SECOND WORLD CONGRESS OF HERPETOLOGY

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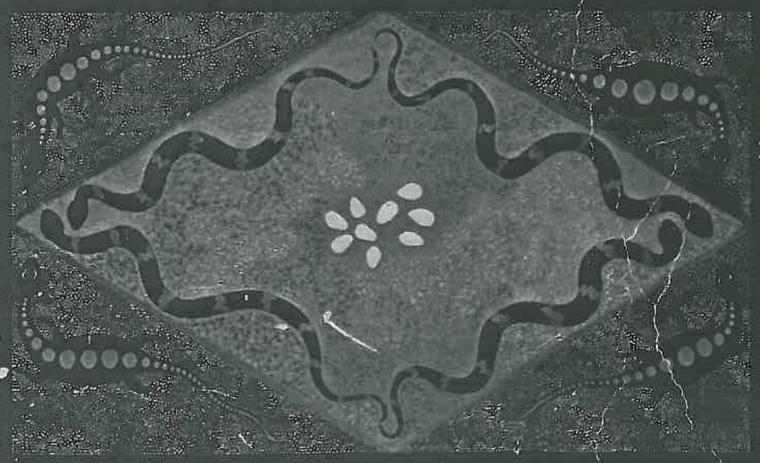

VENUE:
UNIVERSITY OF ADELAIDE
STH AUSTRALIA

December 29, 199
to January 6, 1994

PICTURE LEFT:
Painting by BART WILLIAMS kindly donated by Adella Gallery, Adelaide

"KUNIA" - SNAKE DREAMIN
THIS PAINTING DEPICTS THE DREAMTIME SNAKE OF THE WILLIAMS KINSHIP.
THIS IS THE SACRED SITE OF KUNICE WHERE THE CARPET SNAKES GUARD THIS SITE AND THEIR EGGS FROM THE LIZARDS OR STRANGERS.
ONLY THEIR KIN MAY ENTER THIS SITE.

ABSTRACTS

Second World Congress of Herpetology
Adelaide, South Australia
29 December 1993 – 6 January 1994

Abstracts

Scientific Programme Committee

Kraig Adler
Roger Avery
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Jean Lescure
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These abstracts were edited and compiled by Margaret Davies and Rachel M. Norris.

Some abstracts were edited to conform with size and style constraints. If we have misinterpreted data, we apologise, but time did not allow further communication with authors.

Abstracts are arranged alphabetically by surname of the senior author. Again we apologise if we have inadvertently transposed any surnames — no disrespect is intended. Each abstract is further identified by a key code that indicates the session in which the paper is to be presented.

Time	Thursday 30 December	Friday 31 December	Sunday 2 January	Monday 3 January	Tuesday 4 January	Wednesday 5 January
SESSION 1 9:00–10:30	P1 Evolution	P2 Zoogeography	P3 Physiology	P4 Ecology	P5 Ethology	P6 Conservation & Captive Care
SESSION 2 11:15–12:30	C07 Zoog. C23 Ethol. S01 Evol, S10 Phys. S14 Ecol. S23 C&CC	C26 Ethol. S02 Evol. S06 Zoog. S11 Phys. S15 Ecol. S24 C&CC	C02 Evol. C19 Ecol. S07 Zoog. S12 Phys. S19 Ethol. S25 C&CC	C14 Phys. S03 Evol. S08 Zoog. S16 Ecol. S20 Ethol. S26 C&CC	S04 Evol. S09 Zoog. S18 Ecol. S21 Ethol S27 C&CC S29 Phys.	C32 C&CC S05 Evol. S13 Phys. S17 Ecol. S22 Ethol. S28 History S30 Snakebite
SESSION 3 14:00–15:15	C08 Zoog. C24 Ethol. S01 Evol. S10 Phys. S14 Ecol. S23 C&CC	C27 Ethol. S02 Evol. S06 Zoog. S11 Phys. S15 Ecol. S24 C&CC	C03 Evol. C20 Ecol. S07 Zoog. S12 Phys. S19 Ethol. S25 C&CC	C15 Phys. S03 Evol. S08 Zoog. S16 Ecol. S20 Ethol. S26 C&CC	S04 Evol. S09 Zoog. S18 Ecol. S21 Ethol. S27 C&CC S29 Phys.	C11 Zoog. C33 C&CC S05 Evol. S13 Phys. S17 Ecol. S22 Ethol. S30 Snakebite
SESSION 4 16:00–17:15	C01 Evol. C09 Zoog. C13 Phys. C18 Ecol. C25 Ethol. C30 C&CC		C06 Posters and Trade Fair	C04 Evol. C10 Zoog. C16 Phys. C21 Ecol. C28 Ethol. C31 C&CC	C06 Posters and Trade Fair	C05 Evol. C12 Zoog. C17 Phys. C22 Ecol. C29 Ethol. C34 C&CC S30 Snakebite

Major identifiers of the code are as follows: P = Plenary session; S = Symposium; C = Contributed paper session; C06 = Poster presentation; SS = Satellite symposium *Herpetoculture, Zoos and Private Herpetology* held on 29 December 1993 at Wayville Showgrounds.

A captive breeding research for red turtle *Rinoclemmys pulcherrima*, in Costa Rica. RAFAEL ACUÑA-MESEN AND FEDERICO MUÑOZ. *School of Biology, University of Costa Rica, Costa Rica, Central America.* This paper has five sections (1) Collection and recruitment of specimens. (2) Handling neonates, juveniles and adults under artificial conditions (feeding, recruitment areas, water characteristics such as temperature, pH, salinity, etc.), sorting according to age, recording weight, size, etc. (3) Seasonal assessment of biomass and net primary productivity regarding each specimen as well as the whole population. (4) Egg production, artificial incubation and birth rate. (5) Usefulness of exploiting the species: pets; production of protein; production of other items. [KEYWORDS: captive breeding, turtles, *Rhinoclemmys pulcherrima*, Costa Rica].

Acuña-Mesen & Muñoz

C06–001

Paramyxovirus infections of reptiles. W. AHNE. *Veterinary Faculty, University of Munich, Kaulbachstr. 37, D-80539 München, Fed. Rep. Germany.* Since the first report of a fatal illness of snakes in collection associated with paramyxovirus infection about 20 years ago, paramyxoviruses have been found to be widespread in reptiles suffering from respiratory diseases and nervous symptoms. Several paramyxovirus-like particles have been detected in Testudinidae, Telidae, Boidae, Colubridae, Elapidae, Viperidae and Crotolidae. Epizootics and die-offs associated with paramyxoviruses were documented frequently in a variety of snakes in collections worldwide. The ophidian paramyxoviruses are now considered as extremely important pathogens. However, the pathogenicity and the serological relationships of the several paramyxoviruses isolated from reptiles are not known at present. [KEYWORDS: paramyxoviruses, ophidian paramyxoviruses].

Ahne

S26

Sea turtle conservation in Terengganu, Malaysia — a management case-study. SARALA AIKANATHAN[1] AND MAZLAN BIN JUSOH[2]. [1]*Marine Conservation Program, World Wide Fund for Nature, Malaysia.* [2]*Dept of Fisheries, Malaysia.* In the state of Terengganu four sea turtle species, greens, leatherbacks, olive ridleys and hawksbills, are found nesting. The nesting records of all these species have been found to be declining over the past few decades. The greatest threats faced by the turtles is the collection of their eggs for human consumption. Other threats include: incidental capture of turtles in fishing gear, unregulated coastal development, artificial lights along the coast, sea pollution and the impact of tourism. The local authorities have taken a few measures to help conserve the dwindling population. These measures include the hatchery program, ban on the consumption of leatherback eggs, *in situ* incubation of eggs, fishing restrictions near important nesting grounds, and awareness program to educate local communities, tourists and the general public. Sea turtles are one of the main tourist attractions in Malaysia, therefore the survival of these species is not only important for the preservation of nature biodiversity but also for increasing tourism revenue. All the efforts taken now, especially the hatchery programs, will only show their effectiveness in about 20–30 years time when the present nesting adults stop laying, and the new generation takes over.

Aikanathan & Bin Jusoh

C06–002

Parasites of New Zealand reptiles. RUTH AINSWORTH. *School of Biological Sciences, Victoria University of Wellington, P.O. Box 600, Wellington, New Zealand.*

Ainsworth

C06–003

Parasites may play a role in the evolution, zoogeography, physiology, ecology, ethology, or conservation of reptiles, i.e. all six themes of this Congress. If herpetologists are to consider what this role may be, it is essential that they know the parasitic fauna of the animals they work with. New Zealand reptiles collectively, i.e. skinks, geckos and the tuatara, are host to at least 31 parasitic species, 21 of which have been described. All major parasitic groups — nematodes (round and pin worms), cestodes (tape worms), trematodes (flukes), protozoa, Acanthacephala (thorny headed worms), and Acarina (mites and ticks) — are represented in our reptiles' parasitic fauna. Although some of these parasites are rare, a non-parasitised lizard is just as rare. [KEYWORDS: reptiles, New Zealand, parasites].

Akkaraju *et al.*

C06–112

Phylogenetic classification of the living crocodylians based on DNA melting profiles and DNA-DNA hybridisation: more congruence? SHYLAJA AKKARAJU[1], SCOTT M. MOODY[1] AND JON E. AHLQUIST[2]. [1]*Dept of Biological Sciences, Ohio University, Athens OH 45701, United States of America.* [2]*Dept of Biology, University of Louisville, Louisville KN 40292, United States of America.* The living crocodylians have been studied by many workers using a variety of morphological and molecular data sets. Densmore has demonstrated congruence between different types of molecular data but the resultant phylogenetic hypothesis is at variance with the accepted cladograms based on morphology. That is, molecular data suggest that the monotypic genera *Gavialis* and *Tomistoma* are not only closely related but comprise a distinct clade from the families Alligatoridae and Crocodylidae. The morphological data apparently support the notion that the trophic structures of the true gharial and the false gharial are convergent, and that *Tomistoma* belongs to the family Crocodylidae. The present study has used both DNA melting profiles and DNA-DNA hybridisation to contribute to this controversy. The melting profiles (fifth derivative thermal denaturation) were aligned. Homologous peaks identified and character transformations of peak shifts or absences were analysed with cladistic and phenetic algorithms. Preliminary results suggest congruence with other molecular-based trees. DNA-DNA hybridisation data will be analysed and reported. [KEYWORDS: Crocodylia, DNA, molecular systematics, phylogeny].

Alberch *et al.*

S05

Evolution of ontogenetic pathways in *Salamandra salamandra*. PERE ALBERCH, HERNÁN DOPAZO AND MARÍA J. BLANCO. *Museo Nacional de Ciencias Naturales (CSIC), 28006 Madrid, Spain.* The urodele *Salamandra salamandra*, widely distributed throughout Europe and North Africa, is characterised by the existence of a variety of life-history patterns at the intraspecific level. Some females give birth to aquatic larva while others give birth to fully metamorphosed individuals. Here we focus on the heterochronic changes that accompany different life-history patterns. We studied upland populations from Central Spain. In these localities, females give birth to aquatic larvae that spend up to two years prior to undergoing metamorphosis. This life-history pattern is compared with populations from Northern Spain characterised by embryos metamorphosing inside the mother's reproductive tract, thus eliminating the aquatic larval stage. The latter strategy is accompanied by the presence of incomplete fertilisation of ova and of intra-uterine cannibalism. We postulate that the combined effect of these two factors result in an acceleration of developmental rates

and in the evolution of a"viviparous" reproductive pattern. [KEYWORDS: *Salamandra*, heterochrony, viviparity, intra-uterine cannibalism, life-history strategies].

Alberts & Phillips

S19

Relationship between structure and function in the chemical communication systems of two iguanid lizards. ALLISON C. ALBERTS AND JOHN A. PHILLIPS. *Centre for Reproduction of Endangered Species, Zoological Society of San Diego, P.O. Box 551, San Diego, CA 92112, United States of America.* If natural selection acts to maximise efficiency of information transfer in animal communication systems, then animal signals should exhibit structural features that are optimal for specific functions under particular environmental conditions. Comparative studies on the chemistry and social significance of femoral gland secretions in desert iguanas (*Dipsosaurus dorsalis*) and green iguanas (*Iguana iguana*) will be reviewed. Field and laboratory studies suggest that femoral gland secretions probably function in marking of home ranges and recognition of conspecifics. In desert iguanas, secretions are of low volatility and may be detected initially using long-range ultraviolet visual cues. In contrast, the secretions of green iguanas contain a diversity of volatile lipids and appear to be localised by chemoreception. Differences in the chemical composition and the mode of localisation of femoral gland secretions in these two species may reflect adaptations to the diverse climatic conditions of arid desert and tropical forest environments. (Supported by NIH 2F32DC00025–03). [KEYWORDS: chemical communication, femoral glands, *Dipsosaurus dorsalis*, *Iguana iguana*].

