 decades of the treaty's existence. The effects of trade regulation under CITES are diverse, and include restricting mass trade volumes, the formulation and implementation of annual harvest and export quotas, the formulation of Non-Detriment Findings, enforcing management programs and/or farming for selected species in trade, as well as potentially impeding international exchange of animals for conservation breeding groups, and of museum specimens and other research materials. These effects and their impacts on turtle conservation will be presented and illustrated with brief species case studies.

Seasonal variation in reproductive activity in natural *Xenopus laevis* populations in the Western Cape Province, South Africa

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The African clawed frog, *Xenopus laevis*, mainly aquatic, occur naturally in water bodies in the Western Cape Province and other parts of Southern Africa. Despite being recognized as one of the most studied amphibians world-wide, very little information is available concerning the natural reproductive cycles. *Xenopus laevis* emerged as a valuable model animal in ecotoxicological studies, including, the assessment of the impact of endocrine disruption in natural populations. Base-line knowledge of natural reproductive and associated endocrine cycles are however lacking. For this study, we, on a monthly basis, collected adult male and female frogs from water bodies in pristine areas in the Western Cape Province to assess morphological variation in spermatogenesis, oogenesis and associated organ systems. Blood samples were obtained and analysed for reproductive hormones as well as circulating vitellogenin concentrations. In females, the gonadosomatic index (GSI) reached a maximum during spring (September), the same month during which females displayed the greatest number of mature follicles. Plasma estradiol levels reached a minimum in spring (September) and a maximum during winter (June). Mean plasma vitellogenin concentrations (in-house Vtg ELISA) varied significantly between months and the highest mean concentrations were measured in females collected during spring (September). The male reproductive profiles showed a strong seasonal pattern, in that the GSI and spermatogenesis peaked in spring through summer. Circulating plasma testosterone levels (ELISA) followed the same pattern with peaks in spring (September-November) and summer months (December-February). Seasonal variation in the morphometrics of the male breeding glands varied with

changes in plasma testosterone. This study showed that male and female cycles were well synchronized and that although reproductive activity may occur throughout the year, peak reproductive activity occurred during spring and summer months.

Sexual dimorphism and seasonal reproduction in the South African fresh water turtle, *Pelomedusa subrufa* (Chelonia: Pelomedusidae)

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Pelomedusa subrufa is a freshwater turtle widely distributed throughout Africa and Madagascar. Apart from anecdotal notes, very little is known about the biology of this species. We examined body morphometrics and reproductive parameters of female and male *P. subrufa* turtles. Blood and tissue samples were collected from wild specimens, supplemented by tissue samples obtained from museum specimens. Sexual size dimorphism in *P. subrufa* was pronounced, and data show that adult males were larger than adult females in the seven of eight traits measured. However, there was no difference in the rates of increase in these traits between sexes. In females vitellogenic recrudescence began in summer (December), and continued through winter with ovulation occurring in spring (September-October). Females mostly produced a single clutch during the spring/summer period (September - January). Clutch size varied between 7 - 37 eggs, with the number of eggs being significantly correlated with maternal body size ($R = 0.82$, $P < 0.001$). Plasma estradiol and vitellogenin concentrations peaked once during the ovarian cycle, coinciding with the period of vitellogenesis in summer. Plasma testosterone varied throughout the year, but significant increases were measured during the ovulation and mating period in spring. Plasma progesterone concentrations were significantly elevated during the gestation period prior to ovi-position in summer (December). In males, recrudescence began in summer, following emergence from winter and mating occurred in spring. Peak testicular volume and maximum spermiogenic activity occurred in autumn followed by testicular regression during winter. Spermatozoa were stored in the vas deferens throughout the year. Plasma testosterone concentrations peaked once during the testicular cycle, coinciding with spermiogenesis in late-summer and autumn (February-March). Female and male reproductive cycles were asynchronous in that the peak spermatogenic activity occurred in autumn at the time when most females were depositing yolk in growing ovarian follicles. Therefore, adult females displayed a typical post-nuptial vitellogenic cycle and adult males displayed a typical post-nuptial spermatogenic cycle.

Beauty and the beast - the evolution of sexual dichromatism in Afrotropical tree frogs

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Afrotropical tree frogs (Hyperoliidae) form a monophyletic group with approximately 20 genera. Numerous species of the genus *Hyperolius* (>120 species) display drastic chromatic change in all adult females and some adult males (sexual dichromatism, SDI). The same is observed in some species of *Heterixalus*, a genus endemic to Madagascar. Most other hyperoliids lack SDI. We reconstructed ancestral character states of SDI at genus and species levels applying likelihood and parsimony reconstruction methods. The generic tree was based on three genes (16S, 12S and cytb), whereas the *Hyperolius* and *Heterixalus* species tree for more than 40 *Hyperolius* species and 11 *Heterixalus* species was based on 16S rDNA only. Ancestral character state reconstruction indicates that SDI evolved independently in three generic lineages of Hyperoliidae. At species level, SDI was gained more often than it got lost. Ridelys test revealed no significance for concerted evolution of SDI and ecological factors

The resurrection of oceanic dispersal: biogeography of the Madagascan herpetofauna in the molecular age

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Since the validation of plate tectonics, historical biogeography has been dominated by vicariance hypotheses to explain disjunct distributions of taxa. Madagascar is known to be separated by salt water barriers from Africa since ca. 130 million years ago and from India since ca. 90 mya. Any vicariance explanation for the origin of the endemic Madagascan herpetofauna requires the assumption of extremely old ages of the corresponding clades, but such hypotheses have historically been brought forward for reptiles (e.g., chameleons) as well as frogs. However, current biogeographic methodology suffers from being unable to incorporate temporal information. As reviewed in this talk, molecular data have enormously improved the knowledge on the phylogeny of the Madagascan herpetofauna, with some "black boxes" still left for future research - especially geckos and typhlopoid snakes. Molecular clocks, although obscured by inherent biases and artefacts, in many cases lead to unequivocal evidence for a young age, and thus origin by dispersal, of the Madagascan lineages. The increasing number of studies using nuclear in addition

to mitochondrial genes strongly confirm this trend and lead to further methodological refinements. These studies have significantly contributed to a general shift of paradigm, in which oceanic dispersal is seen not as rare exception but as common mechanism - not only in reptiles but also in amphibians and mammals. Deciphering the origins of the fauna of Madagascar and surrounding islands in the Indian Ocean is a valuable exercise to become aware of the complexity of evolutionary history, often characterized by a mosaic of alternating events of vicariance, extinction and dispersal.

Regional diversity and endemism of Madagascan amphibians and reptiles: state of the art, methodological problems and perspectives

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Madagascar is well known as hotspot for biodiversity conservation. Several components of its biota are characterized by an extremely high degree of endemism and a high diversity. Despite intensive survey work during the past 15 years, the Madagascan herpetofauna is only incompletely known. The rate of discovery and description of new species has not slowed down, not even from well-known and intensively explored areas. This high degree of unknown species results in difficulties to reliably assess regional endemism and diversity. Such analyses also suffer from the undifferentiated use of species as terminal units for analysis. Standardized inclusion of molecular data may help to overcome these problems. Own analyses using a near-complete database of a mitochondrial gene for all ca. 200 nominal Madagascan frog species indicates that newly described species have similar divergences to those historically described, rejecting hypotheses of taxonomic inflation. In a DNA barcoding approach the percentage of sequences of novel "candidate species" was especially high in south-eastern and north-eastern Madagascar, indicating that taxonomic research should be focused on these regions. Assuming that molecular divergence proceeds roughly correlated with time, these divergence values can also be used to calculate the evolutionary history of taxa, and as a future perspective this parameter can be used to weight the importance of single species in regional hotspot analyses. Altogether, known amphibian species diversity in Madagascar has almost doubled since 1991, and is likely to reach 400-500 species according to own estimates.

Cytotaxonomy of Indian caecilians

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India is home to approximately twenty-five species of caecilians in the three families Ichthyophiidae, Uraeotyphlidae, and Caeciliidae. The taxonomy of some of these species is rather uncertain and new species have been regularly described in recent years, particularly from the Western Ghats, a recognised biodiversity hotspot. Within the Western Ghats caecilians are known both forested habitats and from cultivated areas where plantations and paddies have replaced the original forests. Karyotypic data can be very useful for helping to distinguish species or lineages both above and below the species level, and previous work on the caecilians of India and elsewhere have demonstrated trends towards reduction in diploid number and the loss of microchromosomes that correlate with 'advanced' reproductive modes and morphologies that suggest a more burrowing existence, and that can be further investigated using the broad diversity of Indian caecilians. We present new data on mitotic and meiotic chromosomes prepared from liver and testes respectively of a broad range of Indian caeciliids including representatives of all three families that have been collected in extensive recent fieldwork in the Western Ghats, particularly of Kerala and Karnataka. Differences among populations of Ichthyophis indicate considerable karyotypic diversification among known species and suggest the existence of previously unrecognised species also, whereas there is little karyotypic variation among the populations of *Uraeotyphlus* we have sampled. Indian caeciliids (*Gegeneophis* and *Indotyphlus*) have a range of diploid numbers (20-30), similar to the diploid number of the Seychelles caeciliids (26) that are their presumed closest relatives on the basis of molecular sequence data.

Scales of influence:- responses of a reptile community in fragmented woodlands in southern Queensland, Australia

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Remnant native vegetation has been extensively cleared for agricultural development in southern Queensland, Australia, over the past century. Resultant loss and fragmentation of habitat remains the biggest threat to the wildlife in the region. As a part of a broader project on ecological thresholds of habitat retention and management, this study examined relationships between reptile communities and the degree and patterns of fragmentation in a woodland ecosystem in southern Queensland. Sixty sites were sampled four times each by the active searching technique, and subsequent analyses were conducted on the 19 most abundant species in the sample. A range of variables influenced the structure of reptile communities in poplar box woodlands, including variables operating at the plot, patch and landscape scales. At the landscape scale, retained vegetation

cover was an important factor influencing the structure of reptile communities. Although habitat fragmentation influenced the whole reptile community, responses amongst individual species were not uniform. Species sensitive to fragmentation (decreaser species) were: the fossorial skink *Lerista muelleri*, the arboreal skink *Cryptoblepharus carnabyi*, and the arboreal velvet gecko *Oedura monilis*. Several species appeared to be tolerant of fragmentation, including: the terrestrial gecko *Heteronotia bineoi*, the tree skink *Egernia striolata* and the litter skink *Morethia boulengeri*. The clearest evidence of an increaser species came from the arboreal gecko *Gehyra dubia*, which was able to exploit more disturbed environments. This species was almost twice as abundant in areas with <30% retained vegetation (at the property scale), compared with more vegetated areas. This study highlights the importance of an integrated landscape approach to preserving reptile communities in remnant woodlands.

MHC-based kin recognition in *Xenopus laevis* tadpoles

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Kin-recognition abilities, first demonstrated 25 years ago in *Bufo americanus* tadpoles, now appear to be widespread among amphibians. *Xenopus laevis* tadpoles preferentially school with kin over non-kin even if unfamiliar with both. Kin recognition in fishes, rodents, and even humans makes use of highly polymorphic Major Histocompatibility Complex (MHC) genes. We tested whether *X. laevis* tadpoles discriminate among siblings based on shared alleles at the Major Histocompatibility Complex (MHC) class-1a locus. We determined MHC haplotypes by the polymerase chain reaction using sequence-specific primers (SSP-PCR). By mating MHC-heterozygous parents, we obtained families of full siblings that shared variable numbers of MHC alleles. We tested tadpoles for their preferences to associate with particular siblings based on numbers of MHC alleles that they shared. MHC-homozygous subjects preferentially schooled with stimulus groups with which they shared two MHC alleles over those with which they shared one or no MHC alleles. However, MHC-heterozygous subjects did not discriminate between siblings with whom they shared one or two MHC alleles, and MHC-homozygous test subjects did not discriminate between siblings with which they shared one or no MHC alleles. We conclude that the observed MHC-linked schooling preferences are based on allelic differences rather than similarities. We found exceptionally high levels of MHC polymorphism within wild *X. laevis* populations. Hence, a recognition system based on the MHC or closely linked genes should be sufficient for kin discrimination. MHC-based discrimination may be retained through ontogeny and thus serve to maintain MHC polymorphisms by facilitating disassortative mating.

Twenty five years of temperature dependent sex determination in turtles resulted in a revolution in conservation and management practices

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Since 1979 the number of publications on temperature sex determination expanded exponentially for about 10 years. TSD has now been demonstrated to occur in all species of sea turtles, all crocodylians tested, tuataras, a few lizards, most Emydidae, Testudinidae, Bataguridae, Pelomedusidae, Kinosternidae, Dermatemyidae, and Chelydridae. However, all Chelidae, Trionychidae, and Staurotypidae as well as snakes appear to have genetic sex determination. After decades of producing all male hatchlings most sea turtle programs were modified so that they are producing both sexes. Turtles which had been incubated under laboratory constant temperatures, marked with pit tags and released in the wild have been captured after more than 10 years and proven that the sex was in fact determined permanently in the laboratory. Intersex hatchling turtles have been shown not to become hermaphrodites but instead the gonad matured to a single gender. Today large scale conservation efforts are in demand for many species of turtles, there are not enough resources to protect all nesting areas for all species of turtles such that beaches which produce an optimum sex ratio must be selected for. Temperature data for nearly every square m of the earth are available from satellites so we can select which beaches are more likely to produce more females than males. Females of many species are known to store sperm, males and females are highly promiscuous, and many species of turtles in natural populations maintain sex ratios widely different from 1:1, thus producing more females produces more usable biomass rapidly, and in so doing offers the possibility of restoring populations at a faster rate. If funding agencies had granted our projects the \$\$ needed to implant pit tags into thousands of hatchlings 20 years ago we would now have the answers to survivorship and natal homing enigmas as well.

Behavioural biology of *Xenopus laevis*: implications for improved laboratory welfare

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Published studies on the behaviour and ecology of *Xenopus* species in natural habitats in Africa remain sketchy. After the initial 'natural history' interest in *Xenopus* in South Africa (coinciding with increasing use in the laboratory in the 1930s to 1950s), there has been little direct observation of behavioural biology and no

studies of population ecology. More is known from fieldwork on feral populations outside Africa. Most laboratory-based research (principally on *X. laevis*, in biochemistry, developmental, cell and molecular biology) suggests that *Xenopus* is a robust adaptable animal, tolerant of a range of environmental conditions. Indeed, this adaptability was an important factor in the adoption of *Xenopus* as a 'laboratory animal'. However, the most demanding current use of *Xenopus*, especially manipulation of oocytes in molecular studies, suggests that stress may be a significant factor in laboratory welfare producing ill-effects that handicap research efficiency.

Chemosignals in the Archaic New Zealand frog *Leiopelma hamiltoni*

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New Zealand native *Leiopelma* frogs use chemical signals as a primary means of social communication. We conducted experiments on *Leiopelma hamiltoni*, a terrestrial frog not known to vocalise in social contexts, in their natural habitat on Maud Island in the Marlborough Sounds, New Zealand. In the field, *L. hamiltoni* occupy small, well-defined home ranges, generally less than 25 m² in size. Individuals travel slowly over these home ranges at night, in humid conditions, and return to diurnal refuges as morning approaches. We collected frogs, held them in captivity for 72 hours, and then tested their preferences for substrates that they had marked themselves to those marked by conspecifics. Individuals showed evidence of self-recognition as they spent more time on their own substrates than on those marked by frogs collected from other home ranges. This social discrimination was strongest when subjects were exposed to chemosignals of conspecifics from home ranges that did not overlap with their own. To determine the source of the chemosignals used in social discrimination, we collected samples of skin secretions, urine, and faeces from subjects, and in further behavioural tests, we examined their saliency as signals of individual identity. Skin secretions were most effective in eliciting self-recognition, as subjects readily discriminated between their own odours and those of conspecifics based on exposure only to these secretions. Subjects also discriminated between substrates marked by self and non-self urine. However, subjects did not consistently discriminate between their own faeces and that of conspecifics. We currently are characterising *Leiopelma* chemosignals and examining the structure of their secretory glands, which share features with those used for chemical communication by salamanders. More generally, our work raises the possibility that chemical communication may complement bioacoustical signalling abilities to serve a variety of social functions in anurans.

Specific dynamic action in an ambush-foraging snake analogue, Burton's legless lizard (*Lialis burtonis*, Pygopodidae)

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Many animals exhibit a marked increase in metabolic rate after feeding, reflecting the cost of digesting and assimilating a meal. This phenomenon, known as specific dynamic action (SDA), is particularly pronounced in ambush-foraging snakes such as pythons and vipers, and its magnitude in these taxa is thought to be an adaptation to their habit of taking relatively large prey at infrequent intervals. Such species have low resting metabolic rates, saving energy by down-regulating their guts in the long stretches between meals. I investigated whether an independent evolution of an ambush-foraging snake, Burton's legless lizard (*Lialis burtonis*), displays similar physiological adaptations. I measured oxygen consumption of both unfed lizards and lizards given a meal representing 10% of their body mass. Experiments are ongoing, but results analysed thus far indicate that *Lialis*' resting metabolic rate (about 0.050 mL O₂ · g⁻¹ · hour⁻¹) and the magnitude of its SDA response (postprandial oxygen consumption about 3.5 times that consumed at rest) are close to numbers seen in some snakes. *Lialis*' physiological adaptations thus represent one of many convergences with ambush-foraging snakes.

First field metabolic rates for marine turtles: climate and fisheries a one-two punch for Pacific leatherback turtles

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Leatherback turtles, *Dermochelys coriacea*, are critically endangered and their unique physiological and life history traits make quantification of their energetic requirements crucial to conservation of the species. However, metabolism of free-swimming marine turtles has never been measured. We used doubly labeled water (DLW) on adult female leatherbacks to obtain the first field metabolic rates (FMRs) and water turnover rates for free-swimming marine turtles and used the FMRs to calculate the leatherback reproductive energy budget. The FMRs were within the range of reported values of resting metabolic rates for nesting leatherbacks and below values for active leatherbacks on land. These low FMRs suggest that leatherbacks use less energy while actively swimming than in their terrestrial activities. Using these data, we calculated the

energy costs of reproduction, migration, and foraging activities. Our energy budget estimations indicate that resource limitation might lengthen remigration intervals for Pacific leatherbacks as compared to Atlantic leatherbacks, thus decreasing the Pacific population's reproductive success and increasing its exposure to risk of pelagic fisheries mortality. Stochastic resource availability related to El Niño-Southern Oscillation (ENSO), combined with energetic constraints, is probably exacerbating the effects of a high incidental fisheries bycatch rate currently responsible for plummeting Pacific leatherback populations. Therefore, management strategies for fisheries should be more conservative and allow little, if any, take of leatherbacks if there is to be any reasonable hope for recovery of this species.

Sex allocation in squamates: the past, present and future

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Mathematical models suggest that reproducing females may enhance their evolutionary fitness by modifying the relative allocation of resources to sons versus daughters. Sex ratio theory is a specific case of more general sex allocation theory and considers situations when parents are able to control the gender of their offspring. While in its simplest form sex allocation theory predicts that offspring sex ratios should be maintained at parity, deviations may occur when environmental effects have different consequences for male and female offspring; in these cases maternal fitness may be enhanced by facultative skews in sex allocation. Although some remarkable examples of this phenomenon have been documented and sex allocation theory has rightly been hailed as one of the success stories in evolutionary biology because of its powers to explain patterns of allocation, its success is largely limited to invertebrates. Its success with vertebrate taxa has historically been far more limited and is currently strongly debated. One of the reasons is that theoretical and empirical studies of vertebrates are often unable to take into account the complications arising from vertebrate life histories and physiologies. Furthermore, few species have been studied sufficiently to unravel the complexity of factors that may affect sex allocation because of problems with access to large sample sizes, long-term datasets and experiments firmly grounded within natural history. Do squamates reptiles offer a way forward? We argue that squamate reptiles have not received the attention they deserve as models to study sex allocation (although as evidenced by this symposium this is changing). We will briefly review the current field of sex allocation in vertebrates and show how squamates provide outstanding models for empirical testing of theoretical models. Furthermore, we will argue that new, additional, insights into sex allocation biology arises from consideration of squamate biology, and present

suggestions for future research in this historically and currently important field.

An experimental test of the adaptive significance of temperature-dependent sex determination: an example using an Australian agamid lizard

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The sex of many reptiles is determined by the temperature embryos experience during development (temperature-dependent sex determination; TSD). A well-accepted hypothesis for the adaptive significance of TSD states that incubation temperature differentially affects the fitness of male and female offspring. For example, incubation temperature may differentially modify fitness-related phenotypes of males and females, or incubation temperature may affect the timing of hatching so the 'correct' sex is matched with its 'best' time for hatching. I tested these hypotheses using a TSD lizard (jacky dragon, *Amphibolurus muricatus*) native to southeast Australia. Eggs were incubated under 3 temperature treatments; cool (23 ± 5 C), intermediate (27 ± 5 C), and warm (33 ± 5 C), which produced females, both sexes, and females, respectively. Half the eggs within each temperature regime were given an application of Fadrozole (an aromatase inhibitor that blocks the conversion of testosterone to estradiol). This manipulation produced primarily male offspring at all incubation temperatures, thus decoupling the confounded effects of temperature and sex on offspring phenotypes and fitness. Incubation temperature did not differentially influence male and female phenotypes, but individuals from the warm incubation treatment hatched 6-8 weeks earlier than individuals from the cooler incubation treatments. All hatchlings were subsequently 'released' in semi-natural outdoor enclosures and allowed to grow to maturity. Because individuals from the warm incubation treatment hatched early, and thus had a head start, these individuals are likely to reproduce during their first summer and those from the cooler incubation treatments may not become sexually mature until their second summer. Thus, the effect of incubation temperature on the timing of hatching is likely to have a significant impact on the reproductive success of hatchlings. This ongoing experiment will determine if the fitness consequences of the timing of hatching differ between males and females.

The behavioral responses of amphibians and reptiles in microgravity

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Although few vertebrates have been observed in microgravity (<0.01G), certain behaviors are common. Most tetrapods (e.g., rodents, rabbits, cats, turtles, aquatic frogs) interpret weightlessness as if they are upside down and execute repetitive righting responses. However, some unusual behaviors have been observed in the past, including an aggressive display by a rat snake (*Elaphe quadrivirgata*) towards its own body, immobility in a caecilian (*Typhlonectes* sp.), and a skydiving posture in a tree frog (e.g., *Rhacophorus schlegelii*). We exposed 53 individuals from 23 species of amphibians and reptiles to microgravity on an aircraft that flew a parabolic path. The goal was to characterize their behavioral reactions to abrupt exposure to micro-G. Each animal experienced four parabolas, each of 20s micro-G duration. Fossorial caecilians (e.g., *Ichthyophis kohtaoensis* and *Dermophis mexicanus*) and amphisbaenians (e.g., *Geocalamus acutus* and *Leposternon microcephalum*) showed relatively limited movement in micro-G. Limbed quadrupedal reptiles that were non-arboreal (e.g., *Leiocephalus personatus*, *Leiocephalus shreibersi*, and *Scincella lateralis*) showed typical repetitive righting responses with enormous amounts of body motion and tail rotation. We interpreted these violent limb movements as futile attempts to grasp the substrate, and the tail rotations as characteristic of righting responses. In contrast, both arboreal (e.g., *Uroplatus henkeli*) and non-arboreal (e.g., *Palmatogecko rangei*) geckos showed skydiving postures. Terrestrial snakes (e.g., *Thamnophis sauritus* and *Elaphe obsoleta*) initially acted like the limbed terrestrial lizards in microgravity; they twisted violently. However, some individuals became quiescent when they managed to coil upon their own tails. This suggests that thigmotactic input can mute the vestibulomotor defense that these reptiles reflexively show in freefall. More genera of amphibians and reptiles have now been observed in micro-G than any other vertebrate class. The behaviors of these organisms in micro-G can be understood in light of their normal ecology and taxonomic relationships.

On the ecology of a snake at the Northern limits of its range: *Thamnophis sauritus* in Nova Scotia, Canada

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In Canada, the Northern Ribbonsnake (*Thamnophis sauritus septentrionalis*) is found only in southern Ontario and isolated pockets of southwestern Nova Scotia. Its autecology, movement patterns, and hibernaculum sites in Nova Scotia are undescribed. We used radio-telemetry, capture-mark recapture, and direct observation to: 1) assess abundance, summer activity and movement, and 2) locate hibernacula for *T. s. septentrionalis* in Kejimikujik National Park, Nova Scotia. In 2001, 105 individuals were marked, among which 13 adults were surgically implanted with radio-transmitters and tracked from May until November. In 2004 another 135 snakes were observed and captured, with data recorded on their physical characteristics behaviour, location and the surrounding environment. In April, newly emerged ribbonsnakes were found at the highest density in two relatively rocky areas at the edge of a flood plain. By mid May, all snakes were immediately adjacent to the nearest body of water. In September the snakes were concentrated at unusually high-density in a grassy area a few meters from the water. By mid October, the majority were once again in the rocky areas away from the water. Snakes were rarely observed basking fully exposed. Eleven observations of snakes feeding on anurans (Ranidae) and fish (Cyprinidae) were made. Despite radio telemetry, only one hibernaculum was found. The spring and fall snake concentrations suggest though that hibernation sites are in rocky areas near the water table. No individuals were seen in direct contact; however one individual in September was observed coiled around spike rush with its head elevated above the vegetation, and with 9+ other snakes nearby (< 5 m away). This suggests a breeding aggregation. Our observations indicate that *T. s. septentrionalis* is a sedentary, ambush predator on aquatic vertebrates. Its low activity rate and limited seasonal movements suggest that it may be at high risk of local extinction.

Radiotelemetry study of habitat use by queen snakes (*Regina septemvittata*) an extreme dietary specialist

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Queen Snakes (*Regina septemvittata*) are dietary specialists that feed exclusively on freshly molted crayfish. Although this species is relatively common in lotic systems throughout the eastern United States, few studies have examined its foraging ecology and none has used radiotelemetry. Over the past two years we have been studying the habitat use and activity patterns of two populations of queen snakes located in south eastern Ohio as part of a larger effort to understand the foraging strategies of this specialized predator. To date, twenty one adult queen snakes at two different locations have been implanted with radio transmitters and relocated on a daily basis for a period of six weeks (time restricted by transmitter battery life).