Alexander *et al.*

C06–004

Behavioural thermoregulation and voluntary hypothermia in the African elapid snake, *Hemachatus haemachatus*. GRAHAM J. ALEXANDER[1,2], DUNCAN MITCHELL[1] AND SHIRLEY A. HANRAHAN[2]. [1]*Dept of Physiology, University of the Witwatersrand, P.O. Wits 2050, South Africa.* [2]*Dept of Zoology, University of the Witwatersrand, P.O. Wits 2050, South Africa.* The selected body temperature of *Hemachatus haemachatus* was measured in a thermal mosaic with the use of an automated data logging system. Two thermocouples were used to measure body temperature. One was inserted into the gut via the cloaca to a distance of 10% body length from the cloaca for measurement of internal body temperature, while the other was attached to the ventral exterior of the snake at the same location. This allowed for the measurement of the thermal gradient across the body which was used to determine activity periods. Measurements were taken every 15 minutes and experiments lasted for up to 4 days. Snakes were supplied with cover and were not disturbed. Selected temperatures during activity were lower ($\bar{2}$ = 24°-25°C) than those generally reported for other species (Lillywhite, 1987). Snakes regularly became hypothermic by dropping body temperature to below 10°C for extended periods while inactive. However, body temperature was always maintained above 3°C, below which, *H.haemachatus* looses locomotor abilities. It would appear that low selected body temperatures are the result of a voluntary and actively initiated process in *H.haemachatus*, as reported for some species of lizards by Regal (1967). Voluntary hypothermia may be common in reptiles but has not been generally recorded due to inappropriate experimental design. [KEYWORDS: snake, Elapidae, thermoregulation, hypothermia, *Hemachatus haemachatus*].

Relative density and population dynamics of *Bufo marinus*. ROSS A. Alford *et al.*

S16

ALFORD[1], PETER BAYLISS[2] AND MARGARITA LAMPO[3]. [1]*Dept of Zoology, James Cook University, Townsville, Qld 4811, Australia.* [2]*Instituto Nacional de Pesquisas da Amazonia, Manaus, Brazil.* [3]*Instituto Venezolano de Investigaciones Cientificas, Caracas, Venezuela.* The density and dynamics of populations of the cane toad, *Bufo marinus* have been monitored at a series of sites near water. These include sites near Townsville, Australia, where toads have been present for approximately 40 years, sites in the Northern Territory, Australia, which were colonised by toads during 1986, and sites in Venezuela and Brazil which are within the natural range of the species. In the Northern Territory, populations rapidly stabilised following establishment at sizes similar to older populations near Townsville. The composition of Australian populations near water changes seasonally: during the dry season when toads use water for rehydration, sex ratios approach 1:1, while in the wet season when toads disperse, sex ratios are strongly male biased. Juvenile populations peak in the late wet/early dry season. South American populations show broadly similar patterns, but can have very different size and sex structures. In most areas, adult toads disappear from sites at rates of approximately 95–99% per year. This reflects a combination of mortality and migration. Extremely high rates of individual movement may account for the rapid expansion of the range of *Bufo marinus* in Australia. Comparison of toad abundances between sites is complicated by the relative availability of water, which can result in different densities near water when densities in the surrounding habitat are similar. [KEYWORDS: population, fluctuation, density, *Bufo*, monitoring, comparisons].

Allen

C06–005

Antipredator responses of rainbow boas as a function of age and differential growth. LINDA L. ALLEN. *Dept of Biology, University of Texas at Tyler, Tyler, Texas 75799, United States of America.* One antipredator response for neonate rainbow boas (*Epicrates cenchria*) is highly aggressive, consisting of rapid striking and biting. Adults of this species rarely strike; they may have fewer predators and other defence strategies. As the growth in snakes is related to foraging success, the age at which such an ontogenetic shift would take place may be variable. Whether this change in aggression is due to age or large size was evaluated by placing eighty neonates on one of two diets which produced differential growth. Each animal was randomly chosen to be tested once in the next nine months for several aspects of antipredator responses. The stimulus was the finger of a glove mounted on a 1.5 m pole continuously harassing the subject for 5 min. Number of strikes and latency to first strike decreased with age but not snake size. Fleeing behaviour increased with both age and size. This is evidence of phenotypic plasticity in antipredator behaviour of a snake. [KEYWORDS: *Epicrates cenchria*, phenotypic plasticity, antipredator behaviour, ontogenetic aggression].

Amey & Grigg

S13

Lipid- reduced evaporative water loss in two arboreal hylid frogs. ANDREW P. AMEY AND GORDON C. GRIGG. *Dept of Zoology, The University of Queensland, Qld 4072, Australia.* Rates of evaporative water loss were measured in seven species of Australian frogs and compared with agar replicas. The two arboreal species, *Litoria fallax* and *L. peroni*, showed a marked resistance to water loss and each has a cutaneous lipid layer which appears to provide the waterproofing mechanism. Rates of water loss were compared between *Litoria peroni* and one of the other species, *Limnodynastes fletcheri*, at 20, 25, 35 and 40°C. Even at the highest temperatures, *L. peroni* maintained its resistance to water loss, implying no attempt at thermoregulation by evaporative cooling. [KEYWORDS: frogs, cutaneous water loss, lipids, thermoregulation].

Ananjeva *et al.*

C06–006

The differences of skin receptors: contribution to agamid taxonomy. NATALIA ANANJEVA[1], TATYANA DUISEBAYEVA[2], MARAT DILMUCHAMEDOV[2] AND LARISSA IOHANSSEN[1]. [1]*Dept Herpetology, Zoological Institute, Russian Academy of Sciences, St Petersburg 199034, Russia.* [2]*Dept Zoology, Kazakh State University, Alma Ata 480000, Kazakhstan.* The structure and topography of skin sense organs of agamids were compared using histology and SEM (54 species). The study of Australian agamids (31 species) was supported by Grant of Australian Museum in 1992. Besides differences in general structure of cutaneous receptors of agamids (Cohn, 1914; Preiss, 1922; Scortecci, 1937, 1939, 1941; Moody, 1980; Ananjeva *et al.*, 1986, 1991) the variety of distributional patterns was noted. Hair-bearing receptors typical for arboreal complex of agamids from India and South-Eastern Asia complex (*Acanthosaura*, *Calotes*, *Ceratophora*, *Cophotis*, *Draco*) and Afro-Asian complex (*Agama*, *Trapelus*, *Laudakia*, *Phrynocephalus*) have relatively low density on some shield on the head (1–9). Australian agamids and lizards of *Physignathus* genus have lens-like receptors. Considerable differences in their topography were observed. Maximal number of these organs (to 50) in supra- and sublabial shields was noted in *Physignathus* and *Hypsilurus* species and monotypic genus *Chelosania*. These Australian agamids have not only high density of receptors but also their specific topography. They are distributed very regularly on the whole surface of the scale unlike peripheral arrangement of sense organs more typical for other agamids. Differences in structure and distribution of receptors in lizards formerly belonging to *Gonocephalus* genus were shown. It supports Moody's opinion (1980) about the structures of this genus and is in accordance with karyological data (Ota *et al.*, 1992). [KEYWORDS: Agamid lizards, taxonomy, skin receptors].

Andersen

C20

Growth and survival of *Bombina bombina* tadpoles in Danish ponds. ANNE-MARGRETHE ANDERSEN. *Biological Institute, Odense University, Campusvej 55, 5230 Odense M, Denmark.* The purpose of this study was to examine the role of various physical, chemical and biological parameters on the growth rate and survival of *B. bombina* tadpoles. A series of ponds including both old breeding ponds, restored former breeding ponds and new ponds made close to the most promising of the ponds were selected for a rearing experiment with tadpoles in net cages. The ponds in which the tadpoles had the highest growth rate and survival were characterised by a great productiveness and species diversity of algae, amphibians and water insects. The most important predators were species of Hirudinea and Dytiscidae. Statistical analyses of the results indicate a positive correlation between the breeding success of *Bombina bombina* and the food availability in form of algae and bacteria for the tadpoles. Ponds in which *Bombina* bred successfully were characterised by special Kormaphyte communities and a rich organic sediment. The experiment indicated, that it is possible to restore ponds, which are eutrophicated or over-grown in a way, so that *Bombina bombina* are able to breed successfully in them again. It is also possible to create new breeding ponds, when experience with breeding ponds are taken into consideration. [KEYWORDS: *Bombina bombina*, tadpoles, food availability, predation, pond restoration].

Andersson & Johansson C17

Freeze tolerance in the boreal viper, *Vipera berus*. STEFAN ANDERSSON[1] AND LENNART JOHANSSON[2]. [1]*Dept of Animal Ecology, University of Umeå, 90187 Umeå, Sweden.* [2]*Dept of Cellular and Developmental Biology, University of Umeå, 90187 Umeå, Sweden.* In order to examine if freeze tolerance occurs in the adder, *Vipera berus*, eleven hibernating yearling adders were frozen in a temperature controlled environment. The snakes body temperature was monitored continuously. Freezing of the body fluids was determined by the increase of body temperature caused by the released energy from growing ice crystals. The snakes freezing temperature ranged between -3.8°C and -2.1°C and they stayed frozen between 121 minutes and 198 minutes. All but one of the snakes was still alive and well off four weeks after the experiment. The physiological processes enabling the snakes to survive freezing are discussed. [KEYWORDS: boreal adder, frozen body fluids, survival].

Andreadis C16

Control of food intake and expression of hunger in snakes. PAUL T. ANDREADIS. *Graduate Program in Ethology, c/o Dept of Psychology, Austin Peay Building, University of Tennessee, Knoxville, TN 37996, United States of America.* The mechanistic control and behavioural symptoms of hunger and satiety have been well studied in laboratory rodents, animals that can be characterised as 'nibblers'. Snakes lie at the other end of a feeding pattern spectrum, ingesting relatively large amounts at infrequent intervals. I report results of behavioural studies of the control and expression of hunger in snakes, beginning with meal ingestion and termination. The time course of individual meals of multiple, small prey taken by garter snakes (*Thamnophis melanogaster*) followed a decelerating trajectory, as has been seen in other animals. A recent study (Andreadis and Burghardt, 1993. *Physiol. Behav.* In Press) of a two headed rat snake (*Elaphe obsoleta*) in which both heads cannot be satiated by feeding only one of them suggests that oropharyngeal stimuli have an important role in meal termination. Water snake (*Nerodia sipedon*) neonates will consume a meal of much smaller size than their capacity (20% vs. 45% of body mass) when an excess of small prey is offered. In another study, neonate *N. sipedon* were offered an excess of prey weighing either 40, 20, 10, or 5% of snake mass. At 40, 20 and 10% prey sizes, snakes took meals of 1–3 items. Only at the 5% prey size did snakes eat several (5–7) items. At 20, 10, and 5% prey sizes, these snakes again generally consumed less than capacity. A behavioural satiety sequence is described for water snakes which is topographically similar to that seen in mammals; questions about the interpretation of the behavioural sequence are discussed. I close by addressing the return of appetite after a meal. The rat snake (mass = 1100 g) described above significantly alternated large meals with small ones when fed to satiety once every 5 d. A study of the meal size taken by *T. melanogaster* after various lengths of deprivation suggests that gastric evacuation may directly control the return of appetite. In this study, some behavioural correlates of hunger level were also recorded. While attack latency decreased with length of fast, the spontaneous rate of tongue flicking in the absence of prey cues did not change with deprivation. [KEYWORDS: snakes, Serpentes, *Elaphe*, *Nerodia*, *Thamnophis*, behaviour, hunger, satiety, meal].

Andreadis & Marshall C06–007

Food passage time and digestion in the prehensile tailed skink. PAUL T. ANDREADIS AND SAMUEL D. MARSHALL. *Graduate Program in Ethology, University of Tennessee, Knoxville, TN 37996, United States of America.* Lizard herbivory has been studied primarily in the Iguanidae. As the only truly herbivorous member of the Scincidae, the Prehensile Tailed Skink (*Corucia zebrata*) represents an interesting case of evolutionary convergence in diet. In addition to its phylogenetic distance from iguanids and agamids, *Corucia* is distinct from other saurian herbivores in being active nocturnally. Despite these unique characteristics, the digestive physiology of this species has apparently not been studied. From April–August 1990, we measured digestive parameters in a captive group of four *Corucia*. The subjects were kept between 28–31°C, and fed nightly on an exclusive diet of romaine lettuce (*Lactuca sativa longifolia*) which was eaten voluntarily. Passage times of solids were estimated by hand feeding the subjects a measured quantity of small pieces (1.6 × 14.0 mm, 1.4 mg each) of vinyl flagging tape as a bolus wrapped in a lettuce leaf. The floor of the cage was a metal grate that allowed faeces and shed skin to fall out of the skinks' reach. Scats were collected daily, oven dried, and hand picked for marker recovery. For three adult skinks (mean mass = 708 g), mean first appearance of markers was 5.3 d. Mean estimated time to excrete 50% of recovered markers was 8.9 d. Time course of marker recovery was sigmoidal in some cases. One individually housed subject (659 g) fed every night, ingesting an average of 2.6 g dry mass per day (= 33.3 kJ/d). Its scats averaged 0.8 g dry mass, and mean interval between scats was 2.2 d. Apparent dry matter assimilation was quite high (85%), but similar to other reptilian herbivores feeding on low fibre diets. [KEYWORDS: Sauria, Scincidae, *Corucia zebrata*, herbivory, food passage time, digestive efficiency].

Annable C06–008

Morphology and ultrastructure of eggshells of the carphodactyline geckos *Nephrurus* and *Underwoodisaurus* (Sauria: Gekkonidae). T.J. ANNABLE. *School of Biological Sciences A08, University of Sydney, N.S.W. 2006, Australia.* Eggshells of several carphodactyline geckos including *Nephrurus asper*, *N. levis* and *Underwoodisaurus milli* at several stages of development were examined by transmission electron microscopy, scanning electron microscopy and EDS analysis. External surfaces of shells laid in a sandy substrate show a range of textures and features including: 1) Roughened areas with occasional deep pores of variable depth and diameter. 2) Smoother areas apparently unaffected by contact with substrate. 3) Sand grains firmly attached to the shell surface and embedded in it, indicating that when laid the surface layer is soft and adhesive. 4) Depressed areas with raised edges where sand grains were once attached, indicating a degree of fluidity and surface tension effects in surface layer when first laid. 5) Occasional small superficial cracks, indicating that surface layers become more brittle during embryonic development and that growth or other movement has occurred. Cross sections of the shell showed two major zones: 1) A thin innermost, almost amorphous layer at least partly due to desiccated remains of egg contents. 2) The major part of the shell consists of several poorly demarcated layers of interwoven protein fibres. EDS analysis (at the Kα wavelength of Ca^{++}) shows that calcium is present throughout the thickness of the shell but that the concentration may vary from place to place in some shells, indicating that the laying down of calcium is uneven and/or the embryo utilises calcium unevenly. [KEYWORDS: gecko, eggshell, ultrastructure, calcium distribution].