Snakes were relocated most frequently out of the water in a variety of microhabitats including rocks, man-made stone walls, debris piles, root knots, perches, and grass banks. When in the water, snakes were predominantly found in areas containing small to large boulders and/or emergent vegetation. A comparison of these observations with those on the distribution of the crayfish within the creeks suggests that queen snakes in general frequent those microhabitats most likely to hold the highest densities of crayfish.

Biogeography of West-African amphibian – spatial prediction based on satellite derived data

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More than 14 years of research throughout West Africa revealed a much higher amphibian diversity than previously assumed. Many new and cryptic species, as well as richer local species assemblages have been recorded. Therefore West Africa has to be recognized as a major amphibian biodiversity hotspot. However, amphibians in West Africa are highly threatened by anthropogenic induced habitat modification. Especially forest species have been shown to be severely influenced by fragmentation and logging. Satellite derived environmental parameters are a highly valuable tool due to their broad spatial and temporal resolution. Therefore they can be used for a region wide spatial prediction of amphibians and consequently for highlighting areas of conservation priorities. Investigating environmental factors which explain the present diversity pattern and the presence or absence of particular species, will also lead to an improved understanding of amphibian macroecology. This study investigates the importance of environmental parameters (e.g. elevation, vegetation, fragmentation) derived from satellite imagery to explain and predict amphibian diversity patterns. Several different satellite data providers were used (e.g. NOAA AVHRR, MODIS) and down scaled to 1 km ground resolution. We compiled amphibian community data for 484 species at 77 sites of 23 African countries. The species data base consist of own data, data gathered from the literature and museum collections. These data sets were merged using GIS and database capabilities and were predicted using spatial prediction models (e.g. Generalized Additive Models). The results can be used to highlight areas of conservation priority.

CITES: an overview of a treaty designed to protect species from overexploitation for international trade

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CITES, the Convention on International Trade in Endangered Species of Wild Fauna and Flora, currently has 167 member Parties. Designed to protect species from over-exploitation for international trade - whether commercial or non-commercial - the Convention regulates trade in tens of thousands of plant and animals species, most of which are not "endangered." Several hundred amphibian and reptile species are regulated by CITES, under one of the Convention's three Appendices. CITES is administered by the United Nations Environment Programme (UNEP) through a Secretariat in Geneva, Switzerland that is somewhat unique to Multilateral Environmental Agreements. The Parties to CITES meet every 2-3 years (Conference of the Parties) to update the species Appendices, interpret the text of the Convention, and discuss and debate implementation, enforcement, and administration of the Treaty. Between these meetings CITES is implemented via the guidance of the CITES Standing Committee, and two technical committees, the Animals and Plants Committees. CITES is enforced in most countries by Customs authorities, however, a growing number of Parties, such as the United States, utilize specialized wildlife law enforcement units for this purpose. Some of the critical herpetological conservation issues that CITES has dealt with, and continues to work on, include the trade in crocodylians and Asian tortoises and freshwater turtles, as well the snake skin trade, the harvest and trade of marine turtles, as well as the live pet trade in many species of reptiles and amphibians. Mr. Weissgold will discuss these issues and hopes to touch on the conservation implications of evolving interpretations of CITES.

Chytridiomycosis in Africa

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The sudden appearance of chytridiomycosis, as the cause of amphibian deaths and population declines in several continents suggests that its aetiological agent, *Batrachochytrium dendrobatidis*, was introduced into many of the affected regions. Evidence of a directional spread is visible from the pattern of amphibian declines in Australia and Central America. The current knowledge of the geographical distribution of *B. dendrobatidis* in Africa is very incomplete. Positive records have been detected in one west African, two east African and three southern African countries. The gaps in the distribution data do not imply a disjunct distribution, but rather reflects on the intensity of research effort into amphibian diseases on the continent. In South Africa, an ongoing survey has yielded positive records in 12 species of frogs and toads from three families. Collectively, five other species from the rest of Africa have been found to be

infected with *B. dendrobatidis*. *Chytridiomycosis* has been a stable endemic infection in southern Africa before any positive specimen was found outside this region. The prevalence in *Xenopus laevis* from South Africa has been stable over six decades and no geographical spreading pattern could be observed over time. The occurrence of *B. dendrobatidis* in the relatively resistant *X. laevis* that is disseminated globally through the scientific trade makes this species an ideal vector. Associated localized population declines have been observed in the Cape River Frog from Namaqualand, South Africa, while the Kihansi Spray Toad from Tanzania suffered a major species crash in August 2003.

The role of *Xenopus laevis* in pathogen dispersal

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The fungal pathogen, *Batrachochytrium dendrobatidis* has been responsible for amphibian declines in every continent where they occur, except Asia. The hypothesis that supports the pattern of declines holds that the disease was introduced to different countries. The earliest case of *B. dendrobatidis* to date was found for *Xenopus laevis* from the Western Cape coastal lowland in 1938 while recent population surveys indicate a range of prevalence from 0-100%. *X. laevis* from the Cape is a high-risk species for disseminating the amphibian chytrid fungus through the scientific and pet trade. *X. laevis* is highly susceptible to *B. dendrobatidis* infection but not to disease. The risks of exporting infected frogs have been investigated by following the trade route from collection to end-user. The infection is spread through multiple pathways within the country before frogs are selected for export. Histological evidence of *B. dendrobatidis* in frogs acquired from local suppliers in the Western Cape and in feral *X. laevis* populations indicates the involvement of the trade in the international dispersal of this pathogen. A protocol to minimise the risks of spreading the pathogen in South Africa and through export has been developed in collaboration with nature conservation authorities. The management protocol functions around critical control points that divide the process into manageable units. These include the handling of frogs in the field, housing practice for captive colonies and import/export regulations.

Unicellular glands in gecko skin

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In field observations of several gecko species, adhesive tags were placed on the animals' flanks to provide repeated and long-term identification. However, in the case of *Phelsuma laticauda* on Hawaii, unlike with the other gecko species, the tags failed to stick, and dropped off almost immediately. Seeking an explanation for this, we examined the skin of this and other gecko species. Viewed by SEM, the dorsal skin surface (but apparently not the ventral skin) in both *P. laticauda* and *P. klemmeri* showed a unique additional structure unknown in other geckos. As in other geckos and some other lizards the scale surface is covered by a "forest" of short spinules except in the area of the keel, and in most scales there are several small circular mechanoreceptive sensillae. But in the dorsal skin of the *Phelsuma* spp. many of the scales additionally show a few circular or elliptical bold spots in the spinule forest, their size roughly like that of the sensillae, their surface commonly a shallow depression with cluttered bottom, but sometimes elevated like a smooth low cushion. Like in SEM, in thin sections viewed by TEM, the dorsal skin of the *Phelsuma* spp. shows lying over the spots occasional clear dome-like structures, and embedded in the epidermis mucoid-filled goblet cells, which are interpreted as the precursors of the aforementioned "domes". Thus although classically the general integument of reptiles is devoid of glands, the dorsal skin of these geckos contains unicellular holocrine mucoid glands, which resemble those in the skin of fishes and larval amphibians, and to some extent also some of those within the multicellular holocrine glands in the preanal escutcheon scales of some geckos. We hypothesize that these dorsal unicellular glands serve to prevent foreign bodies from adhering to the skin.

The multidimensionality of herpetology expressed in integrative teaching

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Addressing the conservation of the world's herpetofauna in its environments necessitates good herpetologists with broad education. But ironically, zoological teaching is declining at all educational levels, at least in the more 'developed' countries, spawning ignorance of, even, what zoology, or herpetology, comprises. I developed a stepwise graphical explanation of the contents of zoology: (1) The classical bi-dimensional table, the rows harboring the higher taxa (in conventional systematic order), and the columns - the disciplines, e.g. morphology, physiology, ecology, biogeography. (2) A three-dimensional cube, two faces occupied as above, the third by organ-systems, e.g. skin, skeleton, eye. All components along each

dimension exist as professional specializations (e.g., ichthyologist, morphologist, dermatologist) and most sub-cubes defined by intersections exist (e.g., morphology of gecko skin). (3) Additional dimensions, such as place (geographical delimitation), time (ontogenetic or geological) or level of organization (molecular, cellular, community), are demonstrated by stacking many replicas of the initial cube as a macro-cube. Herpetology I regard as the slice of this multidimensional cake that, at the level of Amphibia and Reptilia, transects and involves all other dimensions. My undergraduate herpetology course including discussions, lab work and field trips, comprised 50% taxonomy and 50% biological phenomena. The phenomena were matched to suitable taxa. To give three examples, the lab session on agamids and chameleons included sexual dimorphism and colour change (with histological preparations), and was accompanied by a student seminar on thermoregulation. The session on geckos included, besides foot structure, ecology and physiology of the eye (with live demonstration of light adaptation) and a seminar on reptilian vocal communication. The session on venomous snakes included demonstrations and discussions of mimicry.

Analysis of some factors affecting foraging behaviour of a nocturnal ground lizard, *Goniurosaurus kuroiwae kuroiwae*

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In most lizards the foraging behaviour is either "widely foraging" or "sit and wait" but in geckos it varies and fluctuates, providing an opportunity to examine potential factors modulating the foraging mode. In an endeavour to identify these, marked individuals of *Goniurosaurus kuroiwae kuroiwae* (Gekkonomorpha: Eublepharidae) were observed during July-October 1999 on Okinawajima Island, Japan. The subtropical and nocturnal conditions presumably reduced the number of intervening factors. The statistical analyses including stepwise regression analysis, attributed relative responsibilities to individual factors. Using reflecting adhesive tape, 66 individuals were individually marked. These yielded 60 observation bouts of 30 min, including 28 individuals observed on more than one night. The foraging behaviour was active, relatively "widely foraging" compared to the "sit-and-wait" behaviour of most other geckos, and variable both within and between individuals. Individuals with empty stomachs showed increased activity. Various components of the foraging behaviour and the factors affecting them radically differed between the sexes. The body temperature of females averaged 10C higher than that of males. Female activity exceeded that of

males and increased during July-October, being highest after cessation of oviposition. In both sexes activity correlated negatively with the duration of observation bouts and positively with ambient temperature, receding around midnight. Under full moon males were more active but fewer females emerged from shelters. The effect of tail regeneration differed sexually. These innovative results dictate caution in the manufacture of foraging behaviour data for comparative purposes.

Spitting behaviour in two species of spitting cobras

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Spitting cobras defend themselves by spitting their venom in the face of a harasser or predator. Although it is common belief that spitting cobras direct their venom at the eyes of an aggressor, this has never been investigated. We investigated the spitting behaviour of spitting cobras by using real faces and hands or modified photos of faces as stimuli. We analyzed the spitting patterns on the targets and carried out high-speed video recordings of the spitting acts. Here we show that the spitting act of spitting cobras (*Naja nigricollis* and *N.pallida*) can readily be triggered by a moving human face or by a moving real size photo of a human face. In contrast a stationary human face (real or photo) or a moving or stationary human hand does not trigger the spitting act. If threatened, spitting cobras aim their venom, ejected either in two distinct jets (*N.pallida*) that form circles and semi-circles or in a fine spray (*N.nigricollis*), either between the eyes or at one eye. In both cobra species investigated, the width and height of the area hit by the venom was independent of eye base (test range 5.5 and 11 cm). During the spitting act the cobras performed fast undulating head movements that lead to a larger distribution of their venom. This behaviour increases the probability that at least one eye of an aggressor is hit.

Bright colours and UV signals in a lizard tournament

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Understanding the role 'bright' colours play in sexual signalling is a central theme in animal communication. We examined the role of colour signals in settling disputes among male rivals in an elaborately ornamented African lizard (*Platysaurus broadleyi*), played out in a large 'tournament', in the wild. Males with throats rich in UV but low in overall reflectance had the highest fighting ability. To a large extent, fighting ability also determined reproductive strategy. As a result, males with throats rich in UV held territories,

while males with violet throats tended to be floaters. Following this result, we conducted a field experiment where we manipulated (reduced) UV-reflectance in free-ranging lizards in the field. Preliminary analyses suggest that signal quality was compromised and males were forced to signal to rivals for longer. UV-reflective throats thus constitute a conspicuous, effective signal that males use to honestly advertise their status to rivals. Previous studies of birds have demonstrated a role for UV signals in male reproductive success through female preference for UV-rich males. We show that UV signals may also influence male reproductive success through their role in determining the outcome of contests.

Classification and phylogeny of caecilians (Amphibia: Gymnophiona)

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A brief look at the history of caecilian classification reveals continuing problems with the low level taxonomic foundations of caecilian biology and that these are associated with lack of material and/or lack of study. Variation is much better understood for some species groups than for others. Overall we have too little understanding of natural variation in characters that have been considered useful for distinguishing species or that might be, to have confidence in many of the species that have been described from but one or two specimens. Species limits remain poorly understood within many genera, particularly the speciose genera *Ichthyophis* and *Caecilia*. It is anticipated that much needed revisionary work on these and other genera will reveal numerous synonymies, as have been found in other groups, but that the overall number of caecilian species will rise both from newly collected material and from understudied historical collections. Molecular data is likely to play an increasingly important role, alongside morphology, in delimiting species. Several caecilian genera are probably not monophyletic and less extensive changes in the genus level taxonomy of caecilians are anticipated. Knowledge of caecilian phylogenetics has come from studies of both morphological and molecular data although both types of data remain underexploited. While some major relationships are now well understood and strongly supported by both types of data, others have proven equally difficult to resolve with either data type. Progress has been substantial but does not yet support a strictly monophyletic higher classification of caecilians. Through a combination of extensive fieldwork and appropriate sampling of taxa and genes and morphology, it should be possible to make rapid progress towards a comprehensive caecilian phylogeny that can be used to interpret caecilian evolution.

Palaeobiology and diversity of the turtle fauna from the late Miocene Urumaco formation in Venezuela

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The diverse turtle fauna from the Urumaco Formation (Late Miocene) includes the world's largest extinct turtle *Stupendemys geographicus*, the first reliable reported occurrence of a trionychid in South America, a fossil species of the matamata turtle, and at least two species of pelomedusoids, including *Bairdemys venezuelensis*. New fossils of *Bairdemys* show a great deal of cranial variation in features previously thought to be diagnostic for particular species. The lower jaw of *Bairdemys* has a large triturating surface, which together with the great development of a secondary palate is probably correlated with a diet consisting of hard molluscs. Discovery of a large nesting site demonstrates that *B. venezuelensis* was a colonial nester, which laid its eggs in beaches and lived in a marine or near-shore marine environment, providing the first direct evidence of the marine palaeoecology of this species. New findings of another pelomedusoid consist of several carapaces and postcranial elements of *Stupendemys*, which provide new information about the palaeobiology of this species. A carapace reached a total length of 3.3 mts, a histological study of which reveals that apparently this species did not follow any outstanding way of growth compared to other large turtle species to reach its giant size. Sharpey's fibers are present only in the external cortex of the neural hinting at some kind of anchoring of the overlying soft tissue (probably the upper strata of the dermis) that resides just below the keratinous shields. Comparisons of postcranial anatomy with fossils attributed to *Stupendemys* from Brazil, show that at least two species of this genus inhabited in the Miocene of the Neotropics. This work was supported by the National Geographic Society (7600-04 to MRSV).

Evolution of color and pattern polymorphism in the dyeing poison frog, *Dendrobates tinctorius* (Amphibia: Dendrobatidae)

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Evolution of color and pattern polymorphism in the Dyeing Poison Frog, *Dendrobates tinctorius* (Amphibia: Dendrobatidae) the Dyeing Poison Frog, *Dendrobates*

tinctorius, is a common anuran in the Guiana region of South America. Like many other members in the same genus, this species is highly polymorphic with respect to color and pattern. It was our goal to understand mechanisms of how polymorphism develops. For this purpose, we used standardised quantitative analyses of both color and pattern variation of more than 20 (conspecific) color variants of Dyeing Poison Frog. Our results revealed that the development of color and pattern among them are clearly correlated with each other. The various definable color and pattern elements originate from one plesiomorphic condition, from which they have developed gradually into different directions. Some elements appear to coincide with the frogs' phylogeny, while others can be understood as more adaptive characters, which may be triggered through sexual selection.

Feeding ecology of *Mantella aurantiaca* at Andasibe, Madagascar

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Mantella aurantiaca is a small, toxic, red frog, inhabiting a small area around Andasibe in Madagascar. It can be easily found in Pandanus forest, where it actively feeds within leaf litter in broad daylight. Very little is known about the diet of mantillas, and that of *M. aurantiaca* is particularly poorly understood. Here we describe the composition of the diet and relate it to the arthropod fauna found within the leaf litter in which they feed. One population was studied along a streambed and forest setting. New and recaptured frogs were measured (SVL, mandibular width and height), determined to be male, female, or juvenile, and had their stomachs flushed non-lethally. In total 101 stomachs were flushed and their contents preserved in alcohol. Arthropods in stomach samples were classified to the lowest possible level of classification. The arthropods found in leaf litter samples were identified and sorted out into size class. The composition of the arthropod samples in the stomach and leaf litter may provide an indication of food preferences within the habitats occupied by *M. aurantiaca*.

Micro-habitat selection and home range of the jacky dragon *Amphibolurus muricatus* in remnants of Eastern suburbs Banksia scrub

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The Jacky Dragon *Amphibolurus muricatus* is a semi arboreal Agamid Lizard from south-east Australia. The study site was a golf course in the Eastern suburbs of Sydney. On-site habitat includes small remnant patches of the Endangered Ecological Community

Eastern Suburbs Banksia Scrub. These patches are generally infested with African love grass forming a dense and continuous ground cover 0.3 to 1m high. The micro-habitat selection, home range, daily distance traveled and daily displacement of the Jacky Dragon was recorded using cotton spools attached to the lizard's tail. Connectivity between disjunct patches of remnant vegetation was investigated. Field-work was performed during a period of low lizard activity (May) and at the start of the breeding season (September). Males were found to defend small exclusive territories 343 +/- 271m² (N=7) in September, which occasionally overlapped with neighboring male territories. Activity of males increased significantly in September compared with April/May. The micro-habitats used were predominantly tussocks of African Love Grass, with small shrubs 1-2m high used less often. Lizards used standing dead vegetation, woody debris and the spikes of Grass trees *Xanthorrhoea resinifera* for basking and territorial displays. Territorial displays were only observed in September. Lizards readily moved small distances (<20m) between adjacent patches of vegetation but were not observed crossing larger distances, for example fairways (>50m). A habitat modification experiment was conducted by removing the invasive tussock grass.

Phylogeography of widespread African venomous snakes: is there a pattern?

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Comparative phylogeographic studies of co-distributed organisms can reveal common patterns of association between phylogeny and distribution, which may in turn highlight common historical causes underlying these distributions. In Africa, many widespread species complexes of reptiles and amphibians occupy a distribution corresponding either to the major forest/woodland blocks (the Guinean forest, the Central African rainforests, and the east coast of Africa), or to the intervening areas of more open vegetational formations. Here, we use mitochondrial DNA sequences to investigate phylogeographic patterns in seven widely distributed species or species complexes of venomous African snakes (Elapidae and Viperidae: *Naja haje*, *N. melanoleuca*, spitting cobras, *Dendroaspis*, *Bitis arietans*, *B. gabonica*, *B. nasicornis*), and use molecular dating methods to estimate the timing of lineage splits. Our data reveal hitherto unsuspected genetic divergence in many species groups, which suggests the presence of cryptic species in some groups. Some phylogeographic patterns are repeated across multiple groups, such as the presence of considerable phylogeographic breaks between the Guinean and Central African forests. These contrast with more recent divergences between Central African and eastern coastal forest populations, whereas others reveal incongruent phylogeographic patterns.

Endeavours into the ecology of giant bullfrogs - some preliminary results

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The Giant Bullfrog's (*Pyxicephalus adspersus*) newly acquired "Near-Threatened" IUCN status prompted the inception of a research project designed to fill major voids in our understanding of the ecology of this species. To improve current descriptions of the geographic distribution range of Giant Bullfrogs in South Africa, the first nation-wide photographic "Giant Bullfrog Survey" was launched. To illuminate the structure and functioning of Giant Bullfrog breeding aggregations, three wild aggregations were targeted for mark-recapture sampling. The toes of bullfrogs that were clipped for the purposes of "marking" each study animal with a unique number, were used additionally to: i) age the sampled bullfrogs using skeletochronology; and ii) quantify genetic variation between different bullfrog populations using DNA-sequencing. Furthermore, to investigate their movement patterns, spatial habitat requirements, and burrowing behaviour, more than twenty individual bullfrogs were implanted with radio-transmitting telemers, which allowed these frogs to be tracked with more or less success. Some preliminary results from these various research endeavours are discussed, with special reference made to their implications for the conservation of Giant Bullfrogs in South Africa.

Mitochondrial DNA divergence in Chinese populations of black spotted frog (*Pelophylax nigromaculata*): implication for late Pliocene vicariance

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This study examines the phylogeography of *Pelophylax nigromaculata*, a widespread frog in temperate China. The average 8% sequence divergence of the mitochondrial cyt-b gene and 5' end control region indicates that this species is composed of two deeply split clades, PN-A and PN-B. PN-A consists of two lineages A1 and A2, which present relatively low sequence divergence of 1.2%. Lineage A1 covers most of the species' range in China, whereas lineage A2 and B were found restricting to Southwest and Northeast China respectively. Estimate of molecular clock indicates that the initial vicariance of the two clades took place at about late Pliocene, a period when Siberian periglacial taiga had expanded southward and covered Northeast China. In this period, clade PN-A moved southward into relatively mild regions from

Northeast China. Clade PN-B retreated into Korea Peninsula and then the two clades evolved separately for a long time. The star-like haplotype net-work within lineage A1 combined with slight nucleotide variation and high haplotype diversity indicates that A1 had experienced rapid population expansion. During the warm and long period of Pleistocene, clade PN-A and PN-B met again by recolonizing Northeast China. Earlier than this, lineage A2 recolonized Southwest China and consequently evolved independently with restricted gene flow to lineage A1.

Morphometric variation and relative growth in African lizards of *Agama* group: adaptive and evolutionary implications

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ABSTRACT (250-300 words max.)

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Lizards species of *Agama* group (Moody, 1980) in Africa belong to six genera (*Agama*, *Stellio*, *Trapelus*, *Pseudotrapelus*, *Brachysaura*, and *Xenagama*) which are distributed in different habitats and different zoogeographical regions of the continent. Twenty seven (27) external body dimensions and 40 scalation characters of 18 species of this group including the genera *Agama* s.s., *Stellio* and *Trapelus* with respectively 13, 3 and 2 species (a total of 528 specimens from collections of the National Natural History Museum of Paris, France) were analysed to investigate morphometric variation and relative growth among species. An attempt was made to analyse these taxa according to morphological characteristics and to correlate these variables with habitat quality and behavioural traits. The results indicated that many species *Agama* group studied taxa segregate on the basis of morphometric and habitat features. Morphological differences among species were expressed by differences in behaviour and ecology; species that were similar morphologically were also similar in their ecology and behaviour. It was noted that the most of the variation in morphology and performance could be explained by differences in body size. Habitat structure seems to be important in determining locomotor behaviour through changes in limb proportions. Among the morphometric characteristics, variations in fore- and hind limbs, and body length were dominant discriminating features, especially between stenoec and allotrope species: ground dwellers (from sandy desert to moist savannas) and climbers (from rocky desert to tropical rain forests). Many of the species studied have strongly allometric growth. Allometric change tends to be more rapid in smaller species. Relative growth reflected the ecological adaptations of each species. Comparisons

of the obtained results were made with the published phylogenetic trees based on morpho-anatomical and molecular characters. Morphometric data appear to be more useful taxonomically at the generic level than in the specific one. Allometric or growth coefficients may be useful as phylogenetic indicators.

Water, energy and food requirements in the Moorish tortoise, *Testudo graeca graeca*, in Western Morocco

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Water influx (WI) and Field Metabolic Rate (FMR) were measured with Doubly Labelled Water in free-ranging adult Moorish tortoises, *Testudo graeca graeca*, [Body weight (BW, g) range: 338 - 916] through a year (July 2002 to May 2003) in an arid area of Central Jbilet Mountains, Western Morocco. Microhistological techniques were used to identify plant fragments in tortoise faecal pellets using plant epidermal features. Food consumption, in term of dry matter intake, was also assessed, by calibrated production of faeces in captive tortoises in late spring. Aboveground activity extended over the warm seasons (between February to November) with tortoises remaining buried over two months in summer which help them to cope with the extreme environmental conditions occurring in that season. After a period of activity in autumn, they brumate underground through December to January. Mean WI [mL.(kg.d)⁻¹] was 4.4 ± 2.4 in summer and more than 4 times in autumn-late winter and spring (18.8 ± 5.9 and 19.8 ± 9.5 , respectively). Mean FMR [kJ.(kg.d)⁻¹] was 18.7 ± 2.8 in summer and decreased to 13.1 ± 7.6 in autumn-winter. These values are much low and only 20 and 23.4% of those predicted for tortoises of the same BWs. Production of faeces (FP, g dry weight in 7 days) scaled to body weight 0.65 [FP = $0.137.BW^{0.65}$], and this represent the scaling of dry matter digestive ability which was found to be $65.5 \pm 5.8\%$. The Mean Daily Dry Matter Intake by captive tortoises was significantly related to production of faeces ($r = 0.80$; $p < 0.0001$) and was 5.96 ± 2.32 g.(kg.d)⁻¹. Dry weight percentages were predicted for each main eaten plant species identified from faecal samples, directly from its relative density calculated by the frequency conversion technique using microhistological techniques. Potential food resources are a critical factor to improve survival of this species and its conservational management.

Demography and population dynamics of a Bibron's agama population in Western Morocco

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A population of the North African lizard Bibron's agama, *Agama impalearis*, was studied for six years (from 1993 to 1998) at an arid area of Western Morocco. Demographic parameters were assessed using Multiple mark-recapture methods from 1993 to 1996. The reproductive season was extended in that most of females produced two-clutches of 14 eggs each (range: 5-24 eggs). Annual Reproductive output, growth rates and survival rates were more or less affected by yearly changes in rainfall. Population density showed seasonal low changes and absolute spring density estimates varied from 11 and 15 individuals /ha according to the year. In the postreproductive period, the population density (excluding hatchlings) markedly declined and was only of 4-6 ind./ha. After the completion of the hatching period, the densities of hatchlings were 11 and 13 ind./ha, respectively in 1993 and 1994, while in 1995 and 1996, they were much higher and respectively of 22 and 28 ind./ha compensating thus for the adult losses. The average annual turnover rate of the population did not show a significant change and was of 77%. Adult survivorship after the reproductive activity varied among years and was relatively low within a same season (3.2 to 13%). Juvenile survival during the hatching period was relatively constant and averaged 23% and about 90% of youngs did not complete their first year of life. The predation pressure (the tail injury rate) was relatively high and varied considerably among years, seasons, sexes and age classes. Three life tables showed similar cohort generation times of 1.85 years in average. The net reproductive rates (R0) were of 0.555, 0.838 and 1.279 respectively in 1993-94, 1994-95 and 1995-96 with age one (and also two for 1995-96) contributing most to these rates. On the basis of most of demographic attributes, the studied population tends rather to adopt a classical r selection strategy, but more recent life history theories are discussed.