Aplin & Harding

S17

Ultrastructural observations on spermatozoa of four species of Australian varanids. K.P. APLIN[1] AND H.R. HARDING[2]. [1]*Dept of Terrestrial Vertebrates, Western Australian Museum, Francis Street, Perth, W.A. 6000, Australia.* [2]*Institute of Environmental Studies, University of New South Wales, P.O. Box 1, Kensington, NSW 2033, Australia.* Information on the ultrastructure of spermatozoa is still lacking for many of the major groups of squamates. In this talk we present observations on the spermatozoan of the Varanidae, based on testicular and efferent duct samples from four species of Australasian varanids. The species examined are from two subgenera, as follows: *Varanus* (*V. gouldi sensu* Storr 1980) and *Odatria* (*V. pilbarensis*, *V. acanthurus*, *V. timorensis*). The varanid spermatozoan is compared with those of a variety of other major squamate lineages, based on both published and our own unpublished observations. Special attention is given to features of possible phylogenetic importance.

Arena

S04

Form and function of the alimentary tract in large Australian skinks. PHILLIP ARENA. *School of Veterinary Studies, Murdoch University, South St, Murdoch, W.A. 6150, Australia.* This study examined aspects of the form and function of the alimentary tract of two species of large Australian skink, the King's skink *Egernia kingii* and the bobtail skink *Tiliqua rugosa*. The anatomy of the alimentary tract, as determined by gross dissection, light and electron microscopical techniques was relatively simple. Chronically implanted bipolar electrodes were used to determine the electromyographic patterns associated with the motility of the alimentary tract. Slow waves and action potential activity were recorded from all regions of the alimentary tract. Action potentials were recorded infrequently from the colon which reflected the sporadic movements of this organ. Digesta retention times as determined by radiopaque markers were long despite the simple alimentary tract. Radiological examination revealed the enlarged colon to be the major site of digesta retention. Results of the electromyographic study, together with fluoroscopic examination of visceral movements, further substantiated the slow nature of events associated with digesta passage. Despite both species being omnivorous, primarily herbivorous reptiles, apparent digestive coefficients, determined for both calorific content and nitrogen levels were comparable with those of primarily carnivorous counterparts. These efficiencies were attributed to the long retention times of digesta.

Arena *et al.*

C06–009

Rattlesnake round-ups. PHILLIP ARENA[1], CLIFFORD WARWICK[2] AND DAVID DUVALL[3]. [1]*School of Veterinary Studies, Murdoch University, Murdoch, W.A. 6150, Australia.* [2]*Institute of Herpetology, College Gates, 2 Deansway, Worcester, WR1 2JD, United Kingdom.* [3]*Life Sciences Program, Arizona State University West, 4701 West Thunderbird Road, P.O. Box 37100, Phoenix, AZ 85069–7100, United States of America.* Rattlesnake round-ups, held in several areas in the United States, have been condemned for their cruelty and destructive effect on rattlesnake populations and the environment. Criticism had been aimed at methods of collection, storage, transport and maintenance to miseducation, torture and slaughter. These events no longer serve the original purpose of controlling snake-bite (an unjustified aim) and are used presently to raise money for communities, to provide skins, heads, rattles and whole snakes for the commercial trophy trade, and to satisfy an apparent desire to eradicate a feared venomous creature. Recent investigations and reports have shown that not only are rattlesnake populations in danger of heavy compromise and eradication, but local groups and individuals are allowed and encouraged to perform acts of cruelty and environmental alteration that are probably unprecedented in the United States of America. Both federal and state legislative bodies, the scientific community and round-up organisers are responsible for the continued existence of these events, amongst other reasons, by failing to acknowledge the importance of the species concerned (largely through lack of research and political resistance) by turning a blind eye to the inhumane aspects (largely through ignorance and miseducation) and by fuelling human kind's hatred and fear of the serpent. Various compromises have been called for, however the only sensible and logical option is a total ban of rattlesnake round-ups.

Arnold *et al.*

S22

Sexual selection, encounter rates, and mating systems in snakes. STEVE ARNOLD, DAVID DUVALL AND G.W. SCHUETT. *Dept of Ecology & Evolution, University of Chicago, 940 East 57th Street, Chicago, Illinois 60637–1455, United States of America.* Sexual selection gradients and behavioural encounter rates, derived from formal selection and renewal theories respectively, can be integrated and employed to bring resolution to the study of snake mating systems. Additionally, the breeding sex ratio, or the ratio of actual male to female parents, likewise can be integrated into our system, as an aid in determining and/or predicting relative sexual selection forces acting on males and females. We discuss our models in the context of some of our own work on representative North American snakes. Some of our formulations may be germane to sexual selection and mating systems analyses in other snakes and other animals.

Arntzen

S28

The herpetological materials of Paul Kammerer, Lamarckian biologist in Vienna earlier this century. J.W. ARNTZEN. *Dept of Zoology, University of Leicester, University Road, LE1 7RH Leicester, United Kingdom.* At the turn of the century Lamarckism and Darwinism were competing theories, both aiming to explain transitions of organismal phenotype over time. In Lamarckism, modifications were thought of as induced by the environment while in Darwinism natural selection was considered to be the modelling force in evolution. Dr Paul Kammerer (1880–1926), the productive and successful Austrian researcher, aimed to demonstrate the inheritance of acquired characteristics. For his experiments he mainly used amphibians such as the Midwife Toad, the Olm and the Fire Salamander. I will present an overview of Kammerer's herpetological work, evaluate his materials and results in the light of present day knowledge and attempt to throw new light on the allegations of misconduct and fraud that overshadowed his work and his life. [KEYWORDS: *Alytes*, Lamarckism, fraud, Kammerer P., *Proteus*, *Salamandra*].

Arntzen

C04

Phylogenetic and ecological hierarchy in newt hybrid zones (genus *Triturus*). J.W. ARNTZEN. *Dept of Zoology, University of Leicester, University Road, LE1 7RH Leicester, United Kingdom.* Old World newts of the genus *Triturus* are proper material for studying problems of genetic isolation in a geographical and historical context. The nine species in the genus show a wide range of hybridisation intensities and their phylogenetic relationships and ecology have been studied in detail. Genetic interactions range from the broad intergradation of subspecies, through hybrid zones to cases of oc-

casional hybridisation among species with widely overlapping ranges. The hypothesis that phylogenetic relationships and hybrid zone structure are interrelated (and hence can be predicted from one another) is tested with the four forms of the *T. cristatus* superspecies. [KEYWORDS: ecology, hybridisation, phylogeny, *Triturus*, *Triturus cristatus* superspecies].

Arzabe & de Almeida

C26

Vertebrate predation upon *Leptodactylus troglodytes* (Amphibia: Leptodactylidae) in a burning area in the northeast of Brazil, during a year of drought. CRISTINA ARZABE AND ANTÔNIO CLÁUDIO C. DE ALMEIDA. *Caixa Postal 01 — 58290-000 Mamanguape, Paraiba, Brazil.* The longer limb of the male of *Leptodactylus troglodytes* results from selective pressures exerted by vertebrate predation. Most of the life activities of the species takes place underground and calling activity as well as nest construction of the male are the longest above ground activities in the adult life history. According our researches in two years of drought (1990 and 1993) in the Northeast of Brazil (Paraiba State) the calling activity of *Leptodactylus troglodytes* occurred abnormally until the morning during the unevenly raining nights. In burning area, the males call in the morning (until 7 am – 8 am); as they became very excited, exposed and visible they become prey for hawks predatory activity. Notwithstanding, males used to vocalise close to holes or cavities where they can hide and were protected against any danger. Because of the poverty of vegetation of the burning areas resulted from those years of drought, the males are exposed while vocalising. By observing a burning area in Guaribas Biological reserve (in Mamanguape County, State of Paraiba), in a humid area enclosed in cerrado ("tabuleiro") were found various remains of *Leptodactylus troglodytes* had been prey for *Buteo magnirostris* (roadside hawk) and possibly other kinds of hawks, which left their tracks in diggings searching for amphibians where they were got while flying over the area. Those *Leptodactylus troglodytes* were found dead in that area, were eaten on the ground and also on branches of trees. It is known that the predatory capacity of several sorts of hawks can increase considerably, because of jungle clearings and/or because of burning of fields where prey are easily watched by their predators.

Atayev & Shammakov

C06–010

The herpetofauna of Kopetdag mountains and its zoogeographic characteristics. CH. ATAYEV AND S. SHAMMAKOV. *Institute of Zoology, Turkmen Academy of Sciences, 6 Engels Str., Ashgabat, Turkmenistan.* There are 52 species (3 species of tortoises, 21 species of lizards, 28 species of snakes) known in Kopetdag mountains (including Iran and Turkmenistan). The basis of herpetofauna (43 species or 82.7%) contains Colubridae — 19 species, Lacertidae — 6, Scincidae — 5, Gekkonidae — 4, Agamidae — 3, Boidae — 3, Viperidae — 3. Emydidae, Testudinae, Anguidae, Varanidae, Crotalidae, Elapidae and Typhlopidae are represented by one or two species. 34 species are spread everywhere. 5 species — *Anguis fragilis*, *Eremias arguts*, *Eryx jaculus*, *Malpolon monspressulanus*, *Pseudocerastes persicus* are registered only in southern slopes, 13 species — *Emys orbicularis*, *Mauremys caspica*, *Trapelus saguinolentus*, *Cyrtopodion spinicauda*, *C. longipes*, *Eremias strauchi*, *Lacerta strigata*, *Ablepharus pannonicus*, *Chalcides ocellatus*, *Coluber ladacensis*, *C. atayevi*, *C. nummifer*, *Typhlops vermicularis* are met in northern slopes of the mountain. The zoogeographic face of Kopetdag herpetofauna is defined by Iranian-Afghan (22 species), Sahara-Sind (9), Turanian (7)

fauna complexes (73.0%). The role of Mediterranean (4 species), Indian (3), Eastern Palaearctic (3), European (2) and Caucasian-Asian-Minor fauna groups in forming the herpetofauna of the mountains is not important (14 species or 27.0%).

Avery & Tosini

S29

The parietal eye and lizard thermoregulation: thermographic studies. ROGER AVERY AND GIANLUCA TOSINI. *School of Biological Sciences, Bristol University, Bristol BS8 1UG, United Kingdom.* Infra-red thermography makes it possible to monitor the body temperatures of small lizards non-invasively. The technique has been used to determine upper and lower set point temperatures of unrestrained lizards, and to show how these may be altered by experimental manipulations. Shielding the parietal eye, or removal of wavelengths > 500 nm using filters, results in a transient (3–4 day) decrease in both set points by 1–2°C in the lizard *Podarcis muralis*. Removal of wavelengths < 500 nm has no effect. Heating rates are not affected by any treatment. Lizards with the parietal eye shielded take a longer time to find an overhead source of heat/light. The significance of these results will be discussed. [KEYWORDS: parietal eye, thermoregulation, thermography].

Azevedo-Ramos & Crossland

S16

Antipredator defences in tadpoles from different kinds of habitats. CLAUDIA AZEVEDO-RAMOS[1] AND MICHAEL R. CROSSLAND[2]. [1]*Dept de Zoologia, Museu P.E. Goeldi, C.P. 399, Belem, PA, Brazil.* [2]*Dept of Zoology, James Cook University of North Queensland, Townsville, Qld 4811, Australia.* Communities of tadpoles and their predators generally differ between temporary and permanent waterbodies. Interspecific differences in antipredator defences may influence prey selection and determine tadpole survival in a habitat. We tested six species of tadpoles for the following defences: unpalatability, response to fish chemicals, escape velocity, and tadpole swimming behaviour. Species that live with fish responded to chemical cues or were unpalatable. Species that live with invertebrate predators were motionless or used refugia and showed no response to fish chemicals. *Bufo marinus* tadpoles are a good example of a species adapted to live with fish, but which is very susceptible to invertebrate predation. Their conspicuous behaviour makes them easy prey for such predators. Our results suggest that interspecific behavioural differences in the ability to detect or avoid a predator may explain coexistence with certain predators and ultimately influence tadpole community organisation. [KEYWORDS: Amphibia, antipredator defences, Salientia, tadpoles].

Báez

S02

Mesozoic record of anurans in South America and early diversification of anurans. ANA M. BÁEZ. *Departamento de Geologia, Facultad de Ciencias Exactas, Universidad de Buenos Aires, Pabellón II, Ciudad Universitaria, 1428 Buenos Aires, Argentina.* The earliest known records of anurans in South America are from the Jurassic of the most southern part of the continent. The Liassic *Vieraella herbstii* and the Oxfordian *Notobatrachus degiustoi* currently are considered to be allied with the primitive living anurans *Ascaphus* and *Leiopelma*. However, most of the character states that these taxa share are primitive ones. A reexamination of the material on which these fossil taxa are based has led to new interpretation of their character states and relationships. Several significant differences between *Vieraella* and *Notobatrachus*, i.e. number of presacral vertebrae and ear structure, suggest that they are not closely related. Also, the new evidence casts some doubts about their alliance with *Ascaphus* and *Leiopelma*

and suggests that they might represent an earlier grade of anuran evolution. All other finds are from Early Cretaceous or younger rocks; thus, there is an enormous gap in the record. Apart from the recent discovery of a new anuran of uncertain affinities in the Lower Cretaceous of Brazil, all known Mesozoic occurrences of anuran remains are referable to the Pipidae or to neobatrachian groups already showing considerable endemism. This record is compared with that of other continents in the context of current hypothesis of the relationships of anurans and the paleogeographic scenario. [KEYWORDS: anurans, Mesozoic, South America, diversification].

Bai

C06–011

An observation of the overwintering of *Bufo bufo gargarizans*. BAI YUKUN. *Teaching Research Office of Tancheng, Shandong Province, China.* Hibernation is a characteristic feature of *Bufo bufo gargarizans*. The time of hibernation varies with localities and differs between young and adult *B. b . gargarizans*, in China's Shandong Province (34°25' – 38°23'N, 114°36'– 122°43'E), most adult *B. b. gargarizans* begin their hibernation in mid-October, and most young *B. b. gargarizans* begin to hibernate in mid-November. They wake up from hibernation about the same time, that is, in mid-March the following year, the length of hibernation being about 160 days. Most *B. b. gargarizans* survive the winter in underwater mud; some overwinter under dense weeds or hay, in holes among bricks and stones, or in soft earth beneath bricks and stones. Those staying underwater in winter breathe through the skin. Those overwintering on land breathe through the skin and by the weak functioning of the lungs. The male *B. b. gargarizans* has a black tumour in the back side of the front leg's third toe, and has a vocal sac. The female's case is just the opposite. Embracing occurs almost all the year round, but mainly during the breeding season. Embracing in water during winter is a common occurrence. Most *B. b. gargarizans* begin to embrace in mid-November, a few of them in mid-October. After hibernation, those *B. b. gargarizans*, having spent some of the winter on land, move into the water to embrace, and some of them occasionally embrace during the winter. The biological significance of embracing is to promote the maturing of sex glands as a result of embracing stimulus; and, what's more important, the pressing of the male's front legs stimulates the female to ovulate; therefore ovulation coincides with sperm excretion. The embracing takes place too early; the ovulation consumes too much of the material and energy in the female's body; the water is seriously polluted; skin breathing can provide insufficient oxygen; and there are cold waves in early spring. All these are factors causing death of large numbers of adult *B. b. gargarizans*. [KEYWORDS: Chinese load, overwintering, ecology].

Bai

C06–012

Studies of the amphibians in Shandong Province, China. BAI YUKUN. *Teaching Research Office of Tancheng, Shandong Province, China.* This paper is based on investigations carried out in 1960 and from 1985 to 1992 in Shandong Province (34°25' – 38°23'N, 114°36' – 122°43'E). In the paper are listed 9 species of amphibians: *Bombina orientalis*, *Bufo bufo gargarizans*, *Bufo raddei*, *Hyla arborea immaculata*, *Rana limnocharis*, *R. nigramaculata*, *R. plancyi*, *R. temporaria chensinensis*, and *Koloula borealis* — belonging to 5 families and 6 genera. Among the amphibians, *Hyla arborea immaculata* is newly recorded in Shandong Province, and *Rana limnocharis* is newly discovered in the region of Shandong north of the Huanghe River. This paper discusses

the species, distribution, quantity and ovulation time of the amphibians in Shandong. In terms of flora, topography and distribution of amphibians, Shandong Province is divided into the eastern hilly region, the central southern mountainous - hilly regions, the northwestern plain region and the southwestern plain lake region. The subregions are duly analysed in this paper. [KEYWORDS: Shandong, amphibians, investigation, distribution].

Ballasina & Capecchi

Reproduction and natural incubation success of *Testudo hermanni hermanni* (Reptilia, Testudinata, Testudinidae) in Central Italy and consequences for management and restocking of wild populations. D. BALLASINA[1] AND R. CAPECCHI[2]. [1]*Centro Europeo per la Salvaguardia delle Tartarughe, C.P. 341-58024, Massa Marittima, Italy.* [2]*University of Pisa, Italy.* In the period 1990–1993 a research has been made on reproduction biology and success of *Testudo hermanni hermanni* in central Italy (Tuscany, Province of Grosseto) in the frame-work of the EEC-MEDSPA project called CARAPAX, carried out by RANA International Foundation. Natural areas have been studied in order to find ecological criteria for egg deposition areas, losses through predation etc. Experiments have been made of assisted reproduction within the natural habitat, through the CARAPAX Centre with both extensive and intensive reproduction with an average of over 600 hatchlings a year. The applications of these techniques are discussed for re-introduction strategies as mean habitat restoration and management of populations of a key species.

Banks

C34

A captive action plan for reptiles and amphibians in Australasian zoos. CHRIS B. BANKS. *Herpetofauna Dept, Melbourne Zoo, PO Box 74, Parkville, Victoria 3052, Australia.* The Herp Taxon Advisory Group (Herp TAG) was established in April 1990 to co-ordinate management of reptiles and amphibians in Australasian zoos and maximise the conservation potential of Australasian zoos for the benefit of rare, threatened or poorly- known reptiles and amphibians. The TAG has since been divided into a Reptile TAG and Amphibian TAG, and both have representation from 25 public or private Australasian zoos. A captive Action Plan has been developed, which provides background to regional management and TAGs; current and proposed actions relating to 19 priority taxa, and the rationale for their listings; identifies other taxa for future management; and defines current research and other regional links. The Plan emphasises a forward planning approach and is a management tool to assist implementation of regional or global action plans. [KEYWORDS: captive plan, reptiles, amphibians, zoos, management, TAG].

Banks & Birkett

C06–013

"World of frogs": a display and research facility at Melbourne Zoo. CHRIS B. BANKS AND JON R. BIRKETT. *Herpetofauna Dept, Melbourne Zoo, PO Box 74, Parkville, Victoria 3052, Australia.* "World of Frogs", a new display and research facility was opened at Melbourne Zoo on 18th August 1993. The 45 m^2 extension to the existing Reptile House includes seven exhibits and two holding/research rooms, and is sponsored by Cadbury Schweppes Pty Ltd. A viewing window allows visitors a glimpse behind-the-scenes and provides for exhibition of spawn, tadpoles and static material. Another important component is the external wetland habitat, comprising two ponds, marsh and boardwalk. As well as the facility's exhibit capacity, heavy

emphasis is placed on visitor education of frogs and their plight, and the building's value as a resource for external researchers. The collection's short-term focus is on native Australian frogs and is enhanced by a WWF-funded full-time research position. [KEYWORDS: Melbourne Zoo, frogs, display, research].

Banks & Lau

C33

Captive management and reproduction as an aid to conservation of Romer's tree frog (*Philautus romeri*). CHRIS B. BANKS[1] AND MICHAEL W. LAU[2]. [1]*Herpetofauna Dept, Melbourne Zoo, PO Box 74, Parkville, Victoria 3052, Australia.* [2]*Zoology Dept, The University of Hong Kong University, Pokfulam Road, Hong Kong.* Romer's Tree Frog (*Philautus romeri*, Rhacophoridae) is restricted to three small islands in Hong Kong. A fourth island, Chek Lap Kok, was recently lost as frog habitat due to development of Hong Kong's new international airport. Captive populations were established at the University of Hong Kong in 1991 and at Melbourne Zoo in 1992. The frog acclimates well to captivity and reproduction has occurred to F2 at both institutions. Calling commenced in October-November and 20–70 eggs were laid in small clumps, attached to submerged vegetation. Eggs hatched after 2–3 days and tadpoles metamorphosed after 40–60 days at 22–26°C. Captive-bred frogs reproduced at 12–14 mm body length and 4–6 months of age. Frogs from the Melbourne population will be used to stock new field sites identified in Hong Kong. [KEYWORDS: *Philautus romeri*, Chek Lap Kok, Hong Kong, Melbourne Zoo].

Barday-Hassan & Channing

C03

Ghost frog phylogeny. HANIFA BARDAY-HASSAN AND ALAN CHANNING. *Dept of Biochemistry, University of the Western Cape, Private Bag X17 Bellville 7535, South Africa.* The five species within the genus *Heleophryne* are endemic to South Africa. They are alone in the family Heleophrynidae, with nearest relatives possibly in Australia or South America. We generated a phylogenetic tree of the species relationships within this genus, using data from an allozyme study. Of 25 loci scored, 10 were phylogenetically informative. We used enzymes as characters and addition of alleles to identify changes in states. The data were analysed using PAUP. There is only one tree, which is fully resolved with a consistency index of 1.000. The relationships are: ((((*H. purcelli* + *H. regis)* + *H. hewitti*) + *H. rosei*) + *H. natalensis*). *H. natalensis* was selected as the root due to plesiomorphic morphological characters of the tadpole.

Barreto & Moreira

C06– 014

Annual breeding and activity patterns of anurans in a seasonal neotropical savanna. LARISSA BARRETO[1] AND GLÓRIA MOREIRA[2]. [1]*Dept de Biologia, UFMA, Largo dos Amores 21, CEP65020, São Luis, MA, Brazil.* [2]*Dept de Ecologia, INPA, CP478, CEP69083, Manaus, AM, Brazil.* The seasonal calling patterns of several species of anurans were followed in a permanent grassland pond and in a gallery forest creek located close to the city of Brasilia (15°S 47°W). The number of calling males were estimated on several nights (between 17:00 and 24:00 h) from January 1992 to March 1993. *Hyla pseudopseudis*, *H. gr. rubra* and *Elachistocleis bicolor* were heard calling continuously throughout the year. *Bufo paracnemis* had only a short reproductive period of about two months (August and September), while eight species were active during periods of four to eight months. The noctural calling activity for three species of hylids was significantly higher during the months of October to December. Three hundred pitfall traps were installed in three different terrestrial habitats (grassland,

savanna *sensu stricto* and gallery forest) that represent the range of habitats generally found in Central Brazil, from January to December 1992. The number of bufonids and leptodactylids captured decreased drastically during the coldest and driest months (May, June and July) in all three habitats. [KEYWORDS: anuran, reproduction biology, activity patterns, savanna, Central Brazil].

Barton *et al.*

S16

The macroparasite fauna of the toad, *Bufo marinus*. DIANE P. BARTON[1], CARMEN-LOUISA LOUREIRO[2] AND RICK SPEARE[3]. [1]*Zoology Dept, James Cook University, Townsville, Queensland, Australia.* [2]*Dept of Microbiologia, Instituto Venezolano de Investigaciones Cientificas, Caracas, Venezuela.* [3]*Anton Breinl Centre for Tropical Health and Medicine, James Cook University, Townsville, Australia.* As part of one of the most detailed studies on the biology of an amphibian species ever undertaken, we have detailed the macroparasitic fauna of the toad *Bufo marinus* in a native and an introduced population (Venezuela and Australia, respectively). This comparison has found vast differences between the two populations. The macroparasites considered in this study were internal helminths, which inhabit organs such as the intestinal tract, liver, lungs, the circulatory system, and the peritoneal cavity, and ectoparasitic arthropods, such as ticks. Venezuelan toads are heavily infected with a few species of internal helminths while Australian toads have much lower infection levels but with a greater range of species. While ticks commonly infect toads in Venezuela, no tick has been found to infect toads in Australia. The importance of these parasites to the general biology of the toad will be discussed, especially in their relation to the potential control of this species within Australia.

Bauer

S08

Patterns of endemicity and diversity in New Caledonia and the Isle of Pines. AARON M. BAUER. *Dept of Biology, Villanova University, Villanova, PA 19085, United States of America.* Distributional patterns of the gekkonid fauna of the southwest Pacific strongly support ancient connections of New Caledonia with both Australia and New Zealand, with secondary contact with Australia implied by the distribution of the genera *Rhacodactylus* and *Nannoscincus*. Intra-island diversification in New Caledonia is more extensive than previously thought and cryptic species of both *Calendoniscincus* and *Bavayia* remain to be described. Lizard diversity is lowest at high elevations and in the maquis vegetation, although a few habitat-specific endemics occur. Although some aspects of lizard distribution within New Caledonia are attributable to precipitation differences and the influence of ultramafic soils, patterns of species diversity within the mesic central and northeastern regions of the island remain obscure. Both extensive anagenesis and cladogenesis have occurred *in situ* in New Caledonia. At least 13 lizard species occur on the Isle of Pines, which has a central lateritic plateau surrounded by a raised coralline platform. Many of the southern mainland taxa are present, but others, e.g. *Rhacodactylus auriculatus* and *Tropidoscincus rohssii*, are apparently absent. In addition, the small lygosomine skink *Marmorosphax euryotis*, which otherwise is known only from northeastern New Caledonia, is found in great abundance in the interstices of the raised coral pavement of the Isle of Pines. [KEYWORDS: New Caledonia, biogeography, Scincidae, Gekkonidae].