Trends of reptile species in the Netherlands from long term monitoring

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The Dutch reptile-monitoring program started in 1994 in order to detect changes in populations of the seven native reptile species, of which six occur on the National Red List of Threatened Species. Reptiles are counted by volunteers using a standardized transect-

sampling method. Recruitment of volunteers has proven to be successful with a total of 320 sampled transects in 2004. Trends are calculated using a loglinear regression method. Possible artefacts are corrected for. In 2004, after eleven years of monitoring it is evident that significant positive trends occur for *Lacerta agilis* and *Podarcis muralis*. Both species benefit from a longer reproduction season due to global warming, and from conservation measures. *Lacerta*

vivipara is the only species that is in decline on national scale, where populations of *Natrix natrix* and *Vipera berus* are stable. The trend calculations for *Coronella austriaca* and *Anguis fragilis* have strongly improved after adjusting the analyses. These trends appear significant like those of the other reptile species. The main target of the Dutch Reptile Monitoring Program, to produce reliable trends, is reached. Results and trends will be shown and discussed of all species.

POSTER ABSTRACTS

The influence of forest fragmentation on community composition of leaf litter amphibians in Taï and Lamto regions, Côte d'Ivoire

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The destruction of forest ecosystems is a serious problem leading to major losses of bio-diversity (flora and fauna). The effect and extent of this destruction on biodiversity may be examined and/or expressed relatively fast by studying the presence or absence of known biological indicators (bio-indicators). Amphibians may be used as bio-indicators because they are animals that appear in abundance, are very sensitive to climatic and environmental change (terrestrial and aquatic) and have a short life span. This survey focuses on leaf litter amphibian communities in the fragments of Taï and galleries of Lamto forests in Côte d'Ivoire. Species behavior is studied under different levels of forest degradation in order to assess their suitability as bio-indicators. Both quantitative and qualitative harvesting methods, including standardized (visual and acoustic) sampling and pitfall traps, are applied. Fifteen fragments in Taï and 36 sites (50m x 50m) in Lamto will be studied over an 18month period. Results were expected to confirm the influence of forest deterioration, but not fragment size, on amphibians. However, preliminary results in Lamto show that both fragment size and degradation influence amphibian community composition and predictability. Final results should allow accurate prediction of influence of forest degradation and fragmentation on amphibians in general, thereby allowing their use as bio-indicators.

Trends in amphibian diversity and abundance at Lake Nabugabo and Nyakalengijo in Rwenzori Mountains National Park, in Uganda

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In Uganda nineteen genera and 92 amphibian species have been documented. In the face of accelerating declines in amphibian populations, it is crucial to be able to effectively identify conservation priorities, both in terms of species and localities. Rapid assessment of amphibian community structure is therefore essential. We compare the species diversity and abundance in two ecosystems which will constitute monitoring sites, over an 11-year period, using similar methods but whilst adding one additional new method. The study was carried out in Lake Nabugabo and Nyakalengijo in Rwenzori Mountains National Park Uganda and sampling was carried out during both the dry and wet season, using several methods. At Nabugabo, 14

species of amphibians were recorded in 1994, and 24 species in both 1999 and 2004/2005. The predominant species in all years were *Hyperolius cinnamomeoventris*, *Afrivalus fulvovittatus*, and *H. nasutus*. But *Hy. cinnamomeoventris* had increased considerably whilst *Hoplobatrachus occipitalis* and *Phrynobatrachus natalensis* showed marked declines. Seven species from the earlier collections of 1999 were missing in 2004/5 but only 3 from the 1994 collections were missing in 2004/5. But 4 additional species were found. These changes suggest that there may still be additional species as yet undiscovered. Four species that were recorded in the earlier study were not encountered in 2004/5 but four new species have been added. The change in species diversity in Lake Nabugabo may be due to human activities in the area such as burning which affects the ecosystem whilst at Nyakalengijo it may be attributed to some change in climate. It is also possible that the areas of study that were sampled in 1994, 1999 and 2004/05 were not quite the same. So we recommend that the sites and methods for monitoring be standardized as the basis for a national monitoring programme. The number of man-hours and work effort significantly enhanced species saturation. Comparison of species by altitude showed fewer species as the altitude increased. We recommend that a transect census and recording of calls should be performed.

Behavioural responses of the tadpoles of the Iberian midwife toad, *Alytes cisternasii*, to chemical cues of an exotic predator, *Procambarus clarkii*

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Alytes cisternasii is an endemic species from the Iberian Peninsula. This species reproduces preferably in lotic habitats, where tadpoles are more usually found in stony substrates and *Procambarus clarkii*, an introduced crayfish, is more usually found in finer substrates. The aim of this study was to understand if stony substrates were used as refuge in the presence of chemical stimuli of *P. clarkii* or in the presence of chemical stimuli of conspecific predated by *P. clarkii*, and to assess the survival probability of tadpoles in those substrates. Three experiments were made: 1) importance of periphyton in the selection of the stony substrate; 2) behavioural responses of *A. cisternasii* tadpoles to the presence of chemical cues of *P. clarkii* and predated conspecific; 3) influence of the substrate on the survival of *A. cisternasii* tadpoles in the lethal presence of *P. clarkii*. Our results suggest that tadpoles don't prefer the stony substrate as a food resource. Tadpoles had behavioural responses only during the night period to chemical cue of *P. clarkii*, staying more active and using more the margins and less the refuge

than in control. In the presence of predated conspecific stimulus tadpoles went to the margins and to the water surface. In the presence of chemical cues, the use of the stony substrate was never higher than in control. *A. cisternasii* tadpoles recognise *P. clarkii*, a predator crayfish recently introduced in Portugal, and changing the use of vertical microhabitat seems to be an adaptive response to the predation strategy of *P. clarkii*. Staying at the stony substrate didn't protect tadpoles from *P. clarkii*, which had more success in damaging tadpoles (tail cuts) in that substrate. Probably, tadpoles use stony substrates in nature in order to lower the encounter rate with predators, less abundant in those substrates. *A. cisternasii* is a vulnerable species to *P. clarkii*'s predation; however, since they already seem to recognise this predator and use behavioural responses adapted to its predation strategy, tadpoles of this species can coexist with it in areas of low density of *P. clarkii*.

A new diploid number for the neotropical genus *Leptodactylus* (Amphibia, Anura, Leptodactylidae)

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The genus *Leptodactylus*, is distributed from southern Texas throughout lowland (< 1800 m) Mexico, Central America, portions of the Greater and Lesser Antilles, and in South America on both sides of the Andes to Peru on the west and Argentina on the east. It comprises about 62 recognized species arranged in four "species groups": *fuscus*, *melanonotus*, *ocellatus* and *pentadactylus*. The karyotypes of 24 species have been described; most of them were exclusively based on conventional staining with description of chromosome number and morphology. Overall, *Leptodactylus* species have 22 chromosomes with slight differences in chromosome morphology of some species. Our studies on *L. gracilis*, *L. mystacinus*, *L. petersii*, *L. pustulatus*, *L. macrosternum*, *L. ocellatus* and *L. labyrinthicus* from many localities of Brazil agreed with the genus having $2n=22$. However, our analysis of *L. silvanimbus* from Honduras showed a peculiar unique karyotype for the genus, $2n=24$, composed of bivalent chromosomes. Nucleolar organizer regions (NORs) were detected in two chromosome pairs in *Leptodactylus*: at the proximal region of the long arm of pair 4 in *L. petersii* and in pair 8 in the other species (at the terminal region of the short arm in *L. silvanimbus*, *L. ocellatus*, *L. macrosternum*, *L. pustulatus* and *L. labyrinthicus*; at the interstitial region of the short arm in *L. gracilis*; and at the long arm in *L. mystacinus*). *Leptodactylus silvanimbus* has a relictual distribution and relationships with other species of *Leptodactylus* are uncertain, however recent molecular data suggest that it may have a basal position in the genus. The diploid number reported here for *L. silvanimbus* could represent the ancestral diploid number of *Leptodactylus* and the

$2n=22$ karyotypes would then represent the derived condition in the genus. Additional studies including morphologic and molecular are necessary to clarify the position of *L. silvanimbus*.

Morphological characterization of the infralabial glands of "goo eater" snakes (Colubridae: Dipsadinae)

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Among recent reptiles, there is a great variability of oral glands, classified according to the region they are localized. Because of the great diversity of snake oral glands, their morphological study constitutes a promising field for the understanding of snake biology and phylogeny. Infralabial glands are present in all snakes and generally secrete mucous substances. However, among the dipsadines, they are well developed and their secretion is predominantly serous. This fact is possibly associated with peculiar feeding mechanisms of this group in which most species feed on soft and sticky invertebrates and, for this reason, are known as goo-eaters. We have studied the histology and histochemistry of the infralabial glands of *Atractus zebrianus*, *Dipsas albifrons* and *Sibynomorphus mikanii*. The glands were prepared for histology in glycol metacrylate and serial sections were stained with toluidine blue-fucine and submitted to periodic acid-Schiff (PAS), bromophenol blue (BB) and alcian blue (AB) pH 2.5. Anatomical data show that these glands are very large when compared to other colubrids, and are located along the external side of the articular and mandibular bones, just below the infralabial scales. Although all three species retain infralabial glands that are subdivided in lobuli and constituted of prismatic cells organized in acini, morphological and histochemical inter-specific differences were observed. In *A. zebrianus*, as well as *S. mikanii*, the glands are weakly positive to BB. In *A. zebrianus*, however, in the same acini, cells were positive to BB, AB and PAS. In *D. albifrons*, the glands show reduced internal spaces, a strong reaction to BB and a peripheral differentiated region composed of colunar cells with granules positive to AB and PAS. Our data indicate that the morphology of infralabial glands can be used for the better understanding of Dipsadinae phylogeny and biology. Financial support: FAPESP, CAPES and Fundação Butantan.

Taxonomic re-evaluation of the two subspecies of *Leiolepis belliana* (Hardwicke & Gray, 1827) (Sauria: Agamidae)

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Detailed comparisons are made between *Leiolepis belliana belliana* and *Leiolepis belliana ocellata* for the first time on the basis of karyological study. There are considerable differences between these subspecies, which suggest that both forms should be more appropriately treated as independent species. *L. b. belliana* had $2n = 36$ chromosomes and karyotypic formulae was $10m+2sm+24mc$ (12 macrochromosomes and 24 microchromosomes) whereas *L. b. ocellata* had $2n = 34$ chromosomes and karyotypic formulae was $10m+2sm+22mc$ (12 macrochromosomes and 22 microchromosomes). The comparisons with other closely related species will be discussed from the morphological data and cytotoxic point of view.

Using GPS to establish HR to assess SS and RS

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Sexual selection (i.e., competition for mates) has been studied in a wide range of organisms, but with a slant towards species with parental care such as mammals and birds. This may underestimate the importance of genetic mate choice on offspring fitness because post-parturient parental care may buffer the effects of genetic make-up in estimates of offspring fitness. We are using an intensive field-based program to examine aspects of sexual selection and offspring fitness in a population of snow skinks (*Niveoscincus ocellatus*). We have access to a population of mature snow skinks where all individuals are marked and known (70 females and 60 males). Using independent repeat field observations (N = 780 observations) we have identified the potential mates of every female (i.e. those males whose home ranges overlap with hers and/or occur within typical movement distances). While many studies stop at this point and use home range overlap to estimate male reproductive success, we have developed an array of microsatellites to assign paternity with a great degree of confidence. Females were monitored with respect to the number of copulations received (they have pronounced copulations scars) and were brought to the laboratory for birth. At birth, standard measures offspring phenotypic characteristics will be measured before offspring are released. Paternity within clutches will be assigned and determinants of male reproductive success established. The effect of the identity of the father, mother and offspring phenotype on fitness

(growth, dispersal and survival) of the released offspring will be described.

Captive husbandry and breeding of a laboratory collection of the inland taipan, *Oxyuranus microlepidotus*, with a record of three consecutive clutches

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The inland Taipan, also known as the small-scaled snake or western Taipan was rediscovered in 1972 after no specimens was collected since the two specimens in 1879. It is a highly venomous Australian elapid that occurs in very harsh habitat in the center of Australia. After its discovery in 1879 it remained unknown for almost a century. After the first captive breeding in 1983 the inland taipan has been bred commonly in captive collections. I describe the husbandry and breeding of a laboratory collection of this species held for venom extraction at Venom Supplies Pty Ltd in Tanunda South Australia. The animals in this group originated from Goyders Lagoon, South Australia. Double clutches from the inland Taipan has been recorded in captivity, herein we also include a record of three consecutive clutches. In these clutches the relative clutch mass (RCM) went up from 49.53 % in the first clutch to 71.29 % in the third clutch. The number of eggs also went up from 10 fertile eggs to 17 fertile eggs, respectively. The egg sized was considerably smaller on average when comparing the third clutch to the first. The average weight of the eggs in the third clutch was 40 % less than in the first clutch, and the length and width was 25 % and 6 % less than in the first clutch, respectively.

The role of the MHC in disease resistance in *Xenopus laevis* tadpoles

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Given recent cataclysmic amphibian declines, understanding the mechanisms involved in disease resistance is becoming increasingly urgent. The Major Histocompatibility Complex (MHC) is an integral part of the vertebrate adaptive immune system and has been well characterised in *Xenopus laevis*. To elucidate the importance of the MHC in conferring disease resistance, I challenged *X. laevis* tadpoles, with known combinations of MHC alleles, to lethal and sublethal doses of *Aeromonas hydrophila*. This ubiquitous bacterium, although commonly associated with "red leg" in frogs, tends to affect already immunocompromised individuals. I exposed six MHC types, three homozygous and three heterozygous, to *A. hydrophila* that I had isolated from sick frogs, and I measured the tadpoles' growth and developmental

rate. Initial results suggest an inconsistent effect of heterozygosity at sublethal doses of this pathogen. MHC type significantly affected development and growth, although there was no interaction between MHC type and exposure dose. In one experimental series, homozygotes developed more rapidly than heterozygotes, but in a second series, heterozygosity had no effect. Across both experiments, MHC type significantly affected developmental rate although no individual MHC type consistently developed faster than any other. Possibly the ubiquitous nature of the pathogen generates strong directional selection for resistance, thereby making all alleles equally resistant. Alternatively, the results might be attributable to the low exposure dose or the context-dependent nature of disease resistance. Research is currently underway to assess the effect of MHC heterozygosity on *X. laevis* larval survival when challenged with higher doses of *A. hydrophila*.

Snake names - Dutch dictionary: Slangen en Hun Naam

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Although species names actually can be considered to have no other meaning than just being a binominal label for identifying the species concerned, it is true that the words forming binary combinations apart and often together have a meaning or may have been derived from some source without that being immediately clear. It is therefore customary and wished for indeed to mention meaning or derivation when a new name is formed. Many people often are interested to know what a scientific name might mean or how that has been derived. Vernacular names to some extent present comparable problems, whereas in this case folk lore or the evolution of language also play their part. It is my intention to give some general considerations about nomenclature, popular as well as scientific, followed by a section on vernacular names and misconceptions. Then a list of snake genus names with author, number of species, gender (corrected if necessary), meaning of the word and type species. Next a list of specific epithets – in them selves of course no names at all! – with meaning or derivation as well as possibly some binomina to illustrate or compare the species they do then represent. As a matter of fact when preparing this work the English meaning will almost automatically come into the picture, as will be the case with French and German. So a multilingual tabular version might be possible except for the species given where a few lines become necessary. My first aim is the Dutch edition.

Small-scale phylogeography of Galapagos lava lizards (genus *Microlophus*): patterns of colonization and demographic history

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Galapagos lava lizards inhabit almost all 60 islands, islets and rocks that are part of the archipelago. Two major colonizations of the archipelago appear to have shaped the extant diversity. The “eastern” clade includes only two species from the two easternmost islands (Marchena [*M. bivittatus*] and San Cristobal [*M. habellii*]). The “western” clade includes 7 putative species (*M. albemarlensis*, *M. jacobi*, *M. indefatigabilis*, *M. delanonis*, *M. grayii*, *M. pacificus*, and *M. duncanensis*) from multiple islands. Despite the abundance and obvious suitability for evolutionary studies, *Microlophus* population history within the Archipelago is poorly known and no studies have been conducted to test associations between genetic and geographic variation. In this paper we reexamine and extend the results obtained in the previous phylogenetic assessment of the entire genus by sampling extensively through the Archipelago and by using fast-evolving genetic markers to retrieve genealogical information for island populations. We sample > 600 lizards representing 60 localities and implement coalescent information-based methods (Statistical parsimony, NCA; isolation-migration) to test alternative hypotheses of between-island colonization and to estimate demographic parameters.

Snake richness, abundance and mass in two areas of an Atlantic rainforest area (Ilha do Cardoso, Brazil) with different environmental productivity

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Environmental productivity is an important factor influencing species richness, diversity and mass of organisms that a particular habitat can maintain. At the rainforest of Ilha do Cardoso (25°03'S, 47°53'W), an island (22,500 ha) located in Cananéia municipality, São Paulo State, Brazil, we analyzed (from May 1993 to April 1994) the richness, composition and mass of snakes in a lowland forest and in a sub-montane forest. We related these parameters with the productivity of the areas in terms of arthropod, fruit and small mammal availability. Monthly, indexes of arthropod (in mm³) and fruit (g) availability were estimated, respectively, by establishing pit-fall traps on the ground, and collecting fallen fruits along trails. The small mammals were sampled in a grid with 120 traps which covered the lowland forest (5.2 ha) and the sub-montane forest (3.6

ha). The abundance and mass of the small mammals were standardized for the size of each sampled area (in g/ha). We established 20 pit-fall traps in each area and monthly performed transects in four 1000 m long trails to sample snakes. Snakes found were measured, weighted marked and released. The areas differed consistently in the richness, composition and mass of snakes and in the productivity of arthropod, fruits and small mammals. We found 45 individuals (total mass = 9884 g) of 12 snake species belonging to three families (Colubridae, Elapidae and Viperidae) in the lowland forest, whereas in the sub-montane forest only 9 individuals belonging to 2 species (total mass = 1820g) were recorded. Our data suggested that the lowland forest maintain a richer and a higher mass of snakes, because the productivity of arthropod, fruits and small mammals are greater.

Fetal membranes as exaptations for viviparity: evidence from ultrastructural studies on corn snakes (*Pantherophis guttata*)

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Fetal membranes of oviparous reptiles are responsible for gas exchange, uptake of calcium and water, and protection of the developing embryo. How these functions are accomplished is poorly understood, partly due to the scarcity of detailed anatomical studies. As a result, we lack information vital to a reconstruction of how these membranes have been modified during the evolution of viviparity. This study represents the first electron microscopic investigation of fetal membranes in an oviparous snake. In corn snakes (*Pantherophis guttata*: Colubridae), as in most squamates, the eggshell is lined by two fetal membranes with distinctly different morphological features -- the chorioallantois and the omphalallantois. During development, the chorioallantois shows an increase in vascularity and a decrease in thickness of the chorionic epithelium. These features enhance respiratory exchange across the eggshell. By mid-development, a substantial omphalopleure and isolated yolk mass separates the allantois from the eggshell. However, through digestion of the isolated yolk mass, the omphalopleure becomes converted into a "secondary chorioallantois". Both the chorioallantois and the omphalopleure phagocytose eggshell material. Coupled with recent studies of eggshell morphology and calcium mobilization, these findings offer evidence for the uptake of eggshell material by the fetal membranes. In viviparous squamates, placental transfer of organic and inorganic nutrients appears to be universal. Like gas exchange, the capacity for uptake by the fetal membranes may be a primitive reptilian feature that represents an exaptation for viviparity

The spleen in adult *Typhlonectes* (Amphibia, Gymnophiona)

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The anatomy, histology and development of spleen have been investigated in *Typhlonectes compressicauda* and *T. natans*. Spleen is a bottle-shaped organ situated at the posterior tip of liver. Histological investigations show the presence of both a red and a white pulp. Antibodies directed against the axolotl IgM and IgY, were used in parallel with the antibodies directed against the light chain of both IgM and IgY of axolotl, allowed to visualize B lymphocytes by means of an immunocytological technique. The results also show that these molecules are about identical in Axolotl (*Ambystoma mexicanum*, a neotenic urodela) and Typhlonectids. T lymphocytes have been visualized by an immunocytochemical reaction using an anti CD3ε. Several ramified cells were observed with scanning electron microscope. On sections, some ramified cells were also visualized with an anti-CD1a. These cells were supposed to be dendritic cells.

These observations suggest that the typhlonectid spleen is a lymphopoietic organ and a source of dendritic cells. The authors thank J. Fellah for the gift of Axolotl antibodies.

The study and protection of Horsfield's tortoise in Uzbekistan

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Horsfield's tortoise is wide spread on desert regions of Central Asia. Most of the typical habitats of the tortoise in 8 regions had been thoroughly inspected. Head counts took place in April, when the animals surface after their winter hibernation. The horsfield's tortoise is distributed irregularly on the Uzbekistan territory. Cultural lands in the valleys of large rivers are unfit for tortoise inhabitation. The area of habitats was reduced due to continuous anthropogenic disturbance. On some irrigated territories of Kashkadarya and Surkhandarya valleys the small insulated populations have been kept till now. The mountain landscapes with stony slope are unfitted for tortoise as well. On the altitude above 1100-1200 m a.s.l. it is found rarely. Also the tortoise avoids the saline (solontchak) and clay (takyr) plains without vegetation. For sandy desert with bush and thin

ephemeral vegetation the tortoise population was low – usually below 1.0 individual per hectare. The largest density of tortoise population was registered on desert biotopes between contour lines 300 – 800 m a.s.l. The piedmont plains and foothills (adyrs) of the Uzbekistan mountain system are located on this altitudes. The density of tortoise population closely depended on ground, soil and vegetation conditions. The number of species varied from 0.1 to 3.0 ind/ha on stony-loam piedmont plains near mountains. For foothills formed by loose loam and loess deposits this indices were considerably above – 4.6 ind/ha (Babathag range), 11.5 ind/ha (Malguzar range), 44.9 ind/ha (Nuratha range), 11.5 ind/ha (Karchinsky steppe). However, on an average in these sites of censuses the density of tortoise population varied between 5.0-20.0 ind/ha. In order to preserve the natural populations, control must be tightened over legal captures and measures must be taken against pouching of the tortoise. Breeding and growing the tortoise in captivity on legal breeding farms can become one of the ways of reducing the volumes of commercial capturing for international pet trade.

Sexual dimorphism in body size and tail length in the European grass snake (*Natrix natrix*)

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Sexual dimorphism in body size is a common phenomenon among animals as a result of sexual selection and niche partitioning. Many species of snakes exhibit sexual dimorphism in tail length, with males usually having relatively longer tails than females. Despite of the importance of tail length for mating success, there are very few studies concerned with the tail allometry in snakes. Previous studies of the European Grass Snake (*Natrix natrix*) have shown, that the females are larger than males and that the males have relatively longer tails. However, sexual size dimorphism index is not constant and differs between populations. The only published study of tail proportions in this species showed an isometric growth pattern for both sexes. Here I present evidence that it is not true of all populations. I studied a European Grass Snake population from the “Stawy Milickie” Nature Reserve in SW Poland. I measured the snout-vent (SVL) and tail (TL) lengths, and marked each measured individual. The mean female SVL is significantly greater than the male SVL, but males have relatively longer tails. However, the relative TL decreases with increasing SVL in the males, (negative allometry), whereas this ratio remains constant in the females (isometry). This suggests that the importance of having a longer tail decreases for a male with the increasing body length, thus allowing for a better allocation of energy resources. The TL does not decrease in females possibly because it serves as a fat storage.

Amphibian skin glands as source of chemical signals

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Secretions of many exocrine glands of the *Amphibia* function as signal molecules for survival strategies or social communication. The antipredatory arsenal of these vertebrates mainly consists of poisons produced by skin glands, serous in nature, randomly distributed on the body, or localised in “critical” skin regions, as the parotoid glands of toads and frogs and the caudal glands of some salamanders. The products of these glands consist of different bioactive substances acting as repellent, alarm substance or “venom” with peculiar toxicity and pharmacological actions. Chemical signals released from other cutaneous glands, usually mucous in nature, are involved in social interactions. These odours, named “pheromones”, may be used among conspecifics to recognize sex, social status and reproductive condition. Competitive interactions often include marking and defence of a territory, and chemical signals are critical to furnish advertisements of territorial boundaries. In addition, production of pheromones by the males increase the probability that the female will become sufficiently receptive, so that fertilization can occur. Glands producing courtship pheromones are common in males of *Urodela* and *Anura*, although with different anatomical and morphological characteristics. Emblematic examples of breeding glands in the urodeles are some cutaneous and cloacal gland clusters occurring in the plethodontids, namely mental and vent glands, respectively. Other cloacal glands (dorsal glands) releasing chemical signals during the mating are known in the salamandrids. Although chemical cues are less common in anurans than in urodeles, males of some anurans (e.g. ranids) also produce mate attractants, which sources are referable to specialised exocrine glands. In some cases cutaneous glands may produce “glue” for clasping pairs, as the secretion released on the thumb nuptial pads of many frogs and toads. Finally, secretions from integumentary components have been reported in some parental care adaptations, as in the case of incubation and/or transport of eggs and embryos on the back skin of a nurse adult.

The Amphibia of Gabon: still a time for great discoveries

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The amphibian faunal assessment for Central African countries, as per Frétey and Blanc (2000), set the tally for Gabon at 72 species. This figure was improved by at least 25% in the following four years, resulting from a spate of herpetofaunal assessments conducted during this period. Most noteworthy of these were five surveys within the Gamba Complex of Protected Areas in south-western Gabon, an initiative driven by the Smithsonian Institution's Monitoring and Assessment of Biodiversity Program (SI/MAB), in collaboration with Shell Foundation and Shell Gabon. Another substantial effort was driven by WWF-Gabon, and included surveying some of the most prominent biodiversity localities within Gabon. Most of the 25% increase in richness consists of known species that were new to Gabon, including genera new to Gabon, i.e. *Leptodactylodon*, *Trichobatrachus*, *Werneria*, *Hemisus*, *Hoplobatrachus* and *Kassina*. But several species new to science and endemic to Gabon have also been discovered, three of which were recently named: *Leptodactylodon stevarti* Rödel & Pauwels 2003; *Werneria iboundji* Rödel, Schmitz, Pauwels & Böhme 2004; *Leptopelis crystallinoron* Lötters, Rödel & Burger 2005. A system of 13 national parks was established in Gabon in 2002, comprising 11% of the country's area. As part of these surveys, herpetological work has been conducted in four of these, the richest being Moukalaba-Doudou National Park with 70 amphibian species recorded thus far. A long-term objective of these surveys was to train in-country biologists so that alpha-level taxonomy could proceed with a national drive. The tasks of local biologists in future should be to focus investigations at localities above 500 m in altitude, because these are regions of endemism, and to survey the remaining national parks. Although the greater part of Gabon is currently still under rainforest, most of this is already under logging concessions. The results of these surveys should be applied to protect additional portions of this rich and special biodiversity zone.

Embryonic development and eggshell thickness: recovering three viviparity origins in genus *Sceloporus*

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Oviparity is the basal condition of genus *Sceloporus*, nevertheless, viviparity has raised three independent times within the genus: 1) in a clade formed by *torquatus*, *grammicus* y *megalepidurus* groups, 2) in the *formosus* group and 3) in the *scalaris* group, which contains oviparous and viviparous species. We reconstructed the transition from oviparity to viviparity in the genus mapping two characters over its phylogeny: intrauterine embryonic development stage and eggshell thickness. Under normal conditions all the oviparous *Sceloporus* lay the eggs in the embryonic development stage 30. However, they display a variety of responses to hydric stress. Some species retain eggs and maintain embryonic development in the oviduct beyond the stage 30; even females of oviparous *S. scalaris* can reach stage 40 (full development). Consequently, facultative viviparity could be an intermediate step between oviparity and obligated viviparity. Mapping this character through the genus point out that the *scalaris* group ancestor could maintain embryonic development during retention periods. On the other hand, *megalepidurus*-*grammicus*-*torquatus* clade is not associated to species that can continue embryonic development in utero. Whereas *Spinopus*, sister group of *formosus*, could maintain embryonic development, but their ancestor. Eggshell thickness varies among species; it is positively correlated to egg mass, which is determined by the female size. We suggest that viviparity was originated in small species, because their eggs have thin eggshells that enhance mother-embryo water and gas interchange. It is supported by female size of the viviparous groups ancestors.

Parentage analysis and parental care of *Chirixalus eiffingeri* (Anura: Rhacophoridae) from Taiwan

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Genetic parentage analyses have uncovered many details of reproductive natural history in different animals, notably insects, birds and fishes. The results have also given us revolutionary insights into evolutionary models of animal reproductive and parental care behaviors. *Chirixalus eiffingeri* is a rhacophorid tree frog that breeds in arboreal pools and has unique parental care behaviors. The males stay to attend the clutches during the embryonic period and females provision their offspring, the tadpoles in the pools, by laying unfertilized eggs. It is a good animal model to study the patterns of genetic parenthood and evolutionary ecology of parental care behaviors in the arboreal reproductive mode. We developed 11 polymorphic microsatellites as genetic makers for parentage analysis to resolve the ecology of parental care. The numbers of alleles per locus ranged from 2 to 17. The observed and expected heterozygosity averaged 0.433 and 0.656, respectively. Total exclusionary probability of these loci is 0.984 when no

parental genotypes are known, and is 0.999 when one of the parental genotypes is known. The results indicate that the 11 markers should provide sufficient resolution for inferring genetic parentage in *C. eiffingeri*. Combining with behavioral observations, we would resolve the detail in the reproduction and parental care behaviors in this tree frog.

Endoparasites of five species of Anurans in Thailand

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Amphibians are used as environmental quality index. Declining of amphibian populations are seen by many as a high of deteriorating environmental quality, such as loss of important habitat, increasing ultraviolet radiation, pathogens and predators. Recently, the latter hypothesis has received considerable attention that parasites may be responsible for some amphibian declines. During 2002-2003, specimens of 5 species of anurans in Thailand, that included 26 *Polypedates leucomystax*, 7 *Bufo melanostictus*, 9 *Fejervarya limnocharis*, 11 *Limnonectes pileatus* and 7 *Hoplobatrachus rugulosus*, were examined for helminths, protozoa and blood parasites. The following parasites of internal organs were found: 1 species of Trematoda (*Mesocoelium* sp.), 4 species of Nematoda, (*Aplectana* sp., *Cosmocerca* sp., *Rhabdias* sp. and *Oswaldocruzia* sp.), cystacanth of 2 species of *Acanthocephala* and 2 species of intestinal protozoa (*Opalina* sp. and *Balantidium* sp.). Four species of blood parasites were found: *Trypanosoma* sp., *Hepatozoon* sp., *Lankesterella* sp., and *Aegyptianella* sp. (*rickettsia*). *Hoplobatrachus rugulosus*, the frog that serves as food resources for human in Thailand, harbored the most species of parasites. Moreover, 100 %, 71 %, and 14 % of *Hoplobatrachus rugulosus* were infected with *Hepatozoon*, *Lankesterella* and *Aegyptianella* respectively. These blood parasites infected wide range of invertebrate and vertebrate hosts including many species of mammals. This amphibian-parasite system provided valuable information for biologists to use selected system as an introduction to address several controversial areas in biology.

Conservation of amphibian and reptile diversity in agro-ecosystems

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The present study was performed in central Tuscany (Italy), in an area highly subjected to anthropic pressure. The landscape is dominated by wide arable land characterized by intensive rotation of winter and durum wheat, and fodder crops somewhere alternated by grazing fields, but wood areas (*Quercus* and other shrubs) are also present. Our study is part of a wider research on animal diversity, which also includes arthropods, and micro-mammals. We have tried to determine if the Amphibian and Reptile diversity depend on the different microhabitats occurring in the different cultivations; therefore meadows, grass stripes, cultivated stripes, riparian habitat, intensive culture fields, forest patches have been surveyed. The data derive from Amphibians and Reptiles occasionally fallen into pitfall traps devoted to the arthropod capture and water tanks devoted to hydrological observation, and direct field observations. Many Amphibian and Reptile species present in Tuscany (e.g. *Triturus carnifex*, *T. vulgaris*, *Bufo bufo*, *Chalcides chalcides*, *Podarcis sicula*, *P. muralis*, *Lacerta bilineata*, *Hierophis viridiflavus*, *Vipera aspis*) have been recorded according to a pattern highly related to the microhabitat characteristics. As a rule in agricultural habitats some species as *Triturus carnifex*, and *P. sicula* are the most abundant species. They have been mainly found in meadows and in grass stripes between the cultivated fields. In the riparian habitat many species have been also found as *Triturus vulgaris* and *P. muralis*, the latter is relatively less abundant than *P. sicula* in agricultural environments although it has been found in five of the six studied habitats where shrubs or structures like walls and small bridges were present. These data suggest how important is the maintenance of marginal zones in agricultural land, such as hedgerows, uncultivated field stripes provided by grass soil cover.

Effects of an introduced crayfish, *Procambarus clarkii*, on the breeding site distribution of the Iberian ribbed salamander, *Pleurodeles waltl*

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The introduction of exotic species has been suggested as one of several causal factors of worldwide amphibian declines. The American crayfish *Procambarus clarkii* has been introduced in all continents except Antarctica and Australia. In the 1970's, it was introduced in the Southwest Iberian Peninsula, where there are no native crayfishes. In a mesocosm study *P. clarkii* reduced egg and larval survival of all Southwest Iberian amphibians. However, its effects on natural communities are still to be quantified. The effects of a species introduction are hard to quantify since species are rarely introduced singly or in the absence of other changes like habitat destruction. Our study was focused on a SW Iberian

Peninsula and NW Africa endemic salamander, *Pleurodeles waltl*, and was conducted in the Grândola region, Southwest Portugal, a roughly 1500 Km² area containing numerous water bodies with and without crayfish in both altered and natural areas. In the majority of the natural areas, no other aquatic introductions have been recorded. To quantify the effect of crayfish presence on the distribution of *P. waltl*, simultaneously accounting for potentially confounding variables that may be correlated to the presence of the predator, we used a forward, interactive, stepwise regression with 37 habitat and biotic variables and then added the variable "crayfish presence" to the model obtained. *P. waltl* was found in 41.9% of the water bodies without crayfish and only in 3.6% of the water bodies with crayfish. This salamander uses mainly lentic habitats, choosing temporary, large ponds with submersed vegetation. After accounting for environmental variables and other large predators presence/absence, crayfish presence is still a significant, negative, predictor of *P. waltl* distribution and its inclusion in the model substantially ameliorates its prediction capacity. Our results suggest that *P. clarkii* is capable of excluding *P. waltl* from its breeding habitats. In recent years there has been increasing evidence of amphibians declines (Blaustein and Wake, 1990) and predation by exotic species has been suggested as one of several causal factors (e.g. Fisher and Shaffer, 1996; Adams, 1999; Knapp and Mathews, 2000; Hamer et al., 2002). The red swamp crayfish, *Procambarus clarkii*, originating from North America, has been introduced in all continents except Antarctica and Australia (Hobbs et al., 1989). In the 1970's, it was introduced in the Southwest Iberian Peninsula (Ramos and Pereira, 1981), where there are no native crayfishes (Almaça, 1991), and thus no functionally similar predators. In a mesocosm study *P. clarkii* reduced egg and larval survival of all Southwest Iberian amphibians (Cruz and Rebelo, in press). However, its effects on natural communities are still to be quantified. The effect of a species introduction is hard to quantify since species are rarely introduced singly or in the absence of other changes like habitat destruction (REFS?). Most studies that try to relate the decline of a native amphibian species to a particular introduction are usually based on experimental predation trials where habitat and community structure are simplified (e.g. Lawler et al., 1999), or are based on distribution comparisons (e.g. Hayes and Jennings, 1986; Hecnar and M'Closkey, 1996), not capable of establishing a causal relation. To quantify the effect of crayfish presence on the distribution of *P. waltl*, simultaneously accounting for the effects of potentially confounding variables that may be correlated to the presence of the predator, we used a forward, interactive, stepwise regression with XX habitat and biotic variables and then added the variable "presence of crayfish" to the model obtained. The Grândola region, Southwest Portugal, contains a mosaic of water bodies with and without crayfish. It comprises both altered and pristine areas, and in the majority of the late no other aquatic introductions have been recorded

(livro da hra?). *P.waltl* was found in 41.9% of the water bodies without crayfish and only in 3.6% of the water bodies with crayfish. *P.waltl* uses mainly lentic habitats and prefers temporary, large ponds with submersed vegetation. After accounting for environmental and biotic variables, crayfish is still a significant predictor of its distribution and the inclusion of the variable crayfish presence substantially ameliorates the model prediction capacity. Our results strongly suggest that *P. clarkii* is capable of excluding *P. waltl* from its breeding habitats. *P.waltl* was found in 31 of the 74 water bodies without crayfish and only in 2 of the 55 water bodies with crayfish.

Effects of an exotic crayfish, *Procambarus clarkii*, on the tadpoles of the Iberian spadefoot toad, *Pelobates cultripes*, living on temporary ponds

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The American Red Crayfish, *Procambarus clarkii*, was introduced in the Iberian Peninsula in the early 1970's, spreading rapidly through its southwest, a region with no native crayfish species. *P. clarkii* is known to actively predate eggs and larvae of several amphibian species. However, its impacts on amphibian communities in natural habitats are still to be evaluated. In a uniform landscape in Parque Natural de Doñana, SW Spain, we sampled a network of temporary ponds colonized by the crayfish and ponds that are never colonized. Most of these ponds are the breeding sites of the Iberian spadefoot toad, *Pelobates cultripes*, maintaining its tadpoles throughout most of the hydrological year. Our main goal was to assess *P. clarkii* impacts on the tadpoles of *P. cultripes*, focusing both on its effects on tadpole densities and in the fitness of the tadpoles and metamorphs. In ponds without crayfish, *P. cultripes* reached higher abundances than in ponds without crayfish. When the crayfish is present, both tadpoles and metamorphs were smaller than in ponds without crayfish. By the end of the reproductive season, the frequency of injured tadpoles was much higher in ponds with crayfish. Since during metamorphosis the tail is reabsorbed and its reserves are allocated for the metamorphosis processes and for growth, tail injuries may delay metamorphosis or lead to a small size of the metamorph; this may be an explanation for the small sizes observed in the metamorphs of ponds with crayfish. These results show that *P. clarkii* may have a major impact in the reproductive success and in several components of the individual fitness of *P. cultripes*. Thus, *P. clarkii* may play an important role in structuring amphibian communities in natural habitats.

Frog species richness and composition in coastal Brazilian restinga habitats

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We studied the species richness and composition of frogs in ten restinga habitats (sand dune environments dominated by herbaceous and shrubby vegetation) along approximately 2000 km of coast of three Brazilian States: Rio de Janeiro (Grumari, Maricá, Massambaba, Jurubatiba and Grussaí), Espírito Santo (Praia das Neves and Setiba) and Bahia (Prado and Trancoso). All areas were surveyed under similar sampling effort in the wet season to eliminate differences among areas due to seasonal effects. At each area, the survey involved a total of 80 h of search (20 man/hours), using transects with active search in the different microhabitats available and by dissecting 200 bromeliads. We found 28 frog species belonging to the families Hylidae, Microhylidae, Leptodactylidae and Bufonidae. The richest restinga was Praia das Neves, where we found 13 frog species, followed by Grussaí and Trancoso in which 8 species were found. The commonest frog species in the restingas was *Scinax alter* (found in eight restingas), followed by *Aparasphenodon brunoii* (seven areas). The frog fauna along restinga habitats was significantly nested (matrix community temperature = 26,130; $p=0.00705$) with Praia das Neves being the most hospitable area for the frogs. Our data shows that richness and composition of frog communities tend to vary consistently in restingas along eastern Brazilian coast. Also, frog faunas in restinga areas occur in a nested pattern in which the current frog assemblage of each area partially seems to represent a nested subset of the original assemblage. This, in part, probably results from the intensive fragmentation of restinga habitats. Our data also showed that the most hospitable restinga was Praia das Neves and this area must be protected as a conservation unit. Probably, many frog species may have been lost in some studied areas as a result of the extensive degradation under which restinga habitats presently are.

Niche differences among sympatric lizards in a sand dune habitat of southeastern Brazil (Jurubatiba, Rio de Janeiro State)

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Differences among sympatric lizard species usually result from differences in resource use at primarily

three dimensions: space, time and food, or some combination of them. We analyzed the temporal, spatial and food niche of five sympatric species (*Cnemidophorus littoralis*, *Tropidurus torquatus*, *Gymnodactylus darwini*, *Mabuya agilis* and *M. macrorhyncha*) from Jurubatiba "restinga" (22°17'S, 41°41'W), Rio de Janeiro State, Brazil. Food niche breadth was based on the number of each prey category in the stomachs. Temporal niche was measured performing transects in the area and counting the number of active lizards at each hour interval. Spatial niche was estimated by the frequency of utilization of different microhabitats. Niche breadth for each species was estimated using Simpson's index of diversity and the similarity between species in the above niches by the coefficient of symmetry of overlapping (Ojk). All species were active during diurnal period. *Tropidurus torquatus* (Bij=11.4) had the widest temporal niche breadth whereas *M. agilis* and *G. darwini* the narrowest (Bij=3.0). *Tropidurus torquatus* had the largest spatial niche breadth (Bij=3.03) with *M. agilis* and *G. darwini* having comparatively narrower spatial niches (Bij=1.0). *M. macrorhyncha* had the widest food niche (Bij=6.47) and *C. littoralis* the narrowest niche breadth (Bij=1.45). *T. torquatus* and *C. littoralis* had the largest overlap in spatial niche (Ojk=0.98) whereas the greatest similarity in the food niche occurred between *M. agilis* and *C. littoralis* (Ojk=0.99). The similarity in temporal niche was comparatively lower among species and the highest overlap occurred between *T. torquatus* and *M. macrorhyncha* (Ojk=0.69). The data indicate that, time seemed to be the most important niche dimension differentiating these lizards which may, in turn, facilitate their coexistence at the restinga of Jurubatiba. We conclude that, at Jurubatiba, differences in resource utilization among sympatric lizard species may simply reflect their specific ecological needs rather than competitive pressures.

The critically endangered micro frog colonizes a man-made wetland

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The Micro Frog (*Microbatrachella capensis*), endemic to certain coastal lowland wetlands in the southwestern Cape of South Africa, is a Critically Endangered species with specialized habitat requirements. One of the four populations of this frog is threatened by housing development. Consequently, in 1994, an attempt was made to create a man-made breeding site for this species in a protected nature area <1 km away from the threatened population. After being excavated in a suitable seepage area, this newly designed wetland was left to be colonized by the indigenous wetland vegetation of the area, in the hope of it eventually providing suitable micro frog habitat. Ten years later, during the 2004 micro frog breeding season, a small population of these frogs was found to

have colonized this wetland site. This finding has promising implications for the management and conservation of this highly threatened species.

Regional variation of subdigital setae and seta-like outgrowths on digit IV of the tokay gecko (*Gekko gecko*)

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Gecko setae interact with locomotor surfaces through van der Waals forces to produce an adhesive bond (Autumn *et al.*, 2002). There is a direct relationship between setal geometry and force generation. Setal characteristics such as spatula diameter and number of tips apparently dictate adhesive capabilities. Estimates of maximal adhesive force have assumed that setae are identical throughout subdigital pads. There has been no examination of setal variation throughout the subdigital region of any gecko species, even though some aspects of interspecific variation are well documented. Here we investigate the form and distribution of subdigital Oberhäutchen elaborations throughout pedal digit IV of the tokay gecko (*Gekko gecko*) as an exemplar of structural variation in this taxon. This digit is subdivided into three zones according to morphology and function: the distal region encompassing scansors associated with the penultimate phalanx; the intermediate region that includes lamellae associated with the short intermediate phalanges; and the basal region including lamellae underlying the proximal phalanx. Differences in distribution, length of epidermal outgrowths, basal diameter and tip diameter are reported for each zone of the digit and are related to the gross morphology of the digit. Setal length decreases from distal to proximal along the length of the digit, as does basal diameter. For each individual lamella or scansor, setal length also decreases from distal to proximal, but branching pattern appears to remain constant. The distribution of elaborations, shape and dimensions of setal tips from the distal region of the digit differ greatly from those of elaborations on more proximal zones. We relate form and distribution of elaborations to their function in relation to the locomotor kinematics of *Gekko gecko*, and to the evolution of van der Waals-type interaction of setae from less elaborate structures.

Courtship behaviour at low and high water temperatures in the Alpine newt

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Environmental factors are known to have a major effect on behavioral patterns of organisms. Among these factors, temperature particularly affects ectotherms.

However, although many studies focused on acoustic communication, the effect of environmental temperature on visual courtship displays and sexual performance has been little explored. The aim of this work was to determine the effect of temperature on the sexual behaviour of the Alpine newt *Triturus alpestris* in controlled laboratory conditions. Temperature had a major effect on the two sexes: at low temperatures, the frequencies of several displays, including sperm deposition, is lowered. This variation is in fact caused by the female responsiveness, which is temperature-dependent. However, some other behaviours, such as the fanning movement of the male's tail (i.e., the main courtship display) are directly dependent on temperature: at lower temperatures, the tail beats at a lower rate but for a longer time. The similar reproductive success at the two temperatures indicates that breeding in cold water is not necessarily costly. It allows males and females to mate early in the season. This is particularly adaptive because, in many habitats, the reproductive period is shortened by drying or freezing conditions which may impair survival of branchiate offspring.

Feeding and reproductive ecology of the common chameleon *Chamaeleo chamaeleon* (Linnaeus, 1758) and the African chameleon *Chamaeleo africanus* Laurenti, 1768 from Greece

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In Greece there are two chameleon species, the Common Chameleon *Chamaeleo chamaeleon* (Linnaeus, 1758) and the African Chameleon *Chamaeleo africanus* Laurenti, 1768. The Common Chameleon has the broadest distribution of all chameleon species. The distribution of this species in Greece includes the Aegean islands of Samos, Chios, and Crete. The African Chameleon in Greece (and Europe) is found only at a locality near Pylos, W.Peloponnese. The results of the food and reproductive analysis of the Common Chameleon and the African Chameleon are presented. A comparison of the different species and sexes is also included. This is the first time that information on the diet of Greek specimens of the Common Chameleon and the reproduction of both species is presented. Most of the animals used in this study had been found killed by cars. The two chameleon species studied are euryphagous and feed mainly on insects. The diet tends to differentiate between both the two species and the sexes of the two species. The mean and range of

food item number found was 7 items, 0-44 in *C. chamaeleon* and 15 items, 0-50 in *C. africanus*. The most prevalent prey types found in the stomachs of the Common Chameleon were Coleoptera, Hymenoptera, and Diptera, while for the African Chameleon were Coleoptera, Hemiptera, and Hymenoptera. Plant material forms an important part of the diet of the studied chameleon species. Both chameleon species reach sexual maturity the first year. They both lay their eggs once a year, from the end of August until the beginning of November and incubation continues for 11-12 months. The Common Chameleon lays 4-31 eggs (mean: 16) and the African Chameleon 4-43 (mean: 23.5). We found that the Common Chameleon lays larger eggs than the African Chameleon (mean length and width for *C. chamaeleon* 15.32X9.78 mm, for *C. africanus*: 12.77X8.00mm).

A mine of information: palaeoenvironmental associations of a Sauropterygian community in Northern Alberta, Canada

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Between 1992 and 2000, nine large marine vertebrates (seven plesiosaurs and two ichthyosaurs) were serendipitously recovered from an expansive oil sands mine operated by Syncrude Canada, Ltd. The fossils are revealed during systematic removal of overburden in the mine, using enormous excavators that remove up to 100 tons of rock per pass. Most of this overburden is comprised of a thick sequence of Early Cretaceous marine shale and sandstone that averages 70 meters in thickness. Taking both preservational and collecting biases into account, the specimens exhibit an interesting non-random distribution in the mine. Firstly, all of the fossils, with one minor exception, are restricted to a single, 2.5 meter-thick stratigraphic unit within the Lower Albian Wabiskaw Member of the Clearwater Formation. Secondly, the fossils are associated with topographic highs of the fossiliferous unit, interpreted as elevated portions of the original sea floor. The occurrence of the specimens in the mine provides precise stratigraphic and sedimentologic control, allowing these data to be placed within a detailed depositional framework. Results of a facies analysis, based on sedimentologic and ichnologic characteristics, suggest the fossil-bearing unit was deposited under fully marine conditions in the shoreface-offshore transition zone. The unusual provenance of the specimens, coupled with the immense scale of the mining operation, provides distributional data that are unique in the study of the fossil record. The systematic nature of overburden removal in the mine not only provides information on where the specimens occur within the fossiliferous unit, but also provides meaningful information on where the specimens do not occur. Taken as a whole, these

distributional data, combined with results derived from the facies analysis, allow for unprecedented interpretations of palaeoenvironmental attributes of an extinct marine ecosystem.

Morphological and habitat correlates of melanistic cordylid lizards

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There is a distinct clustering of melanistic ectotherms in the southwestern corner of southern Africa, including at least eight melanistic cordylid lizard species. These species occur as isolated populations at coastal or montane localities where there is a high incidence of fog or cloud cover. Of the eight melanistic cordylid species occurring in the southwest, *Pseudocordylus capensis* has by far the largest distribution range. We investigated morphology and habitat selection for all melanistic cordylid species. We then searched for any correlations between morphology and habitat. Unlike most other cordylids, *P. capensis* has well-developed hind limbs and are able to scale large vertical surfaces. The association with vertical rock faces and/or large boulders, may, through the range of microclimates the latter offer, allow *P. capensis* to survive in lowland situations, normally inhospitable for melanistic species.

Behavioural measurements of infrared detection range in rattlesnakes

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Pit vipers (Crotalinae) and boid snakes (Boidae) can detect infrared (IR) radiation with their so-called pit organs. The highly IR sensitive system allows an assessment of direction and distance of an IR stimulus. The ability to perceive IR radiation enables the snakes to image heat sources in absence of visual cues. Numerous physiological studies have been carried out to investigate IR perception in snakes. However, the aim of this study was to examine the detection range and consequently the sensitivity of the IR sense by means of behavioural experiments. Behavioural responses of twelve rattlesnakes (*Crotalus atrox*) were quantified by measuring head jerks, staring, freezing, rattling and tongue flicking. An IR source of constant size and temperature was presented at various distances (10-150 cm) from the snake's head. The results reveal that the snakes can detect moving IR stimuli equivalent to the body temperature and size of a mouse up to a distance of at least 135 cm. This finding greatly exceeds calculated values (5-30 cm) of the detection range in previous examinations. Furthermore, this study showed the IR system to be 5 times more sensitive than it was shown in electrophysiological investigations. However, the importance of heat stimuli seems to be most relevant within close-up range.

Snakes habituate considerably faster to an IR stimulus with increasing distance.

Comparative study of *Emys orbicularis* and *Mauremys leprosa* in the NE Iberian Peninsula

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Two species of freshwater turtles are found in the NE of the Iberian Peninsula: the European Pond Turtle (*Emys orbicularis*) and the Spanish Terrapin (*Mauremys leprosa*). The two species present different ecological preferences. *M. leprosa* is more thermophilous and is usually found in fluvial currents, while *E. orbicularis* prefers ponds. However, it is not unusual to find the two species in syntopy. The biology of these two species is poorly known. Thus, in order to elucidate the subject we conducted systematic sampling, capturing animals using traps. After marking the individuals and recording biometrical variables, the animals were released for recapturing. As to evaluate clutch size, low intensity radiographies were made during the reproductive period. The habitat preferences and use of the species were investigated based on radio telemetry and direct observation of individuals. Our results show that *E. orbicularis* has a very defined and fixed biological cycle, its reproductive period being longer than that of *M. leprosa*. On the other hand, *M. leprosa* is more effective reproductively, presenting bigger clutch size and reproductive rate in females. Moreover, in *M. leprosa*, hatchlings emerge in autumn, while those of *E. orbicularis* remain in subterranean nests till spring. Concerning habitat use, it was observed that *E. orbicularis* shows a very high habitat fidelity. On the contrary, *M. leprosa* is more mobile, using terrestrial habitats in a higher frequency. Both species might be threatened, since *E. orbicularis* is considered endangered and *M. leprosa* vulnerable in the Red Book of Amphibians and Reptiles of Spain. Thus, population risk was evaluated and some conservation suggestions are made. The results of this study, contribute to the conservation tasks of the "Emys Foundation", which aims for the investigation, protection, study of the Herpetofauna and its habitats and spreading of the knowledge obtained.