Bauer & Günther

S28

The herpetological contributions of Wilhelm Peters (1815–1883) and the

role of the Zoologisches Museum (Berlin) in the herpetological community of his era. AARON M. BAUER[1] AND RAINER GÜNTHER[2]. [1]*Biology Dept, Villanova University, Villanova, Pennsylvania 19085, United States of America.* [2]*Zoologisches Museum, Museum für Naturkunde der Humboldt Universität zu Berlin, Invalidenstraße 43, D(0)-1040, Berlin, Germany.* Wilhelm Peters (1815–1883) was one of the most prolific herpetologists of the 19th Century. Between 1839 and his death he published 170 papers on herpetological subjects in which he described more than 650 species and subspecies of amphibians and reptiles in 50 different families and erected 118 new genera. Peters described material from over 60 countries and spent five years in Africa himself. His *Reise nach Mossambique, Amphibien* (1882) reflects a field-based knowledge that is lacking in the works of many of his contemporaries who knew the animals only as preserved specimens. Although more than 400 of Peters' taxa are currently recognised as valid at the specific or subspecific level, his contributions have remained largely unappreciated. Throughout the period of Peters' curatorship and directorship of the Museum, Berlin played a central role in the museum-based European herpetological community. However, the Berlin Museum became distanced from the centre stage of world herpetology as result of World Wars and later by the isolation of the DDR from the West. Contrary to many reports, relatively little of the Berlin collection was lost or destroyed during World War II and the majority of Peters' types are still intact. [KEYWORDS: Wilhelm Peters, Zoological Museum Berlin, biography].

Bauer & Russell

S04

Functional, ontogenetic and phylogenetic constraints in the digital morphology of gekkonid lizards. AARON M. BAUER[1] AND ANTHONY P. RUSSELL[2]. [1]*Dept of Biology, Villanova University, Villanova, PA 19085, United States of America.* [2]*Dept Biological Sciences, University of Calgary, 2500 University Dr., NW Calgary, AB, T2N 1N4, Canada.* The highly specialised scansorial apparatus of gekkonid lizards appears to have evolved independently in several phylogenetic lineages. Each of these has been faced with the constraints imposed on this mechanism that have been inherited from non-scansorial ancestors. Primitively, lizards possess only two phalanges in the pollex and hallux, yet in general the scansorial system of gekkonids is based upon the mechanical interactions of at least three phalangeal elements. A survey of digital patterns among pad-bearing geckos reveals that the morphology of the first digit of both manus and pes is highly variable. Functional demands operating within the framework of phylogenetic constraint have resulted in either the elaboration of the first digit and its incorporation into the symmetrical scansorial system, or reduction and consequent loss of locomotor function of the digit. In both cases there is a net effect upon the design and function of the remainder of the scansorial system of the manus and pes, including changes in the spreading of the digits, the form of the adhesive pads and the total adhesive surface area. The final form and function of the first digit in certain lineages has further been influenced by the ontogenetic constraints imposed by paedomorphosis and miniaturisation. [KEYWORDS: Gekkonidae, locomotion, constraint, digit, scansor].

Bauer & Russell

S21

Regional integumentary loss as an antipredator strategy in lizards. AARON M. BAUER[1] AND ANTHONY P. RUSSELL[2]. [1]*Dept of Biology, Villanova University, Villanova, PA 19085, United States of America.* [2]*Dept Biological Sciences, University of Calgary, 2500 University Dr., NW, Calgary, AB, Canada T2N 1N4, Canada.*

Self-mutilatory defenses are primitive for squamates, and perhaps for lepidosaurs as a whole. The evolution of such defenses is predicated upon both morphological and behavioural modifications. Caudal autotomy is the most widespread mutilatory strategy, but regional integumentary loss has arisen as a complement to autotomy within the Gekkonidae. Skin loss is dependent upon the existence of weak zones within the collagen matrix of the dermis and upon the mechanical decoupling of inner and outer layers of the dermis. Wounds are initiated by the application of shear forces, usually resulting from both predator grasping or pinning and from body twisting or spinning on the part of the gecko. A minimum of eight independent origins of skin loss have occurred among gekkonine geckos, but the trait is widespread only within some of the clades in which it has evolved. The efficacy of weak skin as a defense is attested to by the prevalence of healed wounds in wild caught animals and by experimental evidence from controlled gecko-predator encounters. Physiological stresses caused by skin loss are minimised by changes in activity patterns that minimise exposure to evaporative environments until after the formation of an effective barrier by the healing skin. [KEYWORDS: integumentary loss, autotomy, skin, Gekkonidae].

Bauer

C06–015

On nomenclature and the contents of taxa named or: official family names should not go with a verb in third person singular. LUCAS BAUER. *Elandstraat 58, NL 2513 GT — Den Haag, The Netherlands.* Family group names and names of higher ranked taxa, according to the Code are words in plural form. Moreover: *-ids* as an adapted Anglosaxon form expresses and words exactly the same as *-idae*. Not only the Code of Zoological Nomenclature but also the botanical code assign plural names to groupings with plural contents — the plural form being expressly mentioned. Recent publications, among them some trendsetting ones in our field of interest herpetology, all use the English third person singular with family names. This is in error. A construction like 'the family of ...' makes it understandable to use a singular as the word family in that case is grammatical subject . With the family name on its own a verb form better fitted is asked for. [KEYWORDS: editing, nomenclature].

Bauer

C06–016

Why Myobatrachidae is not a good family name for the majority of Australian froads. LUCAS BAUER. *Elandstraat 58, NL 2513 GT - Den Haag, .The Netherlands.* The Myobatrachidae, as opposed to neotropical Leptodactylidae cannot form an evolutionary correct assemblage when including *Myobatrachus*, *Neobatrachus*, *Pseudophryne*, *Limnodynastes* etc. If weakly enough defined the family name Myobatrachidae is used for such diverse members, it follows that Australian herpetologists are right in their opinion that only geographical distribution separates the group from almost as weakly defined Leptodactylidae including *Leptodactylus*, *Ceratophrys*, *Hylorina*, *Telmatobius* and other genera. Radiation from at least one antartandic parent group seems likely, with more primitive relicts in Australia. As arrangement in one family should reflect clear relationship of the members included I propose to restrict the family Myobatrachidae, including only *Myobatrachus* and *Arenophryne*. [KEYWORDS: zoogeography, systematics, evolution, Anura].

Bauwens et al.

S29

Concordant evolution of thermal physiology, thermal preferences, and morphology in relation to locomotor performance in lacertid lizards. DIRK

BAUWENS[1], AURORA M. CASTILLA[2], THEODORE GARLAND JR.[3] AND RAOUL VAN DAMME[2]. [1]*Inst. Nature Conservation, Kiewitdreef 5, B-3500 Hasselt, Belgium.* [2]*Dept Biology, Univ. Antwerp (U.I.A.), B-2610 Wilrijk, Belgium.* [3]*Dept Zoology, Univ. Wisconsin, Madison WI 53706, United States of America.* Body temperature has a profound effect on the rate of physiological functions, and therefore also on performance abilities such as sprint speed. The sprinting performance of lizards will be the result of the interplay between: i) maximal sprint speed ability, and ii) the relative performance level. The latter depends on the interaction between thermal physiology (position and shape of the thermal sensitivity curve) and body temperatures maintained during activity (central tendency and variability). Lizards that maintain their body temperature within a narrow range around the optimal temperature for sprinting, or whose running performances are largely independent of their body temperature, will usually be able to sprint near maximal capacities. In each of 13 species of Lacertid lizards, we studied: 1) the thermal dependence of sprint speed, 2) the selected body temperatures maintained in a laboratory photothermal gradient, and 3) morphometric characteristics (body, tail, and hind-leg length, mass). We examined, within an explicit phylogenetic context, the interrelations among these traits and burst sprinting capacities. Results show that quantitative interspecific differences in maximal sprint speed are positively correlated with relative performance levels at the preferred body temperatures. Thus, species with higher maximal sprinting capacities exhibit a higher degree of thermal independence and maintain their body temperature within a narrow range, close to the optimum for sprinting. This concordance implies that factors which select for higher sprint speeds also mediate the evolution of thermal physiology and thermoregulatory behaviour (thermal preferences). [KEYWORDS: thermal physiology, thermoregulation, coadaptation, sprint- speed].

Baverstock *et al.*

S01

Evolutionary divergence in the 12S ribosomal RNA gene in four Gondwanic groups — a test of the molecular clock hypothesis. PETER BAVERSTOCK[1], ALLAN JOHNSON[2], ARTHUR GEORGES[3] AND STEPHEN DONNELLAN[4]. [1]*Southern Cross University, P.O. Box 157, Lismore, NSW 2480, Australia.* [2]*University of Technology, Sydney, Gore Hill, NSW 2065, Australia.* [3]*University of Canberra, Canberra, ACT 2602, Australia.* [4]*South Australian Museum, North Terrace, Adelaide, SA 5000, Australia.* The molecular clock hypothesis predicts that the rates of divergence between Australian and South American members of Gondwanic groups should be similar. We have tested this prediction using data on marsupials and chelid tortoises, and are currently obtaining comparable data on hylid frogs. The results to date are in accord with the hypothesis. [KEYWORDS: turtles, marsupials, ribosomal DNA, clock].

Bayliss *et al.*

S16

Mortality of post- metamorphic toads: a case for introducing predators to control *Bufo marinus* in Australia. PETER BAYLISS[1], ROSS ALFORD[2] AND MARGARITA LAMPO[3]. [1]*Dept of Zoology, University of Queensland, St Lucia, Qld 4067, Australia.* [2]*Dept of Zoology, James Cook University, Townsville, Qld 4811, Australia.* [3]*Centro de Ecologia, Instituto Venezolano de Investigaciones Cientificas, Apartado 21827, San Martin, Caracas 1020-A, Venezuela.* Post-metamorphic mortality and dispersal have been estimated simultaneously for *Bufo marinus* in S. America by means of intensive mark/recapture studies. Mortality rates of juveniles are extremely

high (99%), while mortality rate for adults are 96% for males and 81% for females. In addition to mark/recapture, mortality rates were independently estimated from radiotelemetry and spool-tracking. The overall results on an annual basis were similar: radios — 97% for males and 84% for females; spools — 99.8% for males, 70% for females and 99.9% for juveniles. The major cause of death for females appears to be predation and a type of wasting disease (i.e. healthy toads gradually lose weight, cannot maintain water and thermal balance, cannot feed and eventually die). The major cause of death for males and juveniles in S. America also appears to be predation, followed by seasonal food shortages. In contrast, post-metamorphic mortality of *B. marinus* in Australia appears to be much lower than in S. America, with most local losses to populations explained by emigration. Radio and spool tracking data from Australia suggests that predation on terrestrial adult toads is relatively low and episodic, and that this may explain why the densities of toad populations in S. America are generally lower than those in Australia. [KEYWORDS: *Bufo marinus*, mortality, predation].

Bedford *et al.*

C06–017

Reproduction, growth and juvenile behaviour of frilled lizards (*Chlamydosaurus kingii*). GAVIN BEDFORD, TONY GRIFFITHS AND KEITH CHRISTIAN. *Faculty of Science, Northern Territory University, PO Box 40146, Casuarina, NT 0811, Australia.* Gravid female frilled lizards that were induced to lay eggs in the laboratory had a mean clutch size of 15.3 (n = 9, range: 11–22). Radio telemetry was used to recapture some of these females in February (3.5 months after the first clutch). X-rays showed that 2 of 3 females had a second clutch for the season, but clutch sizes were much smaller (mean = 6). Recaptured juveniles had a growth rate of 8.7 mm/month during the wet season and 3.1 mm/month during the dry season. Morphological features were examined from > 400 lizards, and a broken stick regression showed that the frill of juveniles < 90 mm SVL grew relatively slowly compared to larger lizards. This change in proportional frill size occurred before 1 year of age. Both sexes reach sexual maturity at just under 2 years of age. Above a SVL of 250 mm the head width of males increased disproportionately (relative to females and smaller males). This corresponds to an age of just under 3 years, and we suggest that males are probably not successful in gaining mates until the time when heads become enlarged. Hatchlings displayed to one another using arm movements and frill extensions. The dominance of hatchlings in obtaining thermally optimal perch sites was examined with respect to body size and sex. [KEYWORDS: frilled lizards, clutch size, clutch frequency, growth rates, frill growth, head growth, hatchling behaviour].

Behra & Lippal

S27

Reptile and amphibian utilisation in Madagascar: threat, benefit or both? OLIVIER BEHRA AND CHRISTINE LIPPAL. *BIODEV, Antananarivo, Madagascar.* Malagasy reptiles and amphibians, exhibiting high endemicity, have been the subject of interest among scientists and hobbyists for many years. However their exploitation for export has literally exploded since 1988 and, because it is often the case that certain species occurring in trade are either poorly documented or newly discovered and considered "rare", the international conservation community has now focussed its interest and concern on this utilisation. Rural poverty and habitat destruction in Madagascar are the major factors that contribute to problems of wildlife conservation in the country. If a strategy of sustainable natural resource utilisation could be developed which involved

rural communities as the principal beneficiaries, forest destruction could be balanced and have a positive impact on sustainable development. The sustainable utilisation of reptiles and amphibians in Madagascar in a manner which involves rural communities provides an opportunity to address the problem of wildlife conservation by promoting the awareness among rural communities of the value of native forests.