Development of vaccines against some elapid snake venoms

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We had a chance to examine the serum of a snake handler who injected snake venoms to himself for immunization. Snakes used were black mamba

(*Dendroaspis polylepis*), eastern green mamba (*D. angusticeps*), western green mamba (*D. viridis*), Jameson's mamba (*D. jamesoni*), Thai spitting cobra (*Naja siamensis*), and monocled cobra (*N. kaouthia*). His serum possessed venom-specific IgE and very high levels of venom-specific IgG to all venoms tested. Following these results, vaccines for some elapid snake venoms were developed.

Ranching of Horsfield tortoise in Uzbekistan

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In connection with the preparation of the CITES Project on banning the export of wild tortoises to the EC countries, the ranching of this species has become the matter of current interest. The first attempts of eggs incubation and young tortoises rearing were undertaken by the specialists of "Zoocomplex" in 1997. At the present time the technology of gathering and incubation of eggs and rearing young tortoises is mainly worked out. The period of eggs gathering on an average was from 20th April till 20th of June. The eggs length varied from 38 to 56 mm. The incubation of eggs was carried out on the sand substrate at the temperature 28-32 °C and humidity 70-80%. Juveniles were hatched from the end of July till the end of September, the peak was in August. At the moment of hatching out the size of the juveniles varied from 30 to 50 mm in length, on an average – 43 mm. The average weight was 21 gr. During the eight and a half months of rearing steppe tortoises their average size increased by 25 mm, and the minimum and maximum sizes increased by 23 and 35 mm respectively. The average weight increased by 59.8 g – that is almost four times. Despite the significant variations of individual growth rates, most specimens reached the length of 60 mm and higher within one year; however, in the nature tortoises reach such a size only at the age of 3 years. Thus, in 2001 more than 2,000 heads of tortoises bred in nursery conditions (R) were obtained. In 2002 the figures were also more than 2,000 heads, in 2003 - 5,000 heads, in 2004 – 7,000 heads, respectively. At the present time 13,000 ranched hatchlings are kept in five separate nurseries of "Zoocomplex". The strategy of sustainable use of the species includes the creation of nurseries for breeding animals in controlled environment. Ranching, therefore, is a real alternative for obtaining the tortoise for pet trade to collecting the animals in the wild, reducing damage to the wild populations to a minimum.

The herpetofauna of Upper Niger National Park, Guinea

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We conducted a preliminary survey of the herpetofauna in Upper Niger National Park at the end of the dry season in 2002. Museum holdings and literature records from localities within the park were combined with our data to obtain an overall picture of the park's herpetofauna. The park contains a mosaic of forest and savanna that straddles the Niger River. Twenty-three species of amphibians and 34 species of reptiles were recorded from the park; three species of amphibians and two of reptiles are the first records from Guinea. Seven of the reptile species are listed as threatened by the IUCN Red List or CITES. Conservation of the park is significant because: 1) it is the only protected area containing dry forest in Guinea; 2) gallery forest provides suitable habitat for herpetofaunal and mammal species otherwise restricted to tropical rainforest elsewhere in West Africa; and 3) several species of threatened reptiles endemic to West Africa are in the park.

Morphometric analysis of geographic variation in *Hyla savignyi* and southeastern populations of *Hyla arborea*

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Hyla arborea and *H. savignyi* are two closely related species of mostly European (*H. a.*) and Middle Eastern (*H. s.*) tree frogs. The aim of the present study is to construct morphometrics-based phylogeny of individual populations of both species and compare the intra- and interspecific geographic variation. The study was based on examination of external morphology of museum specimens of *H. savignyi* across the whole species area and *H. arborea* from southeastern part of the species area. We divided the material into 13 operational taxonomic units (OTUs), which were determined in respect to natural biogeographical boundaries within the parapatric areas and to the species identity. Metric parameters were analysed using both multivariate methods after size standardization (PCA, DFA and subsequent cluster analyses – UPGMA, neighbor-joining) and by conservative method of morphometric indexes. The main differential character between the species is colour pattern of inguinal region. *H. savignyi* differs (99.4%) by the absence of anterodorsally oriented inguinal loop formed by dark lateral stripe, which is present in *H. arborea* (99.0%). We found out number of significant interspecific differences in metric characters and in extent of toe webbing, but these differences were too slight for field use. Although morphometric inter- and intraspecific variation is relatively low, DFA confirmed significant differences among OTUs (average classification success was 64.5%). We discuss the possible influence of climatic conditions on morphology of the studied species. Populations from areas of similar climate (Anatolia, Levant,

Mesopotamia, Cyprus) show higher similarity in body shape. We noted also several significant differences between isolated populations of *H. savignyi* (Arabian, Cypriote) and other populations of this species. On the basis of morphology, we can confirm the validity of *H. arborea schelkownikowi* and *H. arborea kretensis*. Nevertheless, we conclude, that the morphological characters are overall not informative enough for understanding the phylogenetic relationships within *H. arborea* and *H. savignyi*. Therefore, we will consider bioacoustic and molecular methods in the future study. [The research was supported by the Czech Ministry of Culture – project MKOCEZ99F0201]

Individual identification of Hungarian meadow vipers (*Vipera ursinii rakosiensis*) by using scale numbers and pattern: possibilities and limitations

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Since 1993 we observed 219 meadow vipers during monitoring populations. Pictures were taken on the top, sides of head, throat and whole body, for later analysis and identification. We tried to standardize and test this identification method. Number of the following plates was counted and recorded: Preventrale, Ventrale, Subcaudale, Sublabiale and Supralabiale on both sides. Later from photos we also counted the following scale numbers: Apicale, Canthale and Intercanthale and Intersupraoculare on both sides (between Frontale and Supraoculare), Circumoculare and Lorealia on both sides. Separately we also used the pattern of Frontale for identification. By using variation of capital scale numbers we observed 102 different combination of the total possible 8640, that divided them into groups 1-8 individuals, which enables their easy identification by using further data, such as gender, source population and other scale numbers (Ventrale, Caudale). While using the frontal scale for identification, we described the shape and pattern. The described different qualities give 2112 combination, with 19 typical symmetric, but we observed several asymmetric types. The ability to use this quality is decreasing by the proximity of shedding. The parallel use of the two methods enables the positive fast identification of individuals at smaller population sizes.

Conservation assessment of the reptiles in South Africa, Lesotho and Swaziland

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The Red Data book for South African reptiles (Branch 1988) is now badly out of date, both taxonomically and in terms of changes in threat factors and the status of

populations. A new project has been launched to produce an updated conservation assessment for the reptiles of South Africa, Lesotho and Swaziland. This project will collate all existing distribution records in museum collections, private collections and the literature, and will add new data from field surveys in high priority areas, identified by means of a gap analysis. The Project Herpetologist will coordinate experts in checking the labelling of problematic taxa in collections. Members of the public will be invited to contribute digital photographs of wild reptiles to a "virtual museum" collection. The main output of the project will be a conservation assessment report and Red List for the reptiles of the region. The project is supported and led by the South African National Biodiversity Institute as part of its programme to meet the requirements of the recently proclaimed National Environmental Management: Biodiversity Act 2004.

Updated distribution, microhabitat use, seasonal activity and diet of the snake-eyed skink (*Ablepharus kitaibelii fitzingeri*) in Hungary with comparisons to sympatric lacertids

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The *Ablepharus kitaibelii fitzingeri* Mertens, 1952, a subspecies of the snake-eyed skink is the northernmost representative of the family Scincidae in Europe, and it is endemic to the Carpathian Basin. Its exact distribution, ecology and conservation situation was practically unknown except for some sporadic observations. Our aim is to give a complete summary of the Hungarian localities, to describe the microhabitat selection, seasonal activity and food composition of the skink, as compared to the two lacertid lizards (*Lacerta viridis* and *Podarcis muralis*) which share many of its habitats. *A. k. fitzingeri* was found to be associated with open habitats of a mosaic type cover of herbaceous plants and bare soil. Activity of *A. k. fitzingeri* strongly decreased in the summer, probably because of the reduced thermal inertia due to the extremely small size of the species. On the basis of stomach content analysis it seems to be a generalist predator of small, mainly flightless arthropod prey. Its diet composition differed from the lacertids, but the overlap between them was still considerable. Competition with juvenile lacertids and predation by adult *L. viridis* present a conceivable risk factor for *A. k. fitzingeri*. The skink requires special conservation measures in its habitat since it is potentially endangered in Hungary. Basic knowledge of its conservation ecology and population genetics is still needed before a sound conservation plan can be outlined. The research was supported by the Hungarian National R&D Programme, entitled: "The origin and genesis of the fauna of the Carpathian Basin: diversity, biogeographical hotspots and nature conservation significance" (Contract No: 3B023-04).

Using natural markings for photographic identification of individual *Leiopelma archeyi*, an endangered New Zealand frog

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In New Zealand, populations of Archey's frog have recently undergone dramatic declines and rigorous population monitoring is needed. Historical monitoring of Archey's frog has primarily been based on capture-recapture methodology, where individual frogs have been identified via toe-clipping. Due to potential risks of this practice, we investigated the possibility of identifying individual frogs using natural markings. Markings on the dorsal, frontal and lateral surfaces of 45 captive frogs were assessed in terms of uniqueness and character combinations were described that allowed frogs to be classified into subgroups. Trials were conducted by novel observers to determine whether individual frogs could be correctly identified, firstly to subgroup and then to individual by photo-matching with prior photographs. There was a high consistency within and between observers in allocating individual frogs to subgroups and once frogs were correctly assigned, success in photo-matching was 99%. A compact, portable photo-stage has been developed that uses mirrors to obtain images of the dorsal, frontal and lateral sides of the frog in a single digital photograph. Use of the photo-stage minimises handling and stress to the frogs and is suitable for use in remote and often wet field conditions. The current prototype has been successfully used to identify individual frogs in the field and mark-recapture monitoring using this technique has been established. The methodology is potentially applicable to other herpetofauna species where there is evidence of unique natural markings.

Microhabitat preference of tadpoles in a temporary pond in the Western Cape, South Africa

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This project is focused on the microhabitat preference of anuran larvae in their natural environment at Kenilworth race course, Cape Town, South Africa. In the centre of the race course there is a patch of relic fynbos vegetation and a series of temporary ponds which fill in winter and dry completely each summer. These ponds are the breeding sites for at least five anuran species, including *Microbatrachella capensis* which is listed as critically endangered on the IUCN list.

The larvae of these frog species must reach metamorphosis in the short time that the ponds are full or risk desiccation. It can be assumed that the larvae will select the environment in the pond that is the optimum for growth and development. Previous studies have shown that factors such as temperature and oxygen concentration affect the success of tadpole development and therefore, the tadpoles must select for these optimum conditions as well as avoiding predators and competition. In this experiment simple funnel traps were placed in a random stratified design throughout the pond, weekly, for two wet seasons. Around each trap factors such as the water temperature and the water depth were recorded. The trapping rate of each species of tadpole was calculated. Here results from the past two seasons are presented.

Does size matter? Investigating constraints on egg laying in the European smooth (*Triturus vulgaris*) and Palmate (*T. helveticus*) newts

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Smooth and palmate newts are very closely related, females look very similar and have closely overlapping size ranges. Little is known about how both apparently coexist successfully but appear to share similar niches: studies report very similar seasonal activity, feeding, oviposition timing, larval size/behaviour etc for both species. Oviposition sequence details however, are little explored, but may offer insight into their coexistence. This study examined the role of body-size in the oviposition behaviour of smooth and palmate newts. Two groups of females of each species were observed during oviposition. Key elements of the sequence were compared between populations of each species. Two further groups of females were matched carefully by size and the same behaviours observed and compared. This removed the size-difference factor from between species comparisons and allowed species-specific differences to emerge. Overall, some differences shown by the two species appeared to be "genuine" species-specific differences whilst others may have been constrained by size. This suggests possible implications for successful co-existence in breeding ponds hitherto unexplored.

Testicular structure and spermatogenesis of *Trachylepis varia* (Family Scincidae)

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Trachylepis varia formally known as *Mabuya varia* (Bauer, 2003) is a both a viviparous and oviparous South African lizard *T. varia* is abundant and wide spread, foraging on rocks and broken ground (Branch 1998). 27 male lizards were collected; 11 in winter; 8 in

spring and 8 in autumn. The reproductive tract removed measured and routinely fixed and processed for light and transmission electron microscopy. The average weight and SNV was 3.7g SNV and 54.6 +/- 1.6mm.respectively. The breeding males (Spring) had prominent red colouration around the hind legs visible bulges in this area (well developed hemipenes). *T. varia* testis had a thin tunica albuginea and the capsule enclosed a peripheral circumtesticular layer of Leydig cells containing lipid droplets. The testicular interstitium is very thin and the seminiferous tubules, loosely packed much like *Mabuya carniata* (Shivanadappa and Devaraj Sarkar, 1987). Peritubular cells were also observed. The germinal epithelium in the seminiferous tubules of the non-breeding males is well developed with no zonal distribution of the germinal stages as seen in mammals. There are approximately five layers of cells depicting the spermatogenic series stages from the basally located spermatogonia to the luminal spermatids yet to undergo spermiogenesis – here the cells undergo degradation therefore no spermatozoa were found. The most noticeable differences between the breeding and non breeding testis were the size of the testis which is increased two fold (0.2ml) and the mature sperm seen in the lumen of the seminiferous tubules and in the epididymus. The spermatozoa have sausage shaped heads with a thin curved hook at the top. The sertoli cells and cells of the spermatid series appeared as distinct "trees" arranged around the seminiferous tubule. In conclusion, *T. varia* is a seasonal breeder. Although the first steps of spermatogenesis occur in the non-breeding animals, spermatogenesis is not completed and no sperm are produced. This work also documents the structure and ultrastructure of *T. varia* testis including the spermatid series and interstitium.

Thermal tolerance and altitudinal distribution of *Takydromus* lizards from Taiwan

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Temperature is one of the main environmental factors affecting distribution of animals. In Taiwan, one of *Takydromus* lizards, *T. hsuehshanesis*, lives only at an altitude range above 1,800m. Two of its congeneric species, *T. formosanus* and *T. stejnegeri*, however, are found in lowland area. The purpose of this study is to determine whether thermal tolerance is one of the main factors that limit these grass lizards living in their specific altitudinal ranges. We measured the critical thermal minimum (CTMin) and critical thermal maximum (CTMax) after the animals had been acclimated at 10 °C, 20 °C, and 30 °C for 2 weeks. We found that acclimation temperature had significant effect on the CTMin and CTMax of the lizards. At 10 °C acclimation, *T. hsuehshanesis* had a significantly lower CTMin than those of *T. formosanus* and *T. stejnegeri*. At 30 °C acclimation, mean CTMax of three species did not differ significantly. The lowest mean CTMin of *T.*

formosanus and *T. stejnegeri* was 5.2 °C and 5.3 °C, respectively, which was similar to that of a montane skink, *Sphenomorphus taiwanensis*, living at high altitude. On the other hand, the highest mean CTMax of these lizards occurred at above 43 °C, which was higher than the ambient temperature at the lowland during the summer. In summary, the results suggested that acute thermal tolerance was not a physiological factor affecting altitudinal distribution of these *Takydromus* lizards. Further study is required to determine whether these grass lizards possess different chronic thermal tolerance in relation to their altitudinal distribution.

Quantifying the “search” in search dogs for desert tortoise in the Mojave Desert

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Search dogs have been prevalent in wildlife conservation applications for many years; however the technology with adequate precision to quantify their effectiveness has not. Using ArcGIS Tracking Analyst, ArcMAP, and Trimble GeoXT handheld GPS units, we developed a series of experimental trials to test the efficacy and reliability of dogs trained specifically to locate desert tortoises in the Mojave Desert. In particular, we looked at the search dogs' abilities to locate and properly identify adult desert tortoises that were located either above or below (in burrows) ground. The use of dogs remained both effective and reliable in all field trials. In addition, we correlate the dogs' performances with the following environmental factors: wind speed, wind direction, temperature, humidity, and total time worked. Understanding the optimal working conditions for dogs will help both scientists and managers make improved decisions regarding censusing and monitoring of desert tortoises populations.

Do female *Bradypodion pumilum* show reproductive synchrony?

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The Cape Dwarf Chameleon, *Bradypodion pumilum* is a viviparous lizard from the Western Cape, South Africa. It exhibits a prolonged breeding season largely due to the asynchrony of the reproductive cycle among individual females. However, previous studies on female reproduction in this species lack the clarity needed to correctly interpret a complex reproductive system. With infrequent samples and inadequate sample sizes, an aseasonal cycle may have been incorrectly concluded. This study aims to provide a comprehensive report on the reproductive cycle of

female *B. pumilum*, with special reference to the synchronicity of individual females within a population.

Diversity and endemism in North African desert and subdesert reptile habitats

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Reptile communities were studied in habitats of Morocco, Algeria and Tunisia representing subdesert wooded steppe, coastal succulent steppe, sandy desert (erg) and rocky desert (hammada). Faunal overlap between the four habitat types was low. Mediterranean elements were present in the two steppe habitats, Afrotropical relicts were found in the coastal steppe, less so in the hammada (a gecko, *Tarentola ephippiata*, associated with *Acacia* trees and a viper, *Echis leucogaster*). Endemism was highest in the sandy desert and in the coastal steppe, both of which harbour a specialized fauna not found in the other habitats. Central Saharan sandy deserts had a poor fauna compared with northern Saharan ergs, while central Saharan rocky areas had a more diverse fauna than northern Saharan hammadas. This can be explained by differences in precipitation.

Locomotor morphometry of the *Pachydactylus* radiation of lizards (Gekkota: Gekkonidae): a phylogenetically and ecologically informed analysis

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The *Pachydactylus* radiation is a diverse group of African gekkonids that includes species that exploit a variety of microhabitats, and that employ both climbing and terrestrial locomotion. The phylogeny of this radiation is well studied, permitting investigation of the correlates of limb proportions with different forms of locomotion, and with ecology and behaviour. Skeletal and external measurements were taken from museum specimens, and analyzed using both conventional and phylogenetically-based statistical methods to investigate the potential for correlated patterns. Many interspecific differences were discovered using conventional analyses, but such differences cannot be easily explained or interpreted. The results of the phylogenetically controlled analyses reveal that although there is no clear differentiation between climbing and terrestrial species, there are some species within the radiation that differ considerably from other members of the group. The results indicate that *Chondrodactylus angulifer* possesses shortened digits and distal phalanges relative to the other species considered, and that *Palmatogecko rangei*, *Pachydactylus austeni*, and the *Rhoptropus* clade

(particularly *R. afer*) possess elongated limbs relative to the rest of the radiation. These differences may relate to certain aspects of these species' lifestyles including increased terrestriality, a reduction or loss of the subdigital adhesive apparatus, digging behaviour, or a transition to a diurnal mode of life. Although grossly similar in terms of statistical segregation from sister taxa, limb proportions in *Rhoptropus* on the one hand, and *Palmatogecko* and *Pachydactylus austeni* on the other, relate to quite different aspects of locomotion and habitat occupancy.

Effectiveness of amphibian monitoring techniques in a Taiwanese subtropical forest

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We compared the effectiveness of three techniques for surveying frogs in four different habitats in a subtropical area of Taiwan. We conducted surveys biweekly from July 2000 to July 2001 employing three sampling techniques (nocturnal line-transects, automated recording systems, and side-flap pail-traps) concurrently in each of four habitats (temporary pond, permanent pond, ephemeral stream, and permanent marsh). We detected 22 species of anurans from five families, representing 76% of the anuran species found in Taiwan. Line-transect sampling and automated recorders detected 22 and 20 species respectively, with an average of 12.3 + 3.2 (mean + SD) and 10.4 + 3.5 species per survey. In contrast, traps only captured 11 species, with an average of 2.1 + 1.5 species per survey. Automated recorders were most effective at detecting hylids, rhacophorids, and microhylids that have loud calls and/or prolonged periods of calling. Recorders were less effective at detecting ranid and bufonid species that have relatively quiet calls. Traps were good at capturing most of the ranids, species that were usually missed with automated recorders. The combination of recorders and traps was equivalent to line-transect sampling, suggesting that these two techniques are a good alternative to nocturnal line-transect sampling, a technique that is difficult to use in remote areas and/or habitats that are inaccessible at night.

Preliminary investigations of the herpetological species richness and community structure on the Kaieteur National Park, Guyana and conservation implications

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The paucity of data regarding the occurrence of amphibians and reptiles in Kaieteur National Park, coupled with impending tourism development in the park, lead to the initiation of studies of herpetofaunal diversity, with the aim of contributing to effective conservation planning and management. Kaieteur National Park, one of the first national parks established in South America has recently been expanded to encompass an area of 62,680 hectares (154,882 acres). The centerpiece of the park is the impressive Kaieteur Falls situated where the Pakaraima Mountains give way to the interior lowlands. The Kaieteur plateau supports unique and interesting habitat types like "Guiana type savanna," dominated by terrestrial bromeliads in the genus *Brocchinia*, cloud forest, and white sand forest. Fieldwork was conducted from June-July 2004 and November-December 2004 (wet and dry season censuses respectively). The species richness and relative abundance of the amphibians and reptiles were mainly determined through the application of visual encounter survey transects, random sampling points and a few pitfall traps. This study resulted in an approximate 200% increase in the number of species reported in previous lists - several taxa being known to be endemic from the area. Kaieteur National Park seems still threatened by diamond and gold mining activities and the associated pollution and deforestation. In addition to the scientific aim of this study we also provided hands on training in field herpetology to two research assistants of Iwokrama, a park warden, a secondary school teacher and nine students from Chenapau village - the only permanent settlement near Kaieteur National Park. We also conducted an environmental workshop for Chenapau teachers, which included demonstrations and sensitization about the critical importance of establishing protected areas and the potential benefits for local people with an emphasis on the local herpetofauna.

The golden rocket frog, *Colostethus beebei*, a charismatic ambassador for conservation in Kaieteur National Park, Guyana

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The Neotropical dendrobatid frog genus *Colostethus* encompasses more than 120 extant species, commonly known as the rocket frogs because of their explosive jumping ability. *Colostethus beebei* is a tiny frog commonly called the golden rocket frog, or Beebe's rocket frog. The species was first described from a single female specimen collected in 1921 by William Beebe near Kaieteur Falls, Guyana. Noble distinguished the new species from other *Colostethus* species by its small size, brilliant coloration (unusual for the genus), and short but well-defined webbing between the toes. Similarities in coloration, pattern, and morphology between different species of *Colostethus*, combined with conspecific color-pattern polymorphism have led to some taxonomic confusion, especially within the species of the Guianas. For example, *Colostethus beebei*, which does not occur in French Guiana, has been erroneously reported from that country on several occasions. Male and female golden rocket frogs live together in stable groups, breeding in the water-filled leaf axils of the bromeliads they inhabit. Social behavior in amphibians usually involves interactions only during reproduction, but our observations indicate that golden rocket frogs also interact with their conspecific neighbors on a daily basis. It seems that that sociality allows individuals to monitor spatial and temporal distribution of water, thereby minimizing mortality by desiccation. We speculate that the daily visits among neighbors increases recognition of individuals and thereby reduces energy expended competing for access to pools. As far as we currently know, *Colostethus beebei* is endemic to Guyana and occurs only in Kaieteur National Park. It is the only species of its genus known to be a bromeliad specialist. Because of its possible very restricted distribution and highly specialized habitat, it is very important that the government of Guyana continue to enforce laws that penalize any habitat alteration within the small range of *Colostethus beebei*.

The enigmatic Round Island burrowing Boa (*Bolyeria multocarinata*): survival in the wild remains unconfirmed

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The extremely rare Round Island Burrowing Boa (*Bolyeria multocarinata*) was sighted only four times in the 20th century. This snake, one of the only two species in its family Bolyeriidae, is known to live only on the small Round Island, north of Mauritius in the

Indian Ocean. The island itself shows an unusually high degree of reptilian endemism: both of its two snake species and 3 out of the 6 lizards living there now have their range exclusively on this 151 ha volcanic island. The hardwood forest was clear-cut as early as in the 18th century, then introduced goats and rabbits continued to destroy native vegetation. Only a proportion of the original palm savanna, characterised by two endemic palm species, has survived until now. The Burrowing Boa was described by Heinrich Boie, German herpetologist, in 1827. Very few specimens are preserved as museum material, including some in the Musée National d'Histoire Naturelle, Paris, The Natural History Museum, London, and the Natural History Museum in Port Louis, Mauritius. Knowledge is limited about the biology and ecology of this snake in the wild. Altogether four reliable sightings were reported during the 20th century. These date from 1937, 1953, 1963 and 1974, and describe a medium-sized (ca. 80 cm) snake with a shovel-shaped head and hence possibly with burrowing habit. The last live specimen was encountered in 1974 during the Edinburgh Expedition to Round Island, on the rocky surface of the western slope. A search project for *Bolyeria* was carried out in 2001 by our Hungarian team, funded by Fauna & Flora International, in order to gain evidence about the survival or extinction of the Burrowing Boa. Despite an intensive search programme applying various methods (traps, night search, digging), unfortunately no signs of any surviving specimens could be revealed. Based on our results and the regrettable history of this snake, the presumption that *Bolyeria multocarinata* is extinct from Round Island and the entire world, is becoming increasingly realistic.

Taxonomy and ecology of the Hungarian populations of the common adder (*Vipera berus*)

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The Common Adder (*Vipera berus* Linnaeus, 1758) occurs in three different regions in Hungary: in Somogy County in the southwestern lowland, in Zemplén Hills in the extreme northeast, and in the lowland forests of Tiszahát in the east. All the populations of these regions seemingly represent morphologically and ecologically separate forms; the specimens differ in the ontogenical change of colouration, in head and body scalation, and environmental requirements. A multivariate analysis supports the hypothesis that the populations in the east and northeast show closer affinities to *Vipera berus* of the Carpathian Chain, whereas the adders of Somogy County (also mentioned as *Vipera berus bosniensis*= *V. b. pseudaspis*) constitute a separate entity. Further investigations, including molecular analyses should decide which taxonomical status it warrants. The research was supported by the Hungarian National R&D Programme, entitled: "The origin and genesis of

the fauna of the Carpathian Basin: diversity, biogeographical hotspots and nature conservation significance”(Contract No: 3B023-04).

Egg shape and size allometry in geckos (Squamata: Gekkota), lizards with contrasting eggshell structure: why to lay spherical eggs?

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Hard, highly calcified eggshells evolved several times during the history of amniotes. Unfortunately, because of widespread phylogenetic conservatism, lineages in which closely related taxa differ in the structure of eggshell are scarce. Two gekkotan families (Diplodactylidae and Eublepharidae) have eggs with ancestral, soft eggshells, while their close relatives (Gekkonidae) lay eggs with hard shells. Geckos thus offer a rare opportunity to compare the impact of the emergence of a hard eggshell on the economy of egg architecture. As sphere has the smallest surface of all three-dimensional solids of a given volume, producing spherical eggs in geckos with hard eggshells should be advantageous for the reduction of calcium investment. We documented that the gekkonid eggs are indeed more spherical than those of the other two gecko lineages. However, within gekkonids, small species lay more elongated eggs than larger species. We conclude that the miniature gekkonid females, which are under stronger selection to enlarge eggs, are forced to produce more elongated eggs due to a pelvic opening limitation even at the expense of larger calcium loss.

Evolution of Mantellid frog mitochondrial genomes: large-scale genomic reconstruction originated within the genus *Mantella*

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Mitochondrial (mt) genomic structures are generally conserved in vertebrates. A common gene arrangement is found in most vertebrate species, from teleost fishes to mammals. In anurans, however, the positions of several genes in the suborder *Neobatrachia* have been found to differ from the corresponding positions in typical vertebrates. Four tRNA genes are rearranged in the families Bufonidae and Ranidae. In addition to these tRNAs, ND5 gene is rearranged in the family Rhacophoridae. To elucidate the evolutionary pathway of the mitochondrial genomic structures in this anuran group, we analyzed mtDNAs from several species of the family Mantellidae. Mantellid mtDNAs shared the translocation of the ND5 gene with rhacophorids, suggesting that this event occurred in a common ancestor lineage of the two

families. In addition, the complete mtDNA sequence of *Mantella expectata* revealed the following unique genomic structures. (1) The genome size (29 kbp) was the largest among vertebrate mtDNAs investigated so far. (2) Two kinds of tRNA-Met gene were coded. (3) The arrangements of several genes and gene regions differed from those of the other anurans. (4) Pseudo tRNA-Met and -Phe genes were observed in the corresponding regions where the tRNA genes were located in other frog mtDNAs. (5) A long mtDNA region containing several structural genes (3 tRNAs and 12S rRNA) and a D-loop was triplicated. *Mantella madagascariensis* mtDNA also possessed two tRNA-Met genes, one pseudo tRNA-Met gene, and two D-loop regions. These features shared among *Mantella* species seem to have occurred in a common ancestor of this genus, and other unique genomic structures found in *M. expectata* may have arisen through divergence of *Mantella* frogs. Furthermore, *M. expectata* mtDNA possessing triplicated structural genes and several pseudo genes seems to be a concrete example of the "duplicate-and-delete model". This mtDNA molecule may provide crucial insight into the genomic reconstruction of animal mtDNAs.

Some procedures in reptile emergency surgery

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The June Carol Lambiris Memorial Surgery for Reptiles and Amphibians is a *pro bono* centre principally for the medical and surgical treatment of wild reptiles referred by veterinarians and animal welfare organisations, although increasing numbers of captives are also being seen. About 350 - 400 patients are seen each year. Operative surgery, frequently including semi-microsurgery, encompasses neurosurgery, orthopaedics, gastroenterology, urinogenital and pulmonary procedures, as well as numerous polytrauma cases. Procedures are continually being developed and refined as resources and experience expand. The Surgery depends almost entirely on donations for continued operation.

Plantations do not perform well as habitat for herps

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Plantations form an increasingly important timber resource in many countries of the world. Coincidentally, they also provide potentially new habitats for reptiles and amphibians to use, especially where they are planted on previously cleared lands. We undertook a stratified survey of differing land units in an area of southeastern Australia to determine the value of

plantations to herpetofauna. The sites surveyed were cleared paddocks, small, medium, large and linear plantations and small, medium, large, very large and linear remnants. Each site was hand searched along a 200m transect, with cover-boards at each end. Ponds present within these sites was also surveyed to assess frog use. Eight reptile species were present in remnants and nine in plantations, but none in paddocks. Abundance patterns differed markedly with 117 individuals recorded in remnants but only 49 in plantations. Larger remnants (> 5ha) had greater mean abundances (2.93) and richness (1.30) than large plantations (0.90 and 0.56 respectively). The same was true when comparing small (< 5ha) remnants and plantations (1.45 and 0.85 vs 0.73 and 0.57). Ponds were too few for comparisons of frog habitat, but frogs were evident in all site types. Simplified structure and, in particular, little ground cover probably account for the poor value of plantations as habitat. Tree plantings for environmental services are planned for the future and, if reptiles are of importance, we suggest that retaining ground cover is critical to the value of the planting to reptiles. The exclusion of grazing is another likely important factor in increasing the value of planted areas.

Biogeography, natural history and taxonomy of *Mabuya croizati* (Reptilia: Scincidae)

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Mabuya croizati Horton 1973, is a poorly known species of Scincidae endemic to the Turimiquire Massif, in eastern coastal range, Venezuela. It was described on the basis of 4 specimens from "Elvecia" and "Mt. Turumquire", Venezuela, previously identified by Schmidt (1932) as *Mabuya nigropalmata*. Museum records of *M. croizati* are scarce, and little is known about its distribution or general aspects of its biology. We present here a redescription of the species, and data on its morphological variation based on new specimens collected during a Herpetological Inventory of the Turimiquire Massif (1999- 2004). We also review the geographic distribution of the species and describe general aspects of its biology (period of activity, clutch size, preys, potential predators). We discuss phylogenetic affinities and possible biogeographic scenarios for the species on the basis on morphological

and molecular data (partial mitochondrial DNA sequences of the 12S gene). Finally, we report the main conservation problems faced by this geographically restricted species, mainly related to habitat loss and modification. Funds was provided by grants from Consejo de Desarrollo Científico y Humanístico (Universidad Central de Venezuela) Fundacite Anzoátegui, Venezuela and Project CGL 2004-00401, Spain.

Conservation status of *Mannophryne* (Anura: Dendrobatidae): a taxonomic and molecular approach

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Mannophryne is a genus of Dendrobatidae endemic to Venezuela and Trinidad & Tobago. Here we present preliminary results of current research focussed on the conservation status, distribution, degree of endemism across the genus, and intra-specific variability. A molecular phylogeny, based on mtDNA, evidences that species richness in this genus is currently underestimated, since many terminal tips represent undescribed species. To exemplify the level of intra-specific diversity within the genus, we studied the phylogeography of *M. herminae*, one of the most widely distributed species. We also evaluated the conservation status of most species of *Mannophryne* at the population level using an ad hoc matrix, designed in order to standardize data recording, based on the criteria used in IUCN-Global Amphibian Assessment. New field data and revision museum specimens were used to update the geographic distribution of most of the species. Most nominal and undescribed species have populations within protected areas, as well as all main clades from the phylogenetic analyses are represented in protected areas. The main conservation problems are: habitat loss and modification related to agriculture and urbanism, and to inadequate management of the protected areas. Some suggestions are proposed in order to incorporate our results in current conservation policies to ensure an adequate management of the diversity within the genus. Grants: Consejo de Desarrollo Científico y Humanístico (Universidad Central de Venezuela), Project CGL 2004-00401, España, and IUCN/SSC Global Amphibian Specialist Group and Conservation International.

Forelimbs musculature and associated tissues in turtles

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Although the myology of the forelimb turtles has been studied (Ribbing, 1938; Haines, 1939; Wyneken, 2002) none of those authors have previously reported what seems to be an extraordinary development of their aponeurotic tissue (except by a short mention on Walker, 1973). In the context of a myological analysis of the forelimb of two types of phylogenetically and ecologically extreme turtles, we focused our attention in the tendons, aponeurosis, and connective tissues associated to the forelimb muscles. This study was performed on *Phrynops hilarii* (a freshwater turtle) and *Chelonoidis petersi* (a terrestrial turtle). Two of the most striking differences that we found between both types of turtles are the muscular fusion and the degree of tendon development. The forelimb muscular pattern of *Phrynops hilarii* reflects the previously described pattern for other reptiles. *Chelonoidis petersi* presents muscles and tendinous structures very developed, but with a remarkably tendency to fusions of the muscular bundles. In both turtles the musculature is covered by a thick connective tissue, highly engrossed in *Chelonoidis petersi* forming a tendinous panicle that precludes the movements of the digits. The structures of *Chelonoidis* suggest modifications related to the endurance training of carrying the carapace weight, that compensates the effect of water's support in *Phrynops*.

The effect of pitfall size and type of funnel trap on trap success

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Herpetofauna are notoriously cryptic. Accordingly, it is often very difficult to collect the requisite number of specimens necessary for comprehensive herpetofaunal surveys. Trapping is widely used as a means of overcoming this sampling problem, especially in cases where snakes are surveyed. Trapping systems typically include drift fences, pitfall traps and funnel traps, which are arranged in various configurations (arrays), depending on the requirements of the survey. We tested for differences in catchability of pitfall traps of 5 and 10 l, and between funnel traps with plastic or mesh entrances. Ten trapping arrays in cross configurations, each with 30 meters drift fence, eight pitfalls and eight funnel traps, were set at Suikerbosrand Nature Reserve, Gauteng, South Africa over a five-week period. The two pitfall types and two funnel trap types were randomly distributed throughout each of the arrays. We found no significant effect due to pitfall size, but plastic-entrance funnel traps had a significantly lower catch rate in comparison to conventional mesh-entrance traps. Differences in the catch rate of the different funnel trap types can be explained by either of two hypotheses (not mutually exclusive); either the plastic-entrance traps catch fewer individuals or, alternatively, they allow a higher proportion of the

trapped individuals to escape. Plastic-entrance funnel traps require significantly less effort than mesh-entrance traps to construct but produce significantly lower catch rates. Small pitfall traps require significantly less installation effort than large pitfall traps and do not significantly reduce catch rates.

Banding patterns and chromosomal evolution in five neotropical species of Teiinae lizards (Teiidae, Squamata)

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Karyotypes of five species of South American lizards (*Ameiva ameiva*, *Cnemidophorus ocellifer*, *Kentropyx calcarata*, *K. paulensis* and *K. vanzoi*) belonging to the subfamily Teiinae are described and compared based on conventional and silver staining, CBG and RBG banding patterns and also meiotic data. Karyotypes of *K. paulensis*, *K. vanzoi* (both with 50 acrocentric chromosomes, similar to that found in *K. calcarata* and in *A. ameiva*) and *C. ocellifer* (with 50 biarmed chromosomes, which seems to be a synapomorphy of *ocellifer* group) are reported here for the first time. Silver staining results indicate that Ag-NORs location on Teiinae presents intergeneric and intraspecific variability, as it was located at the end of the long arm of pair 7 in *A. ameiva*; at the end of the long arm of pair 1 in all species of *Kentropyx* studied and at the end of the long arm of pair 5 in *C. ocellifer*, which also presented heteromorphic features between the two populations sampled. Ag-NOR distribution in *A. ameiva* corroborates the suggestion (based on molecular data) that the species of *Ameiva* from Central and North America (that present NOR in one pair of microchromosome) are different from those found in South America. The RBG banding showed homology among the largest pairs of all species sampled, although the remarkable differences in Ag-NOR distribution. Moreover, the simultaneously RBG and CBG banding data evidenced that the biarmed condition in *C. ocellifer* is due to multiple pericentric inversion events instead of addition of constitutive heterochromatin. In conclusion, differential staining techniques presents many valuable phylogenetic data and made it possible to compare these species in order to evaluate the chromosomal and systematic relationships among them.

The declining amphibian populations task force (DAPTF): achievements and future directions

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Since the first World Congress of Herpetology in 1989, it was clear that amphibians were threatened worldwide and that many of the environmental threats transcended national boundaries, notably climate change and infectious disease. To address these problems, a truly global organisation was required and in 1991, the Declining Amphibian Task Force (DAPTF) was established by the Species Survival Commission (SSC) of the World Conservation Union (IUCN). The DAPTF operates through a global network of issue-based Working Groups focused on specific topics including: disease and pathology, monitoring techniques, chemical contaminants, climatic and atmospheric change and captive breeding. We also support Regional Working Groups representing over 90 different regions to collect data on amphibian declines and their causes. However, in order that we can continue building a truly global assessment of the amphibian decline phenomenon, there are many parts of the world where we would like to further develop our activities. This will require expanding our work in Africa, Asia and the Far East by setting up new Working Groups in these regions and strengthening existing Working Groups. In addition, we would like to make our various funding initiatives available to more people around the world. Since 1989, we have developed a much more complete picture of the global pattern of decline. This has resulted in the IUCN's Global Amphibian Assessment and our own Declining Amphibian Database (DAD), which enable us to identify specific regions and amphibian taxa that most urgently require our attention.

Introduction of *Agama* on Grand Comoro (Indian Ocean) puts endemic *Oplurus* at risk

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The present ranges of the native 'iguana' *Oplurus comorensis* and of the exotic *Agama agama* on the island of Grand Comoro are documented in detail. *Agama agama* is an intended recent introduction (1998). The proliferation of this newly arrived exotic species indicates the ecological threat it represents. Among the native reptiles, especially the 'iguana' seems to be at risk, because agamids and iguanids are not known to coexist in the wild. Comparison of their distribution and the available data on their ecology and biology suggest that the anthropophilic agamid and the anthropophobic oplurid, at present localised at opposite sides of the island, will clash when they will come into contact. This would be a case of a generalist versus a specialist. In order to preserve the endemic species, the eradication of the agamid from the island is recommended.

How does it fit - niche segregation of a sand dune reptile community

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The reptile community of an intermediate sand dune habitat between Hammada and Erg in the Jbil National Park, southern Tunisia has been studied. The surface of this habitat is almost completely covered by sand, accumulated to small dunes of max. 2 m height, often with *Aristida pungens* grasses on top, whereas *Oudneya africana* shrubs grow on thinner sand layers. These plants seem to provide most of the energy input of the system. Even though fresh phytomass is potentially available, the food web is based on detritus consumption by Lepismatidae (Insecta: Thysanura) and Tenebrionidae (Insecta: Coleoptera). Ten reptile species occur permanently, of which *Acanthodactylus dumerili*, *A. scutellatus*, *Scincus scincus*, *Trapelus tournevillei* and *Varanus griseus* are diurnal, *Cerastes vipera*, *Lytorhynchus diadema*, *Stenodactylus petrii*, *Tarentola neglecta* and *Sphenops boulengeri* are nocturnal. Three further species are occasional visitors: *Psammophis schokari* and *Acanthodactylus longipes* (diurnal) and *Cerastes cerastes* (nocturnal). Investigations of activity patterns, behaviour and foraging modes result in narrow time frames for each species, in which the animals search for food and/or mates. Other than that, the animals shelter from overheating and predator pressure or for hibernation by burrowing or using burrows of other animals. Results of stomach samples and observations divide the reptile community into different trophic levels: consumers of second and higher orders. Regarding members of the same trophic level, niches are separated by different activity patterns.

Spawning sites of the side-necked turtles *Peltocephalus dumerilianus* (Schweigger, 1812), *Podocnemis erythrocephala* (Spix, 1824) and *Podocnemis expansa* (Schweigger, 1812) (Testudinata, Podocnemididae) on the Trombetas River's basin, State of Pará, Brazil

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Freshwater turtles of the family Podocnemididae have been wastefully exploited by local people in the amazon region. Used for centuries as protein source, the podocnemidid populations have suffered serious decrease throughout the years, a fact worsened by anthropic modifications of their habitat. In such scenario, the conservation of these chelonians is of the utmost importance considering their value as feeding resource and potential for sustainable use. However, the establishment of satisfactory actions aiming the preservation and sustainable exploitation of

podocnemidid turtles depends on informations related to podocnemidid reproductive biology, still scarce or completely lacking for most species of the family. The present study was undertaken at the Trombetas basin, state of Pará, Brazil, from October to December of 2001 and August to December of 2002, as an attempt to investigate aspects of the reproductive biology of three species of podocnemidid turtles: *Peltocephalus dumerilianus*, *Podocnemis erythrocephala* and *Podocnemis expansa*. Five different spawning sites were found for these species: i) on emerged stem of dead trees, roots and soil across the streams' course; ii) the soil of forest-covered "terra firme" nearby the streams; iii) periodically floodable forests ("igapó"); iv) small sand beaches in periodically floodable forests ("igapó") and v) sand beaches ("tabuleiros"). Sites i, ii and iii are used by *Peltocephalus dumerilianus*; sites iii and iv by *Podocnemis erythrocephala*, and the site v is used only by *P. expansa*. The results obtained herein refer to the period of exposition of the spawning sites in the ebttide. It was notice that the preference for a specific site seems to determine the beginning of the nesting season of each species, as well as the incubation period of their eggs.

The rise and fall of Welsh amphibians- a 30 year perspective

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There have been marked changes in the population status of amphibians in Wales over at least the last 30 years. Several factors have been suggested as causes of change including water chemistry, disease and climate change. Of these factors the best documented is changing phenology in relation to climatic change. Population monitoring has been undertaken in mid Wales since the mid 1970s and the results are summarised on the poster. Common Frog (*Rana temporaria*), Common Toad (*Bufo bufo*) and three *Triturus* species (palmate newt, *T. helveticus*; smooth newt, *T. vulgaris* and great crested newt, *T. cristatus*) have been monitored at Llysindinam Pond in mid Wales for almost 30 years. Current research concentrates on the breeding phenology and larval development of smooth and palmate newts.

Participatory assessment of amphibian fauna in Malindang Range, Philippines

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Fieldwork was conducted on Mt. Malindang, Mindanao, Philippines, from October 2003 until the present in different vegetation types (mossy, montane, dipterocarp, and almaciga, agroforestry and

agroecosystem sites) from elevation of 100 meters to 2175 meters above sea level. Primary data were collected through opportunistic technique. The goal was to assess amphibian faunal richness in 18 selected sites on Mt. Malindang for better understanding and management of critical resources. With the participation of Subanens (indigenous people in the area) as local researchers, assessment revealed 25 species of amphibians, 15 of which are endemic species with eight found only in Mindanao. Twelve species are in the threatened category where 11 are vulnerable and one endangered. *Philautus surrufus*, a Mindanao endemic listed in the endangered category was found to be abundant in the Malindang range. All endemic species captured were found to be forest dwellers. It is apparent from the results of this on-going study that despite habitat degradation in Malindang range, there are still many endemic species of amphibians present. The active participation of Subanen researchers enriched scientific results on assessment of amphibian fauna.

Breeding induction and breeding seasonality of the rice field frog, *Hoplobatrachus rugulosus*, in captivity

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In nature, *Hoplobatrachus rugulosus*, a rice field frog in Thailand has been long observed to exhibit seasonal breeding in rainy season (April-September). Mating in this species occurred only once a year which is triggered by the first rain of the season. In captivity, controlled reproduction of mature frogs (12-14 months old) has been carrying by using GnRH analogue to induce mating during May –September. Spermiation was succesfully induced by intraperitoneal injection of single dose of GnRH analogue, 5-10 µg/kg body weight. For induction of ovulation, a double dosages of GnRH analogue were performed. The first dose, 5-10 µg/kg body weight was administered and followed by the second dose, 10-20 µg/kg body weight. The time interval of the administration was 4-5 hours. Plasma estradiol 17β (E2) and testosterone (T) were determined by RIA in adult female and male frogs throughout the year. Plasma E2 levels in female frogs were found to be as high as 1,000-2,000 pmol /L during April-August, and as low as 100-200 pmol /L during November-February. Plasma T levels in male frogs were found to be high, 1,500-3,000 pmol /L during March-October, and as low as 100-200 pmol /L during November-February. Gonadosomatic Index percentage (GSI%) values in both sexes were found to be correlative with gonadal steroid levels. Results obtained suggested that, in captivity, the rice field frog, *Hoplobatrachus rugulosus*, exhibits seasonal breeding and succesful induction of mating is possible only

during the breeding season.

Use of amphibian models to monitor environmental changes in Korea

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Amphibian declines have reported world-widely. The decline occurred in both disrupted areas by direct anthropogenic activities and relative well-conserved areas such as wildlife refuges or national parks. Major factors for amphibian declines compromise habitat destruction, global climate change, chemical contamination, disease and pathogens, invasive species, and commercial exploitation. Since amphibians are especially sensitive to environmental changes in their habitats because of their physical constraints such as permeable skin and ecological requirements of both aquatic and terrestrial habitats, amphibians have served as a model system to monitor environmental changes. In Korea, to date, little efforts have been made to develop amphibian models for environmental monitoring. Recent accumulating ecological and behavioral data about Korean salamanders and anurans open the possibility to use them in long-term environmental monitoring. For example, ecological and behavioral studies of the long-tailed clawed salamanders revealed that they require unique habitats where water temperature of 6-15°C maintains throughout a year and the streams or brooks where they live should not be disturbed. These characteristics of their habitats required suggest that we may develop the species as a model system to monitor healthy stream systems in mountains. Also, it is highly possible to use Korean anurans to monitor rural and/or urban environmental changes for their wide distribution in Korea. Each species of anurans has unique call that is easily detected in the field and discriminated from other species' calls. Environmental monitoring using anuran calls is widely used in many developed countries for the first level monitoring of which purpose is to detect early signals of environmental changes. In this study, we discussed possible use of Korean amphibians for environmental monitoring in Korea. This study was supported by a grant (R01-2004-000-10450-0) from the Basic Research Program of the Korea Science & Engineering Foundation and Korea Research Foundation Grant (KRF-2004-003-C00187).

Molecular phylogeny and origin of parthenogenesis in lizards of the genus *Leposoma* (Squamata, Gymnophthalmidae)

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Lizards of genus *Leposoma* are a conspicuous component of forest litter herpetofauna of Amazon and Atlantic slopes of eastern Brazil. Two assemblages of species are currently known: the parietale and scincoides. Eight bisexual and one parthenogenetic (*L. percarinatum*) species are recognized in the parietale group, which ranges from Amazonia to Costa Rica. The scincoides group has five known species restricted to the Atlantic Forests, except for *L. baturitensis* which is endemic of the "Serra de Baturité", a relictual isolated forest in the semi-arid Caatingas, northeastern Brazil. Phylogenetic analyses based on combined mtDNA (12S, ND4, cytb) and nuclear (c-mos) sequences (1.829bp) were performed in 35 specimens assigned to four species from Amazon (*guianense*, *osvaldoi*, *percarinatum*, *southi*) and five (*annectans*, *baturitensis*, *nanodactylus*, *puk*, *scincoides*) and two not yet formally described species from Atlantic Forests. Outgroup species included *Anotosaura vanzolinia* and *Colobosauroides cearensis*. Criteria of maximum parsimony, likelihood and partitioned Bayesian methods were explored. The monophyly of the *parietale* and *scincoides* groups is highly supported by all methods (bootstrap above 90%, posterior probability of 1.0). *L. puk*, *L. nanodactylus* and *L. baturitensis* are the basal species of the scincoides group; this placement for *L. baturitensis* suggests a very ancient isolation for the mountains of Baturité with no indication of a subsequent contact with its forests and those in the eastern coast. Populations of *L. scincoides* from south regions of the state of Bahia are not monophyletic. Two very genetically divergent clones (about 10% in corrected cytb sequences) occur within *L. percarinatum*, indicating that the mtDNA might be inherited from two different ancestral maternal species, with the clones representing distinct taxonomic units. With the available data, there is no certain about the maternal species involved in the origin of the parthenoform, but *L. southi*, *L. parietale* and *L. osvaldoi* seems to be putative candidates.

Phylogeography of the genus *Echis*

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The saw-scaled or carpet vipers (*Echis*) are one of the most important causes of snakebite mortality worldwide, causing tens of thousands of deaths every year in parts of Africa, Western Asia, and the Indian subcontinent. In Africa alone, *Echis* is responsible for the majority of the annual total of 20,000 snakebite

deaths. Despite their notoriety, the taxonomy of these vipers remains unstable and confused. Whereas only two species were generally accepted until the 1960s, recent revisions and descriptions have recognised up to 12 species, but there is no consensus on their status and distribution. Variation in venom composition has also been documented in *Echis*, and antivenom against one population often fails to neutralise the venom of another, resulting in greatly increased fatality rates. Similarly, *Echis* venoms have been used extensively in toxicological research, but the usefulness and interpretability of the data is often compromised by the lack of a sound taxonomic framework. As part of an ongoing research project, we have constructed a mitochondrial DNA phylogeny for *Echis*, which represents a framework for the taxonomic revision of the genus, thus providing basic information towards the refinement and rationalisation of antivenom therapy, and an indispensable phylogenetic background for further studies of the venom of the genus.

Universal ELISA to determine plasma vitellogenin (Vtg) in reptile and amphibian species

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Oviparous amphibians and reptiles are known to synthesize a lipo-protein, yolk precursor, vitellogenin in the liver under the control of female hormone, estrogen. During the pre-ovulatory stages of the female ovarian cycle, heightened hepatic Vtg synthesis activity and increased circulating Vtg levels occur. Although several associated biochemical changes could be used as biomarkers for vitellogenin activity, few studies directly measure vitellogenin concentrations in the plasma. Since vitellogenin is regarded as a species specific protein complex, specific anti-Vtg antibodies are needed to be used in ELISA type bioassays. The exponential growth in evidence that man-made environmental chemicals act as modulators of the estrogen associated female reproductive system resulted in studies investigating the potential of the estrogen controlled vitellogenin pathways as biomarker systems for endocrine disrupting activity in the environment. To study circulating Vtg profiles and Vtg induction in female and male vertebrates, we developed an universal Vertebrate Vtg ELISA. Using a specific, in-house developed *Xenopus laevis* Vtg ELISA, we validated the universal Vtg ELISA. Results show that data obtained with the universal Vtg ELISA correlate positively with the concentrations obtained with the *Xenopus laevis* Vtg ELISA (R=0.925). Moreover, the universal Vtg antibody detects the Vtg of a range of amphibian and reptile species. As an application of this universal Vtg ELISA, seasonal variation in plasma Vtg levels were studied in the

freshwater turtle, *Pelomedusa subrufa*. We also employed this Vtg ELISA to screen amphibian and reptile males for induced Vtg production by the liver as the result of xenoestrogenic activity in local water resources.