Belan & Firth

C06–018

A possible influence of host hormones on reptile tick behaviour. INGRID BELAN[1] AND BRUCE T. FIRTH[2]. [1]*Dept of Zoology, The University of Adelaide, SA 5005, Australia.* [2]*Dept of Anatomy & Histology, The University of Adelaide, SA 5005, Australia.* Many ixodid or hard ticks exhibit a three host life cycle, whereby each stage attaches, feeds, and detaches from a different host individual. The detachment phase of a tick's life cycle is very important as the site into which a tick detaches directly influences its survival and the host species which it will encounter and possibly infest in the subsequent stage. Previous studies have indicated that there is a correlation between the time of day at which detachment occurs and the activity of the host species. Detachment occurs when the host is most likely to be in a refuge site. Recent studies suggest that an endogenous host signal, which correlates with host activity, plays an important role in determining the drop-off period. A likely endogenous host signal is the indoleamine melatonin, which is ubiquitous to vertebrates, and exhibits a circadian rhythm. In this study, we examined the detachment behaviour of larval *Aponomma hydrosauri* from their dominant host species, the sleepy lizard, *Tiliqua rugosa*. Tick detachment from 8–10 lizards was monitored every 2 hours for one week using an automated fraction collector. There was a correlation between tick detachment behaviour and the melatonin cycle of the host. Further experiments examined tick drop-off in relation to phase shifting of the melatonin cycle of the host and pinealectomy, which abolishes the host's melatonin rhythm. [KEYWORDS: circadian rhythms, melatonin, tick, lizard, detachment behaviour].

Bell

S23

The systematics, ecology and distribution of New Zealand *Leiopelma* species (Anura: Leiopelmatidae) with a reappraisal of their conservation needs. BEN D. BELL. *School of Biological Sciences, Victoria University of Wellington, PO Box 600, Wellington, New Zealand.* Much new information on the biology of the endemic New Zealand genus *Leiopelma* (Anura: Leiopelmatidae) has been reported over the past 10–15 years. Three extinct subfossil species of *Leiopelma* are now recognised (*Leiopelma auroraensis*, *L. markhami*, *L. waitomoensis*) in addition to the three extant species already known from New Zealand (*L. archeyi*, *L. hamiltoni*, *L. hochstetteri*). The taxonomy of frogs from Maud Island (morphologically resembling *L. hamiltoni*) and from near Te Kuiti (morphologically resembling *L. archeyi*) is under investigation and may reveal further species. Osteological, biochemical and genetic evidence suggests *Leiopelma* should be retained in its own family Leiopelmatidae (rather than being placed with *Ascaphus*). Such studies confirm the broad dichotomy in *Leiopelma* between semi-terrestrial species (eg. *L. hochstetteri*) and terrestrial species (eg.. *L. archeyi*) and generic distinction between the two groups should be considered. *Leiopelma* locally reaches high densities (> 4 frogs/m^2) in suitable habitats and may be relatively long-lived (some Maud Island frogs surviving 20+ years). Experimental translocations of frogs have been attempted on Maud Island (1984 85) and on Stephens Island

(1992), with young being successfully recruited into the new colony on Maud Island. Male parental care occurs in all four populations of terrestrial *Leiopelma L. archeyi*, *L. hamiltoni*, Maud Island frog, Te Kuiti frog), though such parental care is absent in *L. hochstetteri*. New locality records of extant species have extended their known distribution, though research on subfossil bones reveals that both *L. hochstetteri* and *L. archeyi/hamiltoni* were formerly more widespread in New Zealand. No surviving populations of *Leiopelma* are known from mainland areas of the South Island, despite four species being formerly present there, while *L. hochstetteri* and *L. archeyi* have declined in the North Island. Introduced mammalian predators and/or competitors probably had a major and detrimental impact on the survival of *Leiopelma* species in New Zealand, with habitat destruction also being a problem in many areas. The conservation status of surviving taxa needs to be reappraised given recent research on their systematics and distribution. No species is immediately at risk of extinction, but *L. hamiltoni* is now very restricted in range and numbers. *L. archeyi* is local in distribution and *L. hochstetteri* remains relatively widespread in suitable habitats in the northern North Island. [KEYWORDS: *Leiopelma*, New Zealand, conservation, systematics, demography, reproduction].

Bell & Bell

S14

Distribution of the introduced alpine newt *Triturus alpestris* in Shropshire, England, and its impact on the native *T. cristatus* and *T. vulgaris*. A. PAUL BELL[1] AND BEN D. BELL[2]. [1]*Moss Cottage, Brownhills, Market-Drayton, Shropshire, TF9 4BG, United Kingdom.* [2]*School of Biological Sciences, Victoria University of Wellington, P.O. Box 600, Wellington, New Zealand.* Surveys of ponds near Market-Drayton, Shropshire, were carried out in September 1989 and April-September 1993 to determine the local distribution of the Alpine Newt *Triturus alpestris* and to assess its impact on the native Great-crested Newt *Triturus cristatus* and Smooth Newt *T. vulgaris*. *T. alpestris* still survives at the garden pond site at which it was first liberated in 1970, where it co-exists with smaller numbers of *T. vulgaris* and *T. cristatus*. *T. alpestris* were located in other garden ponds up to 70 m away, but none were found in garden ponds at 100–250 m, though *T. vulgaris* was often present. Surveys of farm ponds at 0.5–1.5 km revealed many *T. cristatus* and *T. vulgaris* but no *T. alpestris* or Palmate Newts *T. helvetica*. Surveys at a 1974 liberation site revealed a similar pattern. *T. alpestris* survived in the original garden pond and had moved to a farm pond 50 m away. Both ponds also contained *T. cristatus* and *T. vulgaris*. No *T. alpestris* were found in farm ponds 100–950 m away, though *T. cristatus* and *T. vulgaris* were common. No *T. helvetica* were found. Density indices and size-ranges of adults and larvae of the *Triturus* species are compared for ponds with and without *T. alpestris*. [KEYWORDS: newts, *Triturus*, Britain, conservation, introductions].

Bell & Bell

C27

Local distribution of the rare endemic frog *Leiopelma hamiltoni* on Maud Island, New Zealand. ELIZABETH A. BELL AND BEN D. BELL. *School of Biological Sciences, Victoria University of Wellington, PO Box 600, Wellington, New Zealand.* Systematic surveys in the remnant 16 hectare forest habitat of Hamilton's frog *Leiopelma hamiltoni* on Maud Island, New Zealand, have clarified its local distribution pattern. The frog's distribution in relation to altitude, vegetation and substrate is described and spatial variation in density, size and colour pattern is examined. A

revised estimate of the total population size is made, based on this survey and on longer-term mark-recapture data. The conservation implications of these results are addressed. [KEYWORDS: *Leiopelma*, Maud Island, conservation, distribution].

Bels S04

Evolutionary approach of function of the hyo-lingual system in lizards. VINCENT L. BELS. *Agronomic Centre of Applied Researches of Hainaut, rue Paul Pastur 11, B- 7800 ATH, Belgium.* The hyo-lingual apparatus is one of the main morphological features involved in several behavioural activities (e.g. feeding, chemoreception, drinking, and display). From actual data, morphological and functional properties of this system are well known only for a small number of iguanian and scleroglossan lizards. The first aim of this paper is to compare these data in both sister-groups. This review serves to examine the possible phylogenetical and adaptive characteristics of this system in various lizards. These characteristics are related to the etho-ecological context in which each behaviour is performed. A model of hyoid transformations through lizards in relationship with its complex function is proposed. Transformations of this model related to evolutionary modifications of behavioural activities are emphasized for two iguanians (Agamidae and Iguanidae) and several scleroglossans (i.e. Varanidae). From these data, the second aim is to propose evolutionary functional hypotheses (but not exclusive) on this system in lizards. Comparison with outgroups (chelonians, Serpentes) are used for testing some of the proposed evolutionary trends. [KEYWORDS: hyoid apparatus, tongue, behaviour, lizards].

Bels S20

Foraging and feeding in lizards: does the behaviour constrain the morphology or is it the other way around? VINCENT L. BELS. *Agronomic Centre of Applied Researches of Hainaut, rue Paul Pastur 11, B- 7800 ATH, Belgium.* Foraging and feeding behaviours of lizards involve various types of activities (locomotion, tongue flicking, tongue projection, jaw opening, etc). In feeding, the head, jaws and hyo- lingual apparatus are the main morphological features used in successive phases: capture or ingestion, intra-oral manipulation, transport to the pharynx and deglutition. Based on modes of prey prehension, the division of lizards in two sister-groups (Iguania with lingual prehension and Scleroglossa with jaw prehension) seems to be supported while some examples of scleroglossans using lingual prehension are described. In both sister-groups, the tongue is one of the major mode for gathering chemicals during foraging. Same morphological structures (e.g. head, jaws and/or the hyo-lingual system) act in both activities. Both functions in relationship with species-specific strategies in using the environment impose various constraints on these structures. For instance, tongue morphology in scleroglossans is mainly constrained related to collecting of chemicals (foraging). In contrast, constraints in Iguania are mainly related to food capture (feeding). Both groups use the structures in other phases of feeding (reduction, transport) and in drinking in various ways. Each morphological characteristics related to one function may have reversally an effect on the behavioural characteristics of the other activities. Several examples are presented to illustrate how different species use different shaped structures in feeding and foraging activities. Finally, the major transformations involved in lizard evolution and specific adapations are presented to discuss the possible evolutionary trends in foraging and feeding designs (morphology and behaviour) in lizards. [KEYWORDS: lizards, feeding, foraging, jaws, hyo-lingual apparatus, evolution].

Bels *et al.* C06– 019

Functional evolution of drinking behaviour in lizards. VINCENT L. BELS[1], VÉRONIQUE DELHEUSY[2] AND FRANCE WAGEMANS[2]. [1]*Agronomic Centre of Applied Researches of Hainaut, rue Paul Pastur 11, B- 7800 ATH, Belgium.* [2]*Laboratory of Functional Morphology, quai Van Beneden 22, B- 4020 Liege, Belgium.* Drinking behaviour in lizards involves three successive phases: immersion, emersion and deglutition. During immersion, the tongue is used for liquid gathering. The liquid moves through the buccal cavity in relationship with tongue movements during the emersion phase. The liquid fills the pharynx and enters the esophagus during deglutition. Drinking behaviour in three species of lizards was investigated by high-speed cinematography. Kinematic variables of tongue, jaw and throat movements were quantitatively compared for two volumes of water (drop vs. large volume). *Phelsuma madagascariensis* (Scleroglossa) and *Anolis carolinensis* (Iguania) always use the tongue for collecting liquids. *Oplurus cuvieri* (Iguania) uses the tongue for drops of water but gradually uses buccal pumping movements for large volume of water. The morphology of jaw and hyo-lingual systems in both sister-groups are used to show differences in spatial relationships between the historical (morphological) features of the lizards and the external factors (volumes of water). A principal component analysis (PCA) based on the kinematic variables was used to compare the effects of these features on drinking behaviour. Finally, these data are used to propose a possible (not exclusive) evolutionary mechanism of drinking in lizards. [KEYWORDS: drinking, tongue, Iguania, Scleroglossa.].

Bels *et al.* C22

Throat display in varanids: eco-ethological and functional studies. VINCENT L. BELS[1], JEAN-PIERRE GASC[2], SABINE RENOUS[2] AND ROLAND VERNET[3]. [1]*Agronomic Centre of Applied Researches of Hainaut, rue Paul 2 Pastur 11, B- 7800 ATH, Belgium.* [2]*Laboratoire d'Anatomie Comparée, Museum National d'Histoire Naturelle, rue Buffon 55, F-75005 Paris, France.* [3]*Ecole Normale Supérieure, rue d'Ulm 46, F-75230 Paris, France.* In social activities (e.g. challenge and threat displays), varanid lizards commonly use vertical throat extensions. These movements are either produced alone or associated with displacements of other body elements (i.e. thorax, head, and jaws). The aim of this paper is twofold. First, throat movements of varanids actually described in the literature are reviewed in relationship with the displaying context. These data serve to compare throat displays through varanids and related scleroglossan lizards and emphasise particularities of varanids. Second, the mechanism of the throat display in the desert goanna, *Varanus griseus*, during threat context is reported. Threat throat movements are divided into two display classes: the bucco-pharyngeal breathing pumping and the ventilatory bucco-pharyngeal breathing pumping. Both displays are kinematically compared, and the variability of behavioural properties of both displays is presented. In varanids, the morphology of the hyoid apparatus is unique for reptiles and present transformations compared to the typical iguanian and/or scleroglossan hyoids. Kinematics of hyoid movements during throat displays is analyzed and used for proposing evolutionary hypothesis on throat morphology and behaviour in varanids. This hypothesis is integrated into the general eco-ethological features of all varanid species. [KEYWORDS: display, throat, eco-ethology, Varanidae].

Bennett & Walton S29

Patterns of thermoregulation in Kenyan chameleons. ALBERT F. BENNETT[1]

AND B. MICHAEL WALTON[2]. [1]*Dept of Ecology and Evolutionary Biology, University of California, Irvine, California 92717, United States of America.* [2]*Dept of Biology, Cleveland State University, Cleveland, Ohio 44115, United States of America.* In Kenya, different species of chameleons are geographically stratified altitudinally, ranging from sea level to very high montane slopes. We examined thermoregulatory patterns of six species (*Chamaeleo bitaeniatus*, *C. dilepis*, *C. ellioti*, *C. hoehnelii*, *C. jacksonii*, *C. schubotzi*) which span this entire altitudinal range. We measured behaviourally regulated field body temperatures in natural habitats in animals with implanted thermocouples. We also measured preferred body temperatures and voluntary and critical thermal limits in the laboratory. In the field, body temperature is regulated with considerable precision by basking and shade-seeking behaviours and postural changes, as well as by colour change. Daily average field body temperatures ranged from 19.7°C in *C. schubotzi*, which lives on Mount Kenya, to 32.0°C in *C. dilepis*, which occurs in the arid lowlands. Preferred body temperatures, however, are remarkably similar in all six species, ranging from 30.2 to 33.0°C, and are not correlated with altitudinal distribution, mean annual environmental temperatures, nor field body temperatures. Performance at low body temperatures (e.g. critical thermal minimum, locomotor ability at 10°C) is correlated with these latter factors. Apparently thermal preferendum is a conservative factor and has not differentiated among these species, regardless of current habitat and thermal circumstance: high altitude chameleons attempt to regulate body temperatures equal to those of lowland species. Locomotor performance and competence however are correlated with the lower environmental temperatures experienced by upland species. [KEYWORDS: Africa, body temperature, lizard].