First observations about the embryonic development of the pituitary in Typhlonectes compressicauda, (Amphibia, Gymnophiona)

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Gymnophionan amphibia are still poorly known and more especially the embryonic development of several organs and glands have not been well studied. Using an abundant collection of embryonic *Typhlonectes compressicauda*, a Southern American species, we described the development of the pituitary of this animal.

Pituitary of *Typhlonectes compressicauda* begins to develop from the Rahke's pouch at stage 23, before hatching. At stage 25 (hatching), a rounded flattened pituitary gland is observed under the floor of diencephalon. At this stage, blood vessels directly irrigate the pituitary. Several nerve fibres are now observed. At stage 26-27, the pars nervosa is distinctly observed. At stage 28, the pituitary is globe-shaped, with numerous blood vessels. The cells possess a big nucleus and a dense cytoplasm, and seem to be secretive. At stage 30 (just at the beginning of metamorphosis), using a classical trichroma staining, several cell types are observed. At metamorphosis (stage 31), the cells are grouped in follicles, looking like the adult hypophysis. Development of pituitary is parallel to that of thyroid gland (1). These two glands present a functional aspect at stages 29-30, just at the beginning of metamorphosis. These observations suggest that these two glands are developing and differentiating at metamorphosis and are implicated in this physiological phenomenon, through their hormonal activity, like in other amphibian.

Estabel, J. and Exbrayat, J.-M. 2000. Development of thyroid gland in *T. compressicauda* (Amphibia, Gymnophiona) The new panorama of animal evolution. XVIIIth International Congress of Zoology, Athens (Greece), Abstracts, p. 52.

Lizard fauna of southern Zagros mountains, Iran

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Based on long-term study and research in southern regions of the Zagros Mountains, Iran, 16 species of lizards belonging to 11 genera and 4 families were collected and their morphological characteristics were studied. These taxa are as follows: from the family

Agamidae, *Laudakia microlepis*, *L. caucasia*, *L. nupta nupta*, *Trapelus lessonae*, and *T. agilis agilis*; from the family Gekkonidae, *Tropicolotes helenae helenae*, *T. persicus persicus*, *Cyrtopodion scabrum*, *C. gastrophole*, *Carinatogekko aspratilis*, *Hemidactylus persicus*, and *Asaccus elisae*; from the family Lacertidae, *Mesalina watsonana*, *Ophisops elegans elegans*, and *Lacerta princeps princeps*; and from the family Scincidae, *Mabuya aurata septemtaeniata*. The chromosomal number of two of the above-mentioned taxa were studied: *Laudakia caucasia* having $2n=34$ and *Lacerta princeps* with $2n=36$. Systematics and distribution of these lizards are discussed and the maps of distribution are given.

Systematics and biogeography of lizards of Kermanshah Province, Western Iran

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Systematics, distribution, and biogeography of about 22 taxa of lizards belonging to six families: Gekkonidae, Agamidae, Lacertidae, Scincidae, Uromastycidae, and Varanidae from Kermanshah Province (western Iran) including some new taxa and populations as well as new records are presented. The gekkonids, *Asaccus kermanshahensis*, *A. griseonotus*, *A. elisae*, and *Asaccus* sp., *Cyrtopodion heterocercus heterocercus*, *Cyrtopodion scaber*, *Cyrtopodion* sp., and the agamids, *Laudakia caucasia*, *L. nupta*, and *Trapelus lessonae*; and the lacertids *Lacerta media media*, *Lacerta princeps kurdistanica*, *L. cappadocica*, *Ophisops elegans elegans*, *Eremias montanous*, *Acanthodactylus boskianus*, and *A. nilsoni*; and the scincids, *Mabuya aurata*, *M. vitatta*, and *Eumeces schneideri princeps*; and the Uromastycid *Uromastix loricatus*, and the varanid, *Varanus griseus* are reported from this province. The faunal relationships of the above-mentioned taxa are discussed and it is shown that the formation and uplifting of the Zagros Mountains in the late Miocene and Pliocene have had the most dramatic role in radiation, isolation, and subsequent evolution of these lizards. The effects of severe droughts of recent years as well as man-made habitat destruction on population decline of these animals are discussed and it is shown that some species are now seriously vulnerable.

Analysis of geographic variation in *Neurergus microspilotus* and *N. kaiseri* (Caudata: Salamandridae)

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The genus *Neurergus* encompasses three species in Iran as follows: *N. kaiseri*, *N. microspilotus* and *N. crocatus*. So far, no comprehensive taxonomic study on the species and different populations of this genus has been carried out. In present study an analysis of

geographic variation in four allopatric populations of *N. microspilotus* has been presented based on specimens taken from streams on western edges of the Iranian plateau as well as museum materials. Using principal component analysis for data on 26 external characteristics the first and second components (PC1 and PC2) showed 37.38 and 15.58% of the total variance respectively. This result indicates that different populations of *N. microspilotus* from various areas of the range have acquired a certain degree of divergence. A comparison based on the principle component as well as discriminant function analyses in a number of important characters pertaining to morphology and body stature in *N. microspilotus* and *N. kaiseri* (from southern Zagros Mountains, Lorestan Province) also shows that they are conveniently distinguishable from each other at the specific level.

A new genus and species of microteiid lizard from the Atlantic forests of the state of Bahia, Brazil, with a new generic name for *Colobosaura mentalis*, and a discussion of relationships among the Heterodactylini (Squamata, Gymnophthalmidae)

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A new genus and species of microteiid lizard is described from a series of specimens obtained in the leaf litter at Una (15°10'S, 39°03'W) in the Atlantic Forest of southern Bahia, Brazil. It is characterized by the presence of prefrontals, frontoparietals, parietals and interparietal, parietals longer than wide, distinct ear openings and eyelids, two pairs of genials, absence of collar and of occipital scales, dorsal scales anteriorly smooth and becoming gradually lanceolate and mucronate posterior to the forelimb, and four regular transverse series of smooth ventrals that are longer than wide, identical in size. A phylogenetic analysis based on external morphology, osteology and DNA sequences (mitochondrial and nuclear) confirms this new lizard as a member of the Heterodactylini radiation of Gymnophthalminae. The topology recovered reveals that its closest relatives are the sister taxa *Colobosaura modesta* and *Iphisa elegans* and that *Colobosaura mentalis*, for which a new generic name is here proposed, is basal to this radiation. Our analyses confirm a previous hypothesis suggesting *Stenolepis* as a member of the Heterodactylini radiation and that the clade composed of *Colobodactylus* and *Heterodactylus* is the sister group of the clade formed by *Colobosaura mentalis*, *Stenolepis*, *Colobosaura modesta*, *Iphisa*, and the new genus herein described.

Pretty in profile: tadpole responses to mirrors

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Tadpoles can alter their behavior, morphology and developmental rate in response to changes in their habitat. Chemical signals from conspecifics and/or predators are the best known stimuli for such plastic phenotypic responses. But what about other sensory modalities and stimuli? Recently it has been shown that tadpoles of several European species prefer to view themselves with their left eye in mirrors. This suggests that anuran larvae recognize and react to the visual image of conspecifics. That observation led us to explore the effect of visual information on the phenotypic responses of anuran larvae. In this study we raised tadpoles of *Rana sylvatica* and *Bufo americanus* in aquaria with no or partially (either 25% or 50%) mirrored walls. We compared their responses to the mirrors with those of tadpoles raised without mirrors, but at two different densities. For *Rana* tadpoles increased density, simulated with mirrors, decreased tadpole growth and developmental rates and increased their locomotor activity the same way that actually increasing their density did. *Bufo* tadpoles did not significantly alter their growth and development in response to either being raised at slightly higher density or with mirrored walls on their aquaria. Our data show that images of conspecifics can be used as visual cues by tadpole in habitat assessment and that those images induce phenotypically plastic changes in several traits. The response of tadpoles to visual cues is taxon-specific. Tadpoles of a *Bufo* species that normally lives at very high density were less responsive to mirrors than those of a *Rana* species that normally lives at lower density. Although researchers studying other *Rana* and *Bufo* species have reported that tadpoles prefer to view themselves in mirrors with their left eye, no such eye preference was found in our study.

Comparing the systems for cutaneous water movement in *Moloch horridus* and *Phrynosoma cornutum*: a case for convergent evolution

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Thorny devils, *Moloch horridus*, and the horned lizard, *Phrynosoma cornutum*, both display a remarkable ability to rapidly move water through interscalar channels on their skin's surface to their mouth for ingestion. Surprisingly, the skin structures promoting this ability have never been described in three-dimensions or in detail. Using standard histological techniques and SEM, we have examined, and compared, the structure of the skin of both species. In addition, we have compared the interscalar channels of these two species to several other agamid, and phrynosomatid species, as well as to outgroup species

such as geckos, that are resistant to wetting and do not have the ability to move water. At the hinge joint of each scale, *Moloch* and *P. cornutum* have an expanded and enclosed chamber, forming an integumental-wide channel system with an associated convoluted structuring of the hinge joint walls. The development of this structural complexity dramatically expands the surface area for water adhesion in these channels, and this was not present in outgroups. These hinge-joint structures, previously unreported, increase surface area and provide a partially enclosed "tubular" system into which the water moves, apparently under the influence of exceptionally strong capillary-like forces. We believe the two unrelated species are highly convergent in their hinge-joint skin morphology, although details of their respective systems differ, allowing these desert-inhabiting lizards to take advantage of infrequently available rain collected by "rain-harvesting".

Taxonomy of *Meristogenys* from a stream in Borneo

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Torrent frog genus *Meristogenys* is endemic to Borneo and characterized by the larval abdominal sucker which is adapted to rapid streams. Although it is one of the most popular genera in forests of Borneo, it contains many unresolved taxonomic problems. We investigated adults and larvae of this genus collected from a stream at Mahua Substation, near Tambunan in the Crocker Range National Park, Sabah, Malaysia. From DNA sequences of mitochondrial 12SrRNA, 16SrRNA, and cytochrome b, we could recognize four types, three of which are clearly keyed out to known species: *M. kinabaluensis*, *M. whiteheadi*, and *M. orphnocnemis*. The remaining one type closely resembled to *M. orphnocnemis* in adult morphology, but could be clearly distinguished from it in larval morphology, we, therefore, surmise it to be an undescribed, cryptic species related to *M. orphnocnemis*. We examined our larval specimens of three known species and found that published information about these larval characteristics had many problems. We suspect that descriptions of larvae currently available has been made based on incorrect identifications. Further, a larva which we failed to examine DNA was morphologically completely different from the other four types. From these results, it is clear that at least five (*M. kinabaluensis*, *M. whiteheadi*, *M. orphnocnemis*, a cryptic species related to *M. orphnocnemis*, and a larva which is different from other four types, but has no information of adult) types of *Meristogenys* were revealed to coexist in a limited area of Mahua, and that larvae are more useful than adults in phenetically identifying frogs included in this genus, but current knowledge about larval morphology needs a drastic changes.

Determining interim regional conservation priorities for an endangered hylid using auto-logistic habitat modelling procedures

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Habitat modification and fragmentation remains the most immediate threat to the conservation status of many declining anurans in Australia, particularly in the vicinity of major urban centres. Modelling habitat occupancy patterns of these species provides important insight in the effect of habitat modification and fragmentation on population viability, and can be used to develop interim guidelines for habitat management. We conducted surveys for the growling grass frog (*Litoria raniformis*), an endangered hylid from south-eastern Australia, at 139 sites across a stream catchment on the urban fringe of Melbourne, Victoria, and undertook statistical modelling of the resulting data to explore the processes which determine its distribution. Modelling of the patterns of occupancy was carried out using autologistic regression analysis. The analysis revealed that spatial context, landscape scale factors and site-level habitat variables are all significant determinants of waterbody occupancy by *L. raniformis*. Occupancy of waterbodies was highly positively correlated with the proportion of neighbouring sites occupied by the species, negatively correlated with the density of roads in the area surrounding the waterbody, and positively correlated to water-body permanence and aquatic vegetation cover. The relationships between waterbody occupancy, connectivity and fragmentation indicate that persistence of the species on a local scale is dependant not only on availability of suitable aquatic habitat, but also on features of the surrounding landscape and the presence of other populations of the species in close proximity. Occupied clusters of wetlands generally occur within a neighbourhood of 1-1.5 km, interspersed amongst open terrestrial habitats conducive to dispersal. Interim regional conservation priorities for the species focus on securing these wetland systems in areas allocated for future development and enhancing habitat availability and suitability within areas already effected by habitat alteration and fragmentation. The project has provided base-line information for further research on the population dynamics of the species: information that will be ultimately used to model long-term population viability under varying management regimes.

Is the southern harvester termite, *Microhodotermes viator*, an essential item in the diet of the group-living lizard, *Cordylus cataphractus*?

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It has been postulated that dependence on termites as a food source has been the key factor in the evolution of group-living behaviour in the armadillo lizard, *Cordylus cataphractus*. In this study, we are investigating the relationship between the southern harvester termite, *Microhodotermes viator*, and *C. cataphractus* in terms of range and population effects. This relationship is being investigated at a macro-, meso-, and microscale. We predict that (1) the range of *C. cataphractus* will be included in the range of *M. viator*; (2) *Microhodotermes viator* will be included in the diet of *C. cataphractus* throughout the range of the latter; (3) *Cordylus cataphractus* populations will exhibit high density in areas where termites are abundant; (4) *Cordylus cataphractus* groups will be larger where termites are abundant. Preliminary data will be presented with regard to the above predictions (3), (4) and (5). This poster will also present preliminary data on a scat analysis study that is being carried out to determine whether the degree of utilization of *M. viator* as a dietary component by *C. cataphractus* can be correlated to group size in this lizard species.

Three decades of decline in Wales: a retrospective view

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Studies of amphibian populations in mid-Wales began in the mid 1970's by one of the present authors (FMS) with Paul Gittins and Andrew Parker. Studies have been continued up to the present by EAC, KM and Emma Durward with Pat Wisniewski and Richard Griffiths contributing much along the route. With such a perspective over time and over a range of species, longer term population changes can be traced where decline or reproductive failure has been evident. Local causes can often be suggested such as fungal infection of spawn, sewage pollution; introduction of piscivorous fish to a breeding site or changes in agricultural land management. Changes in the populations of *Rana temporaria*, *Bufo bufo*, *Triturus helveticus*, *Triturus vulgaris* and *Triturus cristatus* are examined in the light of such factors, and a forward view offered with the benefit of hindsight.

Variations on the reptilian neck muscle pattern in tyrannosaurid and avian theropods

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The neck muscles of reptiles are conservative in patterns of gross morphology and functional divisions, but derived patterns of neck contour have yielded novelties of specific musculoskeletal configuration. With acute posterodorsal s-curves to their necks, tyrannosaurids and birds display both homologous and separately exaptive solutions for movement of the feeding apparatus. Dissection of crocodylians, birds, and lizards, and examination of osteological specimens, facilitated bracketed and extrapolatory inference of tyrannosaurid neck muscles. In all of these sauropsid clades *M. transversospinalis capitis/M. biventer cervicis* is well-positioned for head dorsiflexion. Extraordinarily rugose insertions indicate hypertrophy of this muscle in some tyrannosaurids, while division into anterior and posterior bellies in birds indicates nuanced control of cranial dorsiflexion. *M. complexus* of birds is used unilaterally for lateral and dorsolateral flexion of the head, whereas similarly to other reptiles, in tyrannosaurids these functions are inferred to have been divided between discrete *M. longissimus capitis superficialis* and *M. obliquus capitis magnus*. Respectively distinct morphologies of tyrannosaurids and birds have facilitated dorsiflexion of the entire feeding apparatus. For example, in birds *M. longus colli dorsalis/M. transversospinalis cervicis* is uniquely superficial among extant amniotes and dorsiflexes the neck by additive intervertebral flexion. In tyrannosaurids, bilateral contraction of *M. longissimus capitis superficialis* enabled unusually effective dorsiflexion and retraction of the head and neck.

Life history characteristics and population trends of the common frog *Rana temporaria* in Malla nature reserve, northern Finland

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The common frogs in Malla nature reserve, northernmost Finland (69°3'N, 20°47'E) live under harsh conditions because of the area's geographical position in the most northern part of Europe. The arctic environment selects for both behavioral and physiological adaptations to cope with environmental stress. One example of stress caused by harsh climate is that duration of the hibernation ranges from September to late May. Hence, in Malla the active months are around four, as compared to the southern Swedish populations where hibernation ranges between November and March, leading to ca. eight months of activity. This is reflected to growth and maturation patterns of the frogs: the time to reach maturation is roughly twice as high in the north as in the southern Swedish populations, and there is a close relationship between the length of activity period and age at maturation in different populations across Scandinavia. We have also monitored the breeding population in the Malla reserve by counting the number of egg clutches every third year, which gives an estimate of female population size. Data is also

collected in the field on vegetation and pond quality and later complemented by maps and air photos using GIS tools. The monitoring is done in three different years (1999, 2001 and 2003). Population trends in different types of environments of this arctic population will be presented.

HerpNET: an online distributed database of amphibian and reptile museum collections for use in biodiversity and phylogenetic research

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HerpNET (www.herpnet.org) is a collaboration that combines amphibian and reptile museum databases from 40 institutions in the United States, Mexico and Canada. The main goals of the project are to georeference, or assign coordinates to, all localities from these collections using a consistent method, to make these databases available online with mapping capabilities, and to involve more international collections. Each institution has a DiGIR (Distributed Generic Information Retrieval) Server installed that allows a copy of their database to relay information to a main data portal. Any person can query the portal online for information about specific taxa or geographic regions of interest and receive a dataset that can be downloaded as a text file and imported into a spreadsheet format. This contains information about the museum name and catalog number, the species name, the geographic locality, the preparation type, as well as the latitude and longitude. As of April 2005, fifteen museums have their database servers available online through the HerpNET portal; ten more will be online by the end of 2005. Georeferenced data can be mapped on the portal using Berkeley Mapper. The mapping capabilities are very flexible, with a number of interactive features (e.g. points can be labeled by museum, errors can be shown around locality coordinates, distances can be measured, the type of background map can be changed to topographic, political boundaries or satellite imagery, and the map can be exported for print or for use in other documents). These data can be used to determine species' distributions, to determine which museums have collections in areas of interests, and for use in niche-modeling research to determine the climatic variables associated with species' ranges. HerpNET is a valuable tool for herpetologists, conservation biologists, and museum scientists, and we encourage interested museums worldwide to inquire about joining our network.

Multiple approaches to phylogeny of eublepharid geckos (Squamata: Eublepharidae) based on mitochondrial genes and morphological data

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Eublepharid geckos have been shown to be a monophyletic group, probably sister to all other gekkotan lizards. Although several attempts have been made to resolve the phylogenetic relationships within this group, the scarcity of data as well as the ambiguous support of several clades has required the replenishment of dataset and the combination of multiple phylogenetic methods. We analysed newly obtained 12S and 16S rRNA sequences for 11 forms of eublepharids together with previously published datasets of molecular and non-molecular (mostly morphological) characters. We used several computational approaches (maximum parsimony, maximum likelihood, neighbour-joining and Bayesian analysis) together with different methods of alignment acquisition (different gap penalties, "culling" and "elision" method) to molecular data, as well as the total evidence method to fusion of molecular and non-molecular data. Combined, in forms with known DNA sequences, our analyses revealed several well-supported clades: (1) (*Coleonyx mitratus* + *C. elegans*) + (*C. variegatus* + *C. brevis*) (2) (*Holodactylus africanus* + *Hemitheconyx caudicinctus*) + ((*Eublepharis macularius* group + *E. cf. fuscus*) + *E. angramainyu*) (3) (*Goniurosaurus araneus* + *G. luii*) + *G. lichtenfelderi* (4) (*G. kuroiwae* + *G. orientalis*) + *G. splendens*. Nevertheless, the resolution of deeper, probably very old splittings and the position of *Aeluroscalabotes* remained poorly supported. We suggest that these polytomies could be resolved only by addition of new data, preferentially sequences of slowly evolving genes.

Effects of tail damage on the metamorphic traits of the tadpoles of the Iberian spadefoot toad, *Pelobates cultripes*

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In nature, tadpoles are often found with injured tails, which probably reflects the high predation pressure they may experience. The Iberian spadefoot toad, *Pelobates cultripes*, largely distributed in the Southwest of the Iberian Peninsula, often coexists with the red swamp crayfish, *Procambarus clarkii*, introduced in this area in the 70's. *P. clarkii*, a predator of *P. cultripes*' tadpoles, can also inflict them tail injuries. In Doñana Natural Park (Southwest Spain), in water bodies where these two species coexist, the number of tadpoles of *P. cultripes* found with damaged tails is significantly higher

than in places where they do not coexist. To assess the consequences of tail injury in some biometric and biophysical traits of froglets, we performed experiments with tadpoles of *P. cultripes* from Grândola, Southwest Portugal, in which two levels of tail damage were inflicted to tadpoles in two different developmental stages. In the laboratory, tail loss only influenced the weight and body size of the tadpoles that suffered the damage later in their development. These traits increased with increasing levels of injury. For animals in an earlier stage, tail loss had no apparent effects, probably because these animals had more time to recover from the injuries before metamorphosis. These data suggest that tail damage in *P. cultripes*' tadpoles is not likely to have negative consequences for the froglets. Therefore, the sacrifice of the tail may be an important mechanism to decrease the effect of predation, by directing the attention of predators towards a region of the body that can be regenerated rather quickly.

Reproductive isolating mechanisms and genetic divergence in the rice frog *Fejervarya limnocharis* complex from Asia elucidated by crossing experiments and mitochondrial gene sequence analysis

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The rice frog *Fejervarya limnocharis* is one of the most widely distributed species among Asian frogs. Conspicuous variations of this species have been reported based on morphology and mating calls over the distribution range. In reports on the taxonomy of the *F. limnocharis* complex, there have been many citations dealing with the systematics of this species complex (Dubois 1984, 1987, 1992, Dubois and Ohler, 2000). In the present study we conducted crossing experiments among nine populations of the *F. limnocharis* complex from five Asian countries in order to elucidate the reproductive isolating mechanisms among the Asian populations of this species complex. We also carried out mtDNA gene sequence analyses to genetically estimate the intra- and interspecific divergences of this species complex using 27 populations from eight Asian countries. The crossing experiments revealed that the Sri Lanka population is reproductively isolated from the Japan, Thailand, and Bangladesh (BAU-L) populations by complete hybrid inviability at the embryonic stage, but not from the Bangladesh (BAU-S) population by hybrid inviability at the embryonic or larval stage. The Thailand populations were found to be incompletely reproductively isolated from the Japan population by abnormal spermatogenesis. The phylogenetic analysis based on the mitochondrial 16S rRNA gene sequences showed

that the *F. limnocharis* complex from Southeast Asia diverged into two groups; one including the populations from Japan, Taiwan, and Malaysia (known as *F. limnocharis*), and one including the populations from Bangladesh and Thailand (closely related to *F. iskandari*). The South Asian populations from Sri Lanka and India formed a cluster remotely related to the two Southeast Asian groups mentioned above, then diverged into several presumptive species, including the Bangladesh populations (BAU-S and BAU-M). Further examination will be necessary to elucidate the reproductive isolating mechanisms among Southeast Asian populations of this complex, including the type localities of *F. limnocharis* and *F. iskandari* from Indonesia.

Phylogeography of the toad genus *Capensibufo*, endemic to the Cape Floristic Region, South Africa

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The genus *Capensibufo* is endemic to the Cape Fold Mountains of the Cape Floristic Region, South Africa, and currently comprises two species, *Capensibufo rosei* and *C. tradouwi*. These small toads occur in montane habitats, particularly on mountain tops, where populations are potentially isolated from each other. Such segregation could lead to little or no gene flow between areas of occupancy, resulting in the accumulation of genetic differences on a fine geographic scale. To investigate the phylogeography of this genus, 642 bases of the mitochondrial ND2 gene were sequenced for 36 individuals of the two species. Both phylogenetic analyses (parsimony, Bayesian) recovered three equally divergent clades, each restricted to a distinct geographic region. All individuals identified as *C. rosei* grouped as a monophyletic clade. In contrast, *C. tradouwi* consists of two clades that are highly divergent from each other, and occur in different geographic regions. These preliminary results suggest that this genus consists of three distinct lineages, despite there being only two species described. We are currently conducting a morphological assessment to determine whether any morphological characters can be used to support the three genetic lineages.

Passive absorption of water soluble compounds in *Uromastix aegypticus*

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Many nutrients and toxins, natural or manmade, and drugs are hydrosoluble. Efficient transport of hydrosoluble chemicals across the vertebrate small intestine is generally thought to depend on membrane

transport proteins (mediated transport), but some birds can efficiently transport hydrosoluble chemicals through the intercellular tight junctions by a passive, paracellular pathway. However, the extent of passive absorption may vary considerably between endotherms and ectotherms because endotherms typically have higher intestinal surface area and shorter retention time of digesta than ectotherms. In the herbivorous dabb lizard, *Uromastix aegypticus*, we explored (1) the magnitude of paracellular transport through intercellular tight-junctions, and (2) how the tight-junctions restrict transport according to molecular size. We used carbohydrate probes that ranged in size from 150 to 350 Daltons. Preliminary results suggest that paracellular transport does occur in *U. aegypticus*, and that approximately 20% of glucose is absorbed by the paracellular pathway, compared to uptakes of up to 80% in some birds. This study is part of a broader program of research to (1) compare the capacity for paracellular uptake of nutrients in reptiles, birds, in mammals, spanning a broad size range (0.05 - 50 kg), and (2) test mechanisms that may explain differences among species in the importance of paracellular transport of hydrosoluble chemicals. Transport of molecules via the paracellular pathway is non-specific and limited only by molecular size. Thus, high rates of transport may result in exposure to small, hydrosoluble toxins, such as plant secondary compounds or manmade pesticides that would not otherwise be absorbed.