Bennett *et al.*

S11

Metabolic rates and growth rates: inter-individual differences in a natural population of garter snakes (*Thamnophis sirtalis*). ALBERT F. BENNETT[1], B. MICHAEL WALTON[2] AND CHARLES C. PETERSON[1]. [1]*Dept of Ecology and Evolutionary Biology, University of California, Irvine, California 92717, United States of America.* [2]*Dept of Biology, Cleveland State University, Cleveland, Ohio 44115, United States of America.* Patterns of metabolic rate and growth were measured in hundreds of individual garter snakes (*Thamnophis sirtalis fitchi*) from an isolated population resident at a single pond in Northern California (Eagle Lake area). The following physiological variables were measured on each animal: standard metabolic rates (oxygen consumption) at 15 and 30°C, maximal oxygen consumption at 30°C, field metabolic rates (with doubly labelled water), field rates of water influx, and field growth rates. Correlations on size-corrected measurements (size residuals) were calculated among these variables to determine functional associations. Standard metabolic rates were positively and significantly correlated between 15 and 30°C; separate additional studies indicated similar positive associations between 10 and 20°C and between 20 and 30°C, but not between 10 and 30°C. No significant association was detected between maximal oxygen consumption at 30°C and standard metabolic rate at any body temperature, nor were any of these laboratory-measured variables significantly associated with field metabolic rates, water influx rates, or growth rates. Significant positive correlations, however, existed under field conditions among metabolic rates, water influx rates, and growth rates. In this population of snakes, therefore, interindividual differences in common, laboratory-determined measurements of metabolic rate do not apparently predict metabolic or growth rates under field conditions. Energy expenditure in the field however is associated with growth: higher rates of respiratory energy utilisation occur in animals with faster growth rates. [KEYWORDS: field metabolic rate, growth, snake, water flux].

Berdieva & Kichikulova

S30

The mediatory effect of *Naja oxiana* Eichwald, 1831 venom and its components. A. BERDIEVA AND T. KICHIKULOVA. *Chair for Biology, Turkmen Medical Institute, 58 Ata Goushudova Str., Ashgabat, Turkmenistan.* The influence of solid venom and its membrane active components — phospholipase A_2, citotoxin, neurotoxin — or adrenergic — and cholinergic responses was tested in an experiment on an isolated piece of small intestine and synaptosomes of cerebral cortex of white rats. The modulation of M-cholinergic-α and adrenergic-β mediatory responses, the changes of functional properties of cholino- and adrenoreceptors of synaptosomes was noted. The kinetic analysis has shown a large variability in the effect of solid venom and its component on the main parameters of cholinergic and adrenergic responses, dependent on the nature and the concentration of Zootoxines.

Bergallo & Rocha

C06–020

Population decrease : the case of *Liolaemus lutzae*, an endemic lizard of southeastern Brazil. HELENA G. BERGALLO[1] AND CARLOS FREDERICO D. ROCHA[2]. [1]*Depto Zoologia, Inst Biologia, C.P. 6109, Universidade Estadual de Campinas, Campinas, SP, 13081-970, Brazil.* [2]*Setor de Ecologia, Inst Biologia, Universidade do Estado do Rio de Janeiro, Maracanã, Rio de Janeiro, RJ, 20550, Brazil.* The tropidurid lizard *Liolaemus lutzae* is endemic in the "restingas" (sand dune habitats) of the Rio de Janeiro State, where it is restricted to the beach habitats (strips of sand 50 to 100 m wide covered with sparse vegetation). The beach habitats where *L. lutzae* is distributed are under human impacts which consequently affect the population of this lizard. We compared the densities of *L. lutzae* in 1984 and 1991 along two km of the beach habitat of the Barra da Tijuca Biological Reserve and in the Prainha Beach. The average number of lizards in 1991 transects was significantly lower than that of 1984 ($t = 12.4$; $P < 0.001$). Also, while in 1984 we recorded the occurrence of *L. lutzae* along an 18 km stretch of the Barra da Tijuca Beach, in 1991 the remains of the population were observed along only 4 km of the biological reserve and in small patches of vegetation. The population loss was about 65% and most of it seems to be due to the many human disturbances on the beach habitat. In Prainha Beach, the lizard population was extinct in 1991. The main disturbances observed in the *L. lutzae* habitat were: a) road constructions, b) establishment of volleyball sand-courts and trailers and c) vehicle traffic on the beach vegetation. These impacts clearly were responsible for the decrease in the plant covering of the habitat which affected negatively *L. lutzae* populations. [KEYWORDS: lizard, population decrease, conservation, *Liolaemus lutzae*, human impact].

Berven

S14

Population dynamics of the wood frog, *Rana sylvatica* from three geographic localities. KEITH A. BERVEN. *Dept of Biol. Sci., Oakland University, Rochester, MI 48309-4401, United States of America.* The present study summarises the results of 24 years of population data on the wood frog, *Rana sylvatica* from Maryland (2 populations over 7 years), Virginia (7 populations over 8 years), and Michigan (1 population over 9 years). Within each geographic locality breeding population size was

highly variable and fluctuated by a factor of 15. Although none of the ten populations went extinct, all passed through major bottlenecks. Population fluctuations within localities were asynchronous. In all localities variation in adult population size among years was primarily due to variation in larval success and juvenile recruitment. Reproductive failures (no larvae metamorphosed) were not uncommon. During the course of this study 32% of the breeding populations produced no juveniles. The main causes of reproductive failure were early pond drying or outbreaks of bacterial epidemics. Reproductive bonanzas also occurred and the female per capita juvenile production often exceeded 50. Adult and juvenile survival, in comparison, was more stable, and was correlated with adult population size and mean monthly rainfall. However, unusually dry years caused major adult mortality. This study concludes that wood frog population size is rarely constant, and that population fluctuations are largely due to stochastic causes. [KEYWORDS: amphibian, population structure, *Rana sylvatica*, reproduction, survivorship].

Beutel

C06–021

Habitat modelling for geckos in Queensland's mulgalands. TERRY BEUTEL. *Dept of Management Studies, Gatton College, Lawes, Qld 4343, Australia.* Research is currently under way to develop habitat requirement models for several species of gecko (Family Gekkonidae) found in southwest Queensland. The research is being conducted at Currawinya National Park (28° 30'S 144° 30'E) under the sponsorship of the Queensland Dept of Environment and Heritage. This paper presents my results so far, and outlines possible methods for testing the models following their final development. An interesting secondary investigation in the study, whether the recent destocking of the park will effect its gecko fauna, is also addressed. [KEYWORDS: habitat, habitat modelling, Gekkonidae].

Bezy & Camarillo R.

C07

A re-evaluation of the species of xantusiid lizards allied with *Lepidophyma gaigeae*. ROBERT L. BEZY[1] AND JOSE L. CAMARILLO R.[2]. [1]*Section of Herpetology, Natural History Museum, Los Angeles, CA 90007, United States of America.* [2]*Laboratorio de Investigacion Herpetologica, CyMA, ENEPI, UNAM, A.P. 314, Tlalnepantla, Edo. de Mexico, Mexico.* Recently obtained material has led to a re-evaluation of the species status of populations formerly included in the subgenus *Gaigeia*. Discriminant analyses of the populations indicate the existence of eight morphological groups. Univariate comparisons among the groups diagnose four morphospecies. Among these is a previously undescribed species found in Oaxaca, Mexico. It and two additional species, *L. dontomasi* in Oaxaca and *L. gaigeae* in Queretaro and Hidalgo, are specialised for rock crevices. The fourth species, *L. radula*, remains known only from the holotype. Karyotype information indicates that the subgenus *Gaigeia* may not be monophyletic. [KEYWORDS: Sauria, Xantusiidae, systematics, Mexico].

Bickford

C06–022

Diversity and abundance of a montane leaf-litter herpetofauna in Costa Rica: implications of elevational patterns. DAVID P. BICKFORD. *University of Miami, Coral Gables, FL 33124-0421 United States of America.* The species richness, abundance, dominance, and evenness of the leaf-litter herpetofauna of a montane wet forest in la Reserva Forestal de Rio Macho (R.F.R.M.) are estimated and compared to other studies at other sites in Costa Rica. I analyzed data from twenty-two 8 x 8 m

plots and 140 km of transects within the R.F.R.M. Changes in herpetofaunal assemblages over an elevational gradient are discussed. Elevation of the plots and transects ranged from 2450 m to over 2800 m and were compared to studies done at lower elevations. Ninety-six individuals comprising 14 species were identified for the R.F.R.M. The reptiles and amphibians of the leaf-litter habitats of Costa Rica appear to be less diverse and abundant at high elevations. Moreover, species richness and evenness was found to be lower and dominance higher in the montane herpetofaunal assemblages. The herpetofauna of the R.F.R.M. is dominated by a single species *Bolitoglossa subpalmata* with a few rare and extremely rare species. Habitat utilisation for each species will be described. [KEYWORDS: herpetofauna, montane, diversity, abundance, richness, evenness, elevation].

Biermann & Blahak

C31

First isolation of a herpesvirus from tortoises with diphtheroid-necrotizing stomatitis. REINHARD BIERMANN AND SILVIA BLAHAK. *Institut für Geflügelkrankheiten, Justus-Liebig-Universität Gießen, Frankfurter Str. 87, D-35392 Gießen, Germany.* In recent years the so called "stomatitis-rhinitis-komplex" in land tortoises, a severe diphtheroid-necrotizing stomatitis combined with rhinitis, has gained more and more importance. The disease is usually initiated with the introduction of a new animal in the group. The tortoises show salivation, nasal discharge, anorexia and severe diphtheroid-necrotizing stomatitis. Most of them die in spite of antibiotical therapy. The disease spreads very quickly and only few of the tortoises survive. Histopathologic examination of the tissues of tongue, oesophagus and trachea revealed intranuclear inclusion bodies which seemed in size and structure typical for herpes viruses, but isolation of the agents was not attempted or failed so far. In this report we document the spread of disease in a collection of land tortoises (*Testudo hermanni*). Pathologic and histopathologic findings, bacteriological and virological examinations of the tissues of five animals are described. In the mucosa of tongue, oesophagus and trachea of all five tortoises intranuclear inclusion bodies could be found. Isolation of herpes viruses succeeded at 28°C on Turtle Heart cells (ATCC CCl 50) from brain, lung/trachea, intestine and liver of different animals. First data on the characterisation of the virus and comparison with other herpes viruses are reported. [KEYWORDS: tortoises, diphtheroid-necrotizing stomatitis, herpesvirus, isolation].

Birkett

C34

Management and breeding of the frilled lizard (*Chlamydosaurus kingii*) at Melbourne Zoo. JON R. BIRKETT. *Herpetofauna Dept, Melbourne Zoo, PO Box 74, Parkville, Victoria 3052, Australia.* *Chlamydosaurus kingii* is a high profile native Australian lizard, but its wild ecology and captive requirements were poorly understood until quite recently. Melbourne Zoo holds 2.1 adults of the Northern Territory form and four juveniles hatched in January 1992. The breeding pair arrived in 1984 and 1986, and are displayed in a 4.5 m^3 exhibit landscaped with sand, rocks, branches and vertical cycad trunks. Courtship was observed in spring 1991 and 10 eggs were laid in October. Six lizards hatched after 78–80 days and averaged 3.5 g and 47 mm snout-vent length at emergence. The Melbourne specimens are part of a regional management program for the species and young have been exchanged with the Territory Wildlife Park and Taronga Zoo to establish further captive groups. A husbandry manual is being developed. [KEYWORDS: *Chlamydosaurus kingii*, reproduction, Melbourne Zoo].

Bishop *et al.*

S24

The northern limits: factors affecting fluctuations in amphibian populations in Canada. CHRISTINE A. BISHOP[1], MICHAEL BERRILL[2] JOËL BONIN[3], RONALD J. BROOKS[4], NEIL, M. BURGESS[5], MARY GARTSHORE[6], ANDRÉE GENDRON[7], DAVID M. GREEN[8], MEGAN HARRIS[4], DONALD MCALPINE[9] AND JOHN RODRIGUES[10]. [1]*Canadian Wildlife Service, Burlington, Ontario L7R 4A6, Canada.* [2]*Watershed Ecosystems, Trent University, Peterborough, Ontario K91 7B8, Canada.* [3]*Societé d'histoire naturelle de la vallée du St. Laurent, Ste.-Anne-de-Bellvue, Québec H9X 1CO, Canada.* [4]*Dept of Zoology, University of Guelph, Guelph, Ontario N1G 2W1, Canada.* [5]*Canadian Wildlife Service — Atlantic Region, Sackville, New Brunswick E0A 3CO, Canada.* [6]*Ontario Field Herpetologists, R.R. #1, Walsinham, Ontario N0E 1XO, Canada.* [7]*Dept of Biological Sciences, Université du Québec à Montréal, Montréal, Québec H3C 3P4, Canada.* [8]*Redpath Museum, McGill University, Montréal, Québec H3A 2K6, Canada.* [9]*New Brunswick Museum, St. John, New Brunswick E2K 1E5, Canada.* [10]*Canadian Wildlife Service — Québec Region, Environment Canada, 1141 route de l'Eglise, C.P. 10 100, Ste.-Foy, Québec G1V 4H5, Canada.* Canada has 42 recognised species of amphibians, none of which is endemic to the country but all of which extend to the extreme northern margins of their ranges within its territory. Long and short-term monitoring and research reveals that some populations have suffered drastic declines but others may recover to some extent under more favourable conditions. Northern Leopard frogs (*Rana pipiens*) in western Canada have had severe and sudden declines in the 1970s while in southern Ontario in 1992, Northern Leopard frogs were the least frequently encountered species among 1525 three minute call-counts. However, after suffering a decline, Fowler's toads (*Bufo woodhousii fowleri*) at their northern limit have significantly increased in numbers over the past five years. A population of Bullfrogs (*Rana catesbeiana*) in central Ontario has shown no clear trends during eight years of monitoring although fluctuations are evident. Among other current studies underway in Canada are investigations on reduced corticosteroid levels (females only) and increased rates of deformities in mudpuppies from contaminated sites on the St Lawrence River, organophosphate pesticides effects on reproduction in ranids in southern Ontario, and significantly lowered Mink frog populations in forest ponds in New Brunswick where fenitrothion has been sprayed in three or four of the last five years.