Differential sensitivity of anuran species to the toxic effects of malathion and methylmercury

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Species and developmental differences in the effects of toxic chemicals reflect important differences in amphibian physiology. Malathion is an organophosphorus insecticide (contains Fyfanon® ULV and solvents) and may represent a threat to amphibians. Using a static renewal exposure protocol, we determined the acute toxicity of a commercial malathion formulation and individual formulation ingredients for *Xenopus laevis* and the Northern Leopard frog (*Rana pipiens*) tadpoles. *X. laevis* was more sensitive than *R. pipiens*. For example, a dose containing 10mg/ml Fyfanon® ULV killed 50% of the *X. laevis* tadpoles within 24 hr, whereas toxicity was not seen in *R. pipiens* until 72-96 hr into exposure. Few studies have investigated the effects of MeHg on amphibians, even though many species inhabit areas of traditional methyl mercury production – namely wetlands – during especially vulnerable periods of life. Moreover, wetlands are under constant threat of habitat destruction, and are the sites of agricultural run-off and pesticide applications. MeHg is considered to be highly

neurotoxic to wildlife and humans, but low-level, subtoxic effects are rarely examined. The toxicity of dietary methylmercury (MeHgCl: 1-1000ng/g) was determined for the American toad (*Bufo americanus*), *R. pipiens* and *X. tropicalis*. The highest dose was toxic to all species: there was 100% mortality. MeHg LC50 estimates were ~ 323-371 ng/g for Gosner stage (GS) 25 *B. americanus* and *R. pipiens* tadpoles. Older tadpoles were less sensitive; MeHg LC50 estimates were 707 ng/g for *B. americanus* GS 27-32 and 643 ng/g for *X. tropicalis* Nieuwkoop-Faber stage 48-50 tadpoles. Our data suggest that *X. laevis* are more sensitive to malathion than the other North American species tested. In contrast *X. tropicalis* and North American species tadpoles have a similar sensitivity to the toxic effects of MeHg. The physiological and molecular basis for differences in anuran sensitivities is currently under investigation. Supported by the Canadian Network of Toxicology Centres, Environment Canada, and NSERC.

Study on the feeding behavior of Chinese green tree viper, *Trimeresurus s. stejnegeri*

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We fed Chinese green tree vipers with three types of prey, including mouse (ICR), frog (*Rana limnocharis*), and lizard (*Japalura polygonata xanthostoma*, *J. swinhonis*) at 20 ~ 24 C. The feeding behavior was recorded by (infrared light) videotape-recording method or naked eyes. The snake withdrawal and pulled up the prey from the ground following catching it in the laboratory. The prey was hanged and the body tilted, like a lever with the snake-biting site as the fulcrum. Mostly, the snake gradually moved its jaw to the upper end of the prey body and ingested it. The snake stroked mouse mostly at the direction perpendicular to the long axis of its prey, and ingested it mainly from head. The ratio of mouse ingested from anterior to posterior side was 55 : 19 and 23 : 8 under light and dark condition, respectively. The ingested direction ratio in the light was not different from that in the dark. When feeding frog and lizard under light condition, the ingested direction ratio was 11 : 9 and 8 : 2, respectively. The time from catching prey to start moving the jaws (T1) was longer in feeding lizard or frog than feeding mouse. The action time of venom to different prey type may affect T1. The time from moving the jaws to start flicking the tongue following the ingestion (T2) was longer in feeding lizard than feeding frog or mouse. The scales and long tail of lizard may retard T2.

Can Taiwan slug snake, *Pareas formosensis* follow the mucus trail of a slug?

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Pareatinae is a specialist on slug or snail in Asia. Because slug left a mucus trail after its movement, we predict Pareatinae may follow the mucus trail and find its food. We used Taiwan slug snakes, *Pareas formosensis* to test this prediction. The snakes were fed with 10% of food and fasted for more than 3 days to standardize their hungry extent. We put the fasted snake in a box, connected to the base of a Y maze for 5 minutes before the experiments. After the slug mucus or water was daubed at a piece of waterproof paper, which was put in the Y maze we opened the door of the box. The Y maze with infrared sensors can detect snake's location in a totally dark condition. Each snake was tested for 10 trials for both mucus and water in dark and dim conditions, and we tested each snake only once per day. A total of 15 snakes were tested and we define the snake is succeed if it follow the trail to one end of the Y maze within 20 minutes. The mean succeed percentages of following mucus in dark and dim conditions were 70.6 ± 21.8 and $72.6 \pm 18.8\%$. While the mean succeed percentages of following water in dark and dim conditions were 50.3 ± 17.4 and $60.7 \pm 16.1\%$. No interaction was found between factors of light and smell. Also, we found no significant difference between dark and dim conditions. The succeed rate of following mucus was significantly higher than that of water either in dark or dim condition. In conclusion, Taiwan slug snakes can follow the smell of slug's mucus trail.

The food habits of the sea snake, *Laticauda semifasciata*

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We collected *Laticauda semifasciata*, a dominant species of the sea snake at Orchid Island, and dissected them to investigate their food habits. A total of 219 snakes were dissected. Most of them (67%) did not have any food in their stomachs. From a snake cave we found more individuals with empty stomachs than from other place. This was probably because the snake cave was the place for reproduction. We found 73 (33%) snakes had food in their stomachs, and identified 16 fish families from their food. *L. semifasciata*, is clearly a generalist, preying on several families of fish. Hatchling snakes ate only Mugiloididae, while subadult and mature snakes fed mainly on Emmelichthyidae, Acanthuridae, and Pomacentridae. We found more variety of fish families in the stomachs of mature males (15 families) than in those of adult females (6 families). Male snakes ate more frequently on Emmelichthyidae (35%) and Acanthuridae (19%).

Females preyed more frequently on Acanthuridae (25%) and Pomacentridae (25%).

Western Cape Nature Conservation Board's long term frog population monitoring project

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Western Cape Nature Conservation Board initiated a long term frog monitoring project in 2002 at two sites in the Western Cape. One site is a medium altitude site and the second is a high altitude site. Both sites are equipped with weather stations. Presence and absences of each frog species as well as categorical estimations of abundance are presented. The short period of time since initiation of the project prevents robust analysis of population trends or correlation with weather patterns but does allow some preliminary conclusions.

Paternity in adder (*Vipera berus*): is big really an advantage?

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Males' reproductive success is particularly difficult to estimate. To evaluate this factor, molecular techniques can help us to evaluate this factor. Within European vipers, males fight vigorously mating opportunities and large ones generally win. But sneaking males can also copulate with females. Further studies have shown that the first mating male sires a higher number of offspring. In this study, paternity assessments were conducted using microsatellite markers to estimate (i) if only the biggest males copulate (ii) if the males' length has an impact on the number of offspring and (iii) on the number of copulations.

Anura from a Western Cape, South Africa, archaeological site

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The Middle to Late Stone Age archaeological site at De Kelders is situated close to the sea at a small elevation. Changes in sea level may have had considerable effect on conditions at the site and in the area, and the Anura found at the site. To date about 740 bones have been sorted from samples representing a column at the site. Pipid, bufonoid, ranoid and brevicipitid frogs are represented, the Pipidae by only two bones, while brevicipitid bones are by far the most numerous. The

assignable bones are: Pipidae: vertebra II and vertebra IV? – distinguishable by opisthocelous centrum and fluted zygapophyses. Both vertebrae are small. The apparent absence of a rib on Vertebra II suggests a new taxon, distinct from all described xenopodines. Bufonoidea: an atlas vertebra; four sacra (procoelous); five scapulae (no inner flange). Ranoid: atlas vertebrae (8) with widely spaced cotyles and undivided neural arch, assignable to the burrowing ranid *Tomopterna*; only at the higher levels; ilia with crests (alae), the characteristic ilia of *Tomopterna* with rudimentary ala separate from dorsal protuberance; sacra with boss on the centra anteriorly (indicating diplasiocoelous condition); coracoids; scapulae with inner flanges of varying lengths (suggesting different genera); elongated ankle bones (tibiale+fibulare). Brevicipitid: a fused atlas/axis; fused sacrum/urostyles (including two with sacrum apparently consisting of two vertebrae); scapula (1); coracoids; humeri; radioulnas?; presumed ilia; femuri; tibiofibulae; ankle bones. Other columns at the site are being investigated.

***Microbatrachella capensis* (Anura: Petropedetidae), Western Cape, South Africa**

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Aspects of the biology and anatomy of *Microbatrachella capensis* are illustrated. These include the habitat, the gut contents of tadpoles and adults, the characteristics of the tadpole, and the skeletal anatomy of the adult as revealed by X-rays and Alizarin/Alcian Blue preparations.

Frog community from the floor leaf litter from an Atlantic rainforest area from southeastern Brazil

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The Atlantic Rainforest covered much of the Brazilian coast and is now reduced to approximately only 7% of its original area. Data on community composition and abundance distribution of anuran living on the forest floor leaf litter in the Atlantic Rainforest is scarce and restricted to only two areas in Southeastern Brazil. In this study, we analyzed the species richness and composition, density, and the effect of litter depth on abundance of frogs from the leaf litter in an area of Atlantic Rainforest, Ilha Grande, Rio de Janeiro State, southeastern Brazil. We performed monthly samples (nocturnal and diurnal) from August 1996 to October 1997 using small (2 x 1m) plots. We sampled 233 plots, totalling 466 m² of forest leaf litter. We estimated leaf litter depth (mean of five measures taken with a caliper to the nearest mm) and tested its effect on the

total abundance of frogs using linear regression analysis. We found eight species from four families: *Brachycephalus didactylus* (Brachycephalidae), *Eleutherodactylus parvus*, *E. guentheri*, *E. binotatus*, *Zachaeus parvulus*, *Adenomera marmorata* (Leptodactylidae), *Dendrophryniscus brevipollicatus* (Bufonidae) and *Chiasmocleis* sp. (Microhylidae). *Brachycephalus didactylus* was the most abundant species, with 91 individuals (mean density of 19.5 frogs/100m²), whereas *D. brevipollicatus* was the less abundant (N = 2; mean density of 0.43 frogs/100m²). Overall frog density was 39.7 frogs/100m². This mean density of frogs in the forest floor leaf litter at the study site in Ilha Grande is similar to other species-rich areas. Mean litter depth significantly affected abundance of frogs (R² = 0.16; F_{1,108} = 20.557; P < 0.001) indicating that microhabitat characteristics may affect local distribution and abundance of frogs in the forest floor.

Diet and microhabitat use by four sympatric species of *Tropidurus* (Squamata, Tropiduridae) in northeastern Brazil

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The South American *Tropidurus* comprises mainly heliophilous, predominantly insectivorous, lizards living in open habitats. At Morro do Chapéu, Bahia State, northeastern Brazil, four species occur in sympatry (*T. hispidus*, *T. cocorobensis*, *T. erythrocephalus*, *T. semitaeniatus*). In this study we analyze the similarity in diet composition and microhabitat use by these species. Field work was carried out between November and December 2000 in a high elevation caatinga. Diet was based on preys found in the stomachs. In all species, diet was composed mainly by ants and flowers, either in frequency (number of lizards), in number and volume of prey. *T. hispidus* (N=20) occurred mainly on bare rocks (34.8%) and rocks under shrubs (34.8%), *T. cocorobensis* (N=13) occurred mainly (92.3%) on the ground under shrubs, *T. erythrocephalus* (N=13) occurred mainly (76.9%) on rocks under shrubs, and *T. semitaeniatus* (N=33) occurred mainly (91.2%) on bare rocks. Cluster analysis for microhabitat use indicated that *T. erythrocephalus* and *T. hispidus* were the nearest species (Euclidean distance: E.d.=0.224) and *T. cocorobensis*, the most distant (E.d. from the other species=0.339). Concerning the diet, *T. semitaeniatus* and *T. hispidus* were the nearest (E.d.=0.027) based on the number of preys consumed, mainly because ants and flowers comprised similar proportions of the number of preys consumed (ants:36% for both; flowers:T.s.=43%, T.h.=50%). In terms of volume, *T. semitaeniatus* and *T. cocorobensis* were the most similar (E.d.=0.10), mainly due to the large proportion

of flowers in their diet (T.s.=89% and T.c.=91.4% of the total volume). In terms of prey occurrence in lizard stomachs, *T. cocorobensis* was the most distant species (E.d.=0.156), due to its higher consumption of spiders (69.2% of the lizards), bugs (38.5%) and termites (38.5%) when compared to the other species. We conclude that, at the study site, flowers and ants are important components of the diet of the four species. Differences in microhabitat use and in diet may favor coexistence of these co-generic species in the area.

***Xenopus laevis* breeding glands (nuptial pads) as biomarkers for androgenic modulation by environmental chemicals.**

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Nuptial pads are areas, digits and fore-arm, characterized by epidermal keratin hooks and dermal breeding glands opening on the epidermis surface in male frogs. The presence of the epidermal hooks and secretory activity of the breeding glands are androgen dependent and considered functioning during mating. Chemical pollutants released into the aquatic environment by humans are suspected of disrupting the normal hormonal pathways and functioning. Among the best known of these endocrine-disrupting contaminants (EDCs) are compounds that mimic the steroid, 17 β -estradiol. However, recently specific anti-androgenic activity by certain EDCs, including DDE and several fungicides, including vinclozolin, have been shown in mammalian studies. The African clawed frog, *Xenopus laevis* has been proposed as an ideal species to be used as a model system for screening of endocrine disruptors. In this study we investigated the effect of anti-androgenic compounds on breeding (nuptial) gland activity, using gland morphometric variation as a biomarker system. Our results indicate that anti-androgen pharmaceuticals, flutamide and finasteride did significantly (P<0.05) effect the androgen-dependent breeding (nuptial) glands and plasma testosterone concentrations in male *Xenopus laevis*. Our results further confirm that the dicarboximide fungicide, vinclozolin, and DDT congener, DDE, mimic the anti-androgenic action of flutamide. Vinclozolin, however, did not significantly effect the plasma testosterone concentration. Preliminary data regarding breeding success showed that anti-androgens significantly inhibited clasping as well as fertilization success following males being exposed to anti-androgen compounds.

Karyotype diversity among the species of the endemic Brazilian lizard genus *Enyalius* (Leiosauridae, Squamata)

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Species of *Enyalius* range in forested habitats of Brazil. Six species (two polytypic) are currently admitted: *E. brasiliensis* (two subspecies), *E. catenatus* (three subspecies), *E. bilineatus*, *E. iheringii*, *E. leechii* and *E. perditus*. Except for *E. leechii*, which occurs in the Amazon basin, all the remaining species are widely distributed throughout the Atlantic Forest. Isolated populations of *E. bilineatus* are known from gallery forests in the Cerrados of Central Brazil, and of *E. c. bibronii* (herein referred as *E. bibronii*) from isolated patches of forest in the Caatingas. *E. bilineatus*, *E. iheringii*, *E. leechii* and *E. perditus* share a similar $2n=36$ (12M+24m) karyotype, with the macrochromosome pairs 1, 3, 4 and 5 metacentrics, and pairs 2 and 6 submetacentrics. *E. bibronii* shows also $2n=36$ (12M+24m), but has an acrocentric pair 6. *E. catenatus catenatus* exhibits a distinct $2n=38$ (14M+24m) karyotype, with pairs 5 to 7 acrocentrics. It is suggestive that the acrocentric pairs 6 and 7 of the latter and one metacentric pair, probable from *E. bibronii*, are involved in a fission/fusion rearrangement. In all species, the 24 microchromosomes seem to be acrocentrics, but *E. perditus* has at least two biarmed pairs. All species present the NORs located at the secondary constriction of distal end of the long arm of pair 2 and share small amount of constitutive heterochromatin at the pericentromeric region of some chromosomes and at the secondary constriction of pair 2. Proximal C-bands equidistantly located at pairs 1 and 2 occur in *E. bilineatus* and *E. bibronii*. Sex determination of the XX:XY type involving microchromosomes (dot-like Y and medium-sized X) characterizes *E. bilineatus*, *E. leechii* and *E. perditus*. Considering the problematic taxonomy of the genus the present cytogenetic data may contribute to improve it.

Response characteristics of infrared sensitive multi-units in the *tectum opticum* of *Crotalus atrox*

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Pit vipers (Crotalinae) possess highly sensitive infrared reception that is mediated from the facial pit organs via the trigeminal nerve and the hindbrain into the midbrain and forebrain. The pit organs enable the snake to detect minute thermal differences within their environment, which helps them to find their warm-blooded prey. Infrared sensitive tectal neurons may receive additional visual input. We investigated the functional properties of infrared sensitive multi-units within the midbrains *Tectum opticum* of anaesthetized western diamondback rattlesnakes (*Crotalus atrox*). We stimulated the pit organs with a red laser beam (650 nm) of different intensities focused onto the pits

membrane with a diameter of 25µm. Recordings of multi-units were carried out with tungsten electrodes in the stratum griseum centrale of the contralateral *Tectum opticum*. The response latencies varied from 170 ms at threshold levels to 20 ms at higher stimulus intensities. The latency of the first spike in the tectal multi-units shows a systematic variation with the intensity of stimulus at the pits membrane. The results indicate that infrared sensitive tectal neurons use the response latency to encode the stimulus intensity. Spike rates of multi-units are increasing steadily with increasing stimulus intensity up to a maximal spike rate of a stimulus intensity of 1mW. Temperature measurements on the membrane revealed an effected temperature of 0.6° for this stimulus intensity.

Determinants of social spacing in a social lizard

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Australian lizards of the genus *Egernia* appear to be among the most social of all reptiles with reports of social aggregations documented for 23 of the 32 recognised species. The size, complexity, and stability of these aggregations appear to vary considerably between species, and even among populations of the same species, making it an ideal genus to understand the selective pressures favouring the evolution and maintenance of social behaviour. Information relating to an individual's home range size and overlap and their determinants constitutes basic data for any study of social behaviour. We calculated home range size and overlap in a population of *Egernia whitii* on the East Coast of Tasmania, Australia. Home range overlap was used to describe social groupings within the population. The home range overlaps between adult males and females were used to identify the potential mating system present (solitary, monogamous, and polygynous) and that between adults and juveniles was used to infer indirect parental care/acceptance. Home range size is correlated with sex, body size, population density, and social behaviour. These results will form the basis of future study in which the home range analyses will be integrated with molecular analyses of paternity. The home range size will be correlated to the extent of extra pair paternity in females' litters, the social system present (monogamy versus polygyny), and male (and female) reproductive success. This work will also allow the relationship between a juvenile's location within an adult's home range and the actual relatedness of the individuals to be examined and, in the long term offers the possibility to correlate this relatedness with the future reproductive success of the juvenile.

Genetic variability between populations of the critically endangered frog *Microbatrachella capensis*

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The genetic diversity between and within the six populations (Kenilworth, Grootwitvlei, Kleinmond, Buffeljacht, Hagelkraal, Lamloch) of *Microbatrachella capensis* in the Western Cape Province of South Africa was assessed. Genetic diversity was determined using 620 bp of the mtDNA ND2 fragment for 12 specimens per population. The genetic data were analyzed for geographic structure using the AMOVA option as implemented in ARLEQUIN. Gene flow among the populations was assessed using the programme MIGRATE. A phylogeographic analysis (in PAUP) and a nested clade analysis (in GeoDis) of the populations of *Microbatrachella capensis* sampled will be presented. The habitat has the potential to be degraded due to the threat of human encroachment. The genetic relationships between the subpopulations and the threats were evaluated to assist in the future conservation plans for the critically endangered *Microbatrachella capensis*.

The salinity effects on the growth and development of tadpoles of the Indian rice frog, *Rana limnocharis* in Taiwan

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Almost all amphibians are reported to inhabit or breed in fresh water habitats, but studies have showed that some amphibians may inhabit or tolerate in the brackish water. The Indian rice frog, *Rana limnocharis*, distributes widely in Taiwan and adjacent Eastern and Southern Asia. The tadpoles of this species have been noticed that to inhabit in the tide pools of coastal regions of Green Island and Orchid Island. Tadpoles that are confined in these small water bodies face osmoregulatory and thermal stresses due to the combined effects of wave spraying, raining and evaporation. From July 2004, we collected the tadpoles of *Rana limnocharis* from Green Island of Taitung County (brackish water environment) and Guoshin of Natou County (freshwater environment) to conduct following experiments: the intra-specific of

saline tolerance of tadpoles, the effects of salinity on the growth and development of tadpoles, and hemolymph osmolality of tadpoles when acclimated in different salinities. Results showed that 1) tadpoles of two populations could survive in salinity between 0 and 9 ppt SW within 48 hours. When the water salinity was up to 11 ppt SW, the tadpoles' survivor from Green Island was higher than from Guoshin. Tadpoles of two populations could not survive in 13 ppt SW within 24 hours. 2) Tadpoles from Green Island could grow and develop normally below 7 ppt SW, but when the salinity was up to 9 ppt SW, the growth and development of tadpoles were retarded. In contrast, tadpoles from Guoshin could only grow and develop normally below 5 ppt SW, when the salinity was up to 7 ppt SW, the growth and development of tadpoles were retarded. 3) The size at metamorphosis of tadpoles from Green Island decreased as salinity increased. 4) *R. limnocharis* tadpole from Green Island is an osmoregulator from 8 to 250 mOsm / kg. Results suggest that tadpoles from Green Island are more adapted physiologically to brackish environment.

Preliminary phylogeny of *Phrynobatrachus* (Anura: Petropedetidae) inferred from mitochondrial 12S and 16S rRNA sequences

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Phrynobatrachus (Anura: Petropedetidae) is a genus comprised of approximately seventy species and distributed across sub-Saharan Africa within diverse terrestrial habitats. Historically, species of *Phrynobatrachus* have been taxonomically difficult to investigate due to numerous species, lack of distinguishing morphological characters, intrapopulation variation, and inadequate descriptions. In addition to seventy species of *Phrynobatrachus*, the phrynobatrachine lineage includes eight species of *Arthroleptella* and the monotypic genera *Dimorphognathus*, *Natalobatrachus*, *Phrynodon* and *Poyntonia*. Nucleotide sequence comparisons were used to investigate relationships within the phrynobatrachines; mitochondrial DNA from 12SrRNA, tRNA^{Val}, and 16SrRNA regions were sequenced in order to obtain a continuous fragment of approximately 2,350-base pairs. The phylogeny constructed with this data will be used to assess the monophyly of the phrynobatrachines, clarify relationships among the species, and investigate interesting biological questions regarding chromosomal variability and evolution of small body size.

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Ernst HW Baard

Chair: Local Organising Committee
Fifth World Congress of Herpetology, Stellenbosch 2005

Addendum to Programme

The anuran lymphatic system: how frogs “get it up” – Poster

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The anuran lymphatic system is unique among vertebrates, composed of (usually) two sets of tiny, contractile dorsal lymph hearts and a series of lymph sacs with one-way valves located between the skin and the musculature (the only exception being the subvertebral sac which lies within the body, between the lungs and the ventral surface of the vertebral column). In the major areas of the trunk, the skin together with the lymph sacs is very compliant. Hillman et al, 2004 have shown that lymph heart contraction alone is not sufficient to move lymph from the ventral parts of the frog dorsally to the lymph hearts and thus back into the circulatory system. Recent work (Hillman, et al. in press) has also indicated that lymph sac/skin compliance in the extremities increases from distal to proximal and because of this distal low compliance, lymph is forced inward passively in what has been termed a “compliance pump”. However, the high compliance and position of the proximal lymph sacs suggest that additional mechanisms must exist to overcome gravity and move lymph dorsally to the lymph hearts. We identify a series of muscles in both *Rana catesbeiana* and *Bufo marinus* whose activity on lymph sacs, together with lung inflation, serves to vary compliance of the sacs and force lymph upward into the region of the lymph hearts. Although the same purpose is served, the suite of muscles involved in *Rana* and *Bufo*, and their respective Neobatrachian relatives, is different.

Hillman, et al. 2004. *Physiol. Biochem. Zool.* 77:161-173

Hillman, et al. in press. *Physiol. Biochem. Zool.*

Elements of a strategy to conserve Milos viper, *Macrovipera schweizeri* (Werner, 1935) on Milos Island – Poster

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Milos Viper (*Macrovipera schweizeri*) is an endemic species of western Cyclades. Its total distribution is restricted to four small islands, namely Milos, Sifnos, Kimolos and Polyaigos. Milos Island holds more than 60% of the total species population. Recognizing the importance of this island for Milos Viper, the Regional Development Agency of Cyclades is implementing, the project “Protection and Promotion of the Habitats and

Species of the Milos Island Natura 2000 area”. Habitat destruction is the major threat for the future survival of the species. The reduction of the suitable habitat for the species during the last 60 years is documented in this poster. The most severe problem at the moment is overcast mining. Although the largest part of Western Milos has been proposed as a Natura 2000 area, the fact that most of this area is private and the absence of imagination in the use of land, leads to the threat of extensive building development. The establishment of an information office on Milos aims at giving alternatives to the landowners for more sustainable use of their lands and to propose them funding opportunities for those activities. Complementary actions in that direction include the restoration of an inactive mine, and the planting of scrubs in a recently burned area.

Road mortality is a direct threat for the species. Preliminary data on the results of restrictions to the night traffic during summer for the mining companies and the implementation of a pilot project of barriers and underground passages, are given in this poster.

The continuation of the monitoring project for Milos viper that started in 1993 (Nilson *et al.*, 1999) aims at the collection of long term data on the population trends, the evaluation of conservation actions and the location of viper populations on the eastern part of the island, which has received little attention during the previous project.

Nilson G., Andr n C., Ioannidis Y., Dimaki M. 1999. *Amphibia-Reptilia* 20(4) : 355-375

Reptile quarantine – the importance for captive breeding – Oral paper

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Quarantine is an important aspect of preventative medicine programmes for captive animals and is crucial to preventing the importation and spread of disease into a collection. This presentation will discuss the importance of quarantine to the management and breeding of captive reptiles. The quarantine facilities and protocols at Johannesburg Zoo will be illustrated and their relevance for smaller scale reptile keepers discussed. Topics covered will include the basic set up of a quarantine unit, the importance of optimum husbandry during the quarantine period, recommended lengths of quarantine, hygiene and disinfection, pest control, post mortem examination and disease monitoring and treatment, including ectoparasite control. Control and detection of the snake mite *Ophionyssus natricis*, nematode endoparasites and of reptilian viruses such as Ophidian paramyxoviruses, adenoviruses and Inclusion Body Disease Virus will be emphasised.