Bishop *et al.*

C15

The common snapping turtle as a biomonitor of the levels and effects of chlorinated hydrocarbons in the Great Lakes — St Lawrence river basin. CHRISTINE A. BISHOP[1], RONALD J. BROOKS[2], PEGGY NG[3], SEAN KENNEDY[4], JOHN J. STEGEMAN[5], AND ROSS J. NORSTROM[4]. [1]*Canadian Wildlife Service-Ontario Region, Environment Canada, Box 5050, Burlington, Ontario L7R 4A6, Canada.* [2]*University of Guelph, Dept of Zoology, Guelph, Ontario N1G 2W1, Canada.* [3]*Institute for Social Research, York University, 4700 Keele St., North York, Ontario M3J 1P3, Canada.* [4]*National Wildlife Research Centre, Canadian Wildlife Service, Environment Canada, Hull, Quebec K1A 0H3, Canada.* [5]*Woods Hole Oceanographic Institute, Dept of Biology, Redfield 342, Woods Hole, Massachusetts 02543, United States of America.* Eggs of the common snapping turtle (*Chelydra s. serpentina*) were analysed for organochlorine pesticides, PCBs, PCDDs and PCDFs from 13 locations in Ontario, Canada and Upper New York State, USA during 1981–1991. These eggs show significant geographic and temporal variation in contamination. Contaminant levels in the eggs are not related

to female body size or clutch characteristics and show little within clutch variation in contamination. This makes the species a practical, annual biomonitor of contaminant trends in wetlands. Maximum Total PCB (42 congeners) and polychlorinated dioxin levels were 5.01 mg/kg (St. Lawrence River) and 67 ng/kg (Hamilton, Lake Ontario) respectively. The eggs from Lake Ontario and the St. Lawrence River are the most contaminated and the rates of unhatched eggs, and deformities are highest in eggs from Lake Ontario. Cytochrome P-4501A induction was found in hatchling turtle livers from Lake Ontario but not from an inland control site, Algonquin Provincial Park. Ethoxyresorufin-o-deethylase, and porphyrin levels were also measured in hatchling livers and results will be discussed. [KEYWORDS: chlorinated hydrocarbons, turtles, biological effects].

Bishop *et al.*

C06– 023

Environmental fate and effects of organophosphorus insecticides on amphibians in Ontario, Canada. CHRISTINE A. BISHOP[1], JOHN STRUGER[2], AND KAREN PETTIT[1]. [1]*Canadian Wildlife Service-Ontario Region, Environment Canada, Box 5050, Burlington, Ontario L7R 4A6, Canada.* [2]*Environmental Quality Branch, Environment Canada, Box 5050, Burlington, Ontario L7R 4A6, Canada.* Organophosphorus insecticides (OPs) are used heavily in the production of onions and carrots in muck soils in Ontario, Canada. Much of this land is reclaimed wetland in which wildlife still utilises the remnant habitat along the river and dyked canal as breeding sites. Thirteen OPs were analysed by nitrogen/phosphorus detector and an electron capture detector. Trace concentrations (< 1.0 μg/L) of terbufos, fonofos, malathion, diazinon, guthion and chlorpyrifos were observed in surface water. Trace concentrations of chlorpyrifos, ethion and fonofos were observed in sediment. The number of amphibian species found breeding in the agricultural areas was four versus six in the wetland habitats downstream and upstream of the dyked agricultural area. Hatching success of *Rana sylvatica*, *Bufo americanus*, and *Rana clamitans* was assessed by placing amphibian eggs in cages at 5 sites in the watershed. Hatching success was not significantly different among the five sites in field or lab trials. Deformity rates were also assessed and results will be discussed. [KEYWORDS: organophosphorus, insecticides, hatching, deformities, amphibian, diversity].

Black *et al.*

C10

Microgeographic variation in mitochondrial DNA of of the Tenerife lacertid. HEATHER BLACK, ANITA MALHOTRA AND ROGER S. THORPE. *Dept of Zoology, University of Aberdeen, Tillydrone Ave., Aberdeen AB9 2TN, Scotland, United Kingdom.* The island of Tenerife has a variety of distinct habitat types and a complex geological history. The lacertid lizard, *Gallotia galloti*, varies morphologically (colour pattern, scalation, body dimensions) in response to selection for these habitat types. However, the mitochondrial genome, which is thought to be selectively neutral, also varies across the island. For example, cytochrome b shows about a 3% difference between parapatric populations. Various hypotheses are considered in relation to this variation. [KEYWORDS: *Gallotia galloti*, cytochrome b, mtDNA, geographic variation].

Blahak

S26

Isolations of new paramyxo- and adenoviruses from snakes and a reovirus from an iguana. SILVIA BLAHAK. *Institut für Geflügelkrankheiten, Justus-Liebig-Universität, Gießen, Frankfurter Str., 87, D-35392 Gießen, Germany.* Virus infections

in reptiles are well-known for causing severe disease and death in collections, for example paramyxovirus infections in snakes. In this paper the isolation of three new paramyxoviruses from two corn snakes (*Elaphe guttata*) and another non venomous snake (*Elaphe situla*) is described. The isolates originate from different collections with health problems over a longer period of time. The clinical signs differed between the collections. Antibiotic therapy in all three groups was without success. Clinical, pathological findings, bacteriological and virological results are documented. It was possible to isolate an adenovirus from the feces of a rat snake (*Elaphe obsoleta*) which showed anorexia. First attempts for characterisation are described. One of three Green Iguanas died two weeks after acquisition showing anorexia. A post mortem was carried out and virological investigations of the organs revealed the presence of a reovirus. Furthermore, results of bacteriological and parasitological examinations are reported and discussed. [KEYWORDS: paramyxovirus, adenovirus, snake, reovirus, *Iguana*].

Blanchard

C06–025

Captive tuatara. BARBARA J. BLANCHARD. *Wellington Zoological Gardens, Newtown Park, Wellington, New Zealand.* Worldwide there are 20 holders of tuatara, all but 5 in New Zealand. The latter are permanent populations but in New Zealand some institutions participate in the "head start" program, where juveniles from artificially incubated eggs are raised for 4 to 5 years to a size which should optimise their chances of repopulating restored habitats or colonising new ones. Aspects of this co-operative venture, the maintenance of captive populations and enclosures used are represented. Research projects involving tuatara (*Sphenodon punctatus* and *S. guntheri*) are summarised. [KEYWORDS: Tuatara, *Sphenodon punctatus*, *S. guntheri*, captive populations, maintenance, enclosures, research].

Blaustein

S19

Chemical cues and kin recognition in tadpoles. ANDREW R. BLAUSTEIN. *Dept of Zoology, 3029 Cordley Hall, Oregon State University, Corvallis, Oregon 97331-2914, United States of America.* The larvae of anuran amphibians are model vertebrates for studying kin recognition mechanisms. The larvae of most species studied are able to distinguish between kin and non-kin but there is considerable interspecific variability in how kin recognition is manifested. In all species in which it has been investigated, the phenotypic marker(s) (i.e. cues, signals, signatures) by which individuals are identified is chemically based. Ontogenetic changes in the kin recognition signal/perception system do not occur within the larval stage of most species. However, the production of the chemical signature in the larvae of at least one species, the red-legged frog (*Rana aurora*), changes ontogenetically. Moreover, in this species, the ability to perceive the marker also changes during development. These changes may relate to changing social and environmental conditions.

Blomberg

C30

The size-classified demography of the southern water skink: estimation of transition probabilities and the analysis of matrix models. SIMON P. BLOMBERG. *Zoology A08, School of Biological Sciences, University of Sydney NSW 2006, Australia.* The estimation of demographic parameters is important for a thorough understanding of population dynamics and for life history theory. I conducted a capture-recapture experiment on a population of southern highland water skinks (*Eulamprus tympanum*) from 1990 to 1992 at Kanangra-Boyd National Park, west of

Sydney, in order to estimate transition probabilities for a Lefkovitch matrix population model. Transition (growth and survivorship) probabilities were estimated under the Arnason-Schwarz model, and a reduced-parameter (constant time-specific transition probabilities, variable catchability) model. Goodness-of-fit tests suggested that both models performed poorly, and log- likelihood ratio tests were unable to distinguish between the models. The resulting periodic matrix population models suggested that the population was in rapid decline ($\lambda = 0.52$ for the Arnason-Schwarz model estimates, and $\lambda = 0.47$ for the reduced-parameter model estimates). Analyses of the two matrix models differed in important respects, however, including stable-stage distributions and reproductive values. I discuss the importance of obtaining good statistical models for capture-recapture experiments if demographic analyses are to have robust conclusions. [KEYWORDS: *Eulamprus tympanum*, demography, Lefkovitch, matrix, Arnason-Schwarz].

Bobrov

C06–027

On the zoogeographical analysis of the lizard fauna of Indo-Australian Archipelago. VLADIMIR V. BOBROV. *Institute of Animal Evolutionary Morphology and Ecology, 33, Leninsky Prospect, Moscow 117071, Russia.* The known lizard fauna of the Indo-Australian Archipelago consists of about 250 species, representing 59 genera and 9 families. Only one monotypic family (Lanthanotidae) is endemic to this region. Four families (Gekkonidae, Agamidae, Scincidae, Varanidae) are widely distributed both in Eurasia and in Australia. Remaining four families (Dibamidae, Pygopodidae, Lacertidae, Anguidae) have a limit of distribution in this area. According to the geographic distribution of the lizard families, Indo-Australian archipelago can be divided into three parts. 1) Borneo, Sumatra, Java Philippines, Sulawesi, Moluccas, and Lombok belong to the Indo-Malayan region. Among 47 genera occurring in this part of Archipelago 12 are endemic, 11 — Indo-Malayan, 5 — shared only with New Guinea. 2) Aru Islands belong to the Australian region. 3) New Guinea, Sumba, Flores, Timor are confirmed as a "transition" zone between the Indo-Malayan and Australian regions. New Guinea is faunally heterogeneous (3 of 30 genera are endemic, 10 — shared with Australia 5 — shared with Indo-Malaya). Sumba, Flores, Timor, with four families lack many taxa which are found in the Great Indo-Malayan islands or in Australia. [KEYWORDS: lizards, zoogeography, Indo-Australian archipelago].

Bodson

C06–028

EURYDICE. Computerised data bank on traditions and common knowledge about reptiles and amphibians in (1) the French-speaking countries of Europe. LILIANE BODSON. *Séminaire d'histoire des connaissances zoologiques, University of Liège, place du 20- Août 32, B-4000 Liège 1, Belgium.* The data bank EURYDICE is based on an international programme launched in 1987 and temporarily limited to the French-speaking countries of Europe for practical and financial reasons. It records folk traditions, usages and beliefs about reptiles and amphibians either orally transmitted and therefore threatened with disappearance or printed and yet often difficult to traced out because scattered in many and sometimes confidential sources. Two softwares were devised by the Center for Computerization in Humanities (University of Liege): PALAMDE, as the recording part of the whole device, and HERMES, as a structured query product. They will be presented with selected examples showing how the bank may favour both research in history, ethnology, sociology, etc., when reptiles and amphibians are concerned, and educational campaigns aiming at the pro-

tection of such animals by throwing light on the prejudices which still victimise them in the general opinion. [KEYWORDS: amphibians, data bank, EURYDICE, folklore, reptiles, traditions].

Bodson

S28

Aristotle as an herpetologist. LILIANE BODSON. *Séminaire d'histoire des connaissances zoologiques, University of Liège, place du 20- Août 32, B-4000 Liège 1, Belgium.* Evidence on reptiles and amphibians recorded by Aristotle (384–322 B.C.) in his biological treatises is less developed than on any of the other classes of animals. This may not be considered as the effect of cultural prejudices nor as the result of some lack of interest in snakes and amphibians. The Greek philosopher and scientist still identified today as "the father of biology" did not only recommend "to boldly enter upon researches concerning animals of any sort and kind" (P.A. 1.5.645 a 24–25), he put his own theoretical principles into practice in a thorough investigation conducted thoughout the whole animal kingdom. Nevertheless when mentioning snakes, lizards, toads, frogs, etc. in his accounts on anatomy, physiology, or ethology, he keeps to rather general statements and does not differentiate reptiles and amphibians at the genus (or species) level as he does when dealing with insects, fish, birds and mammals. This paper aims at surveying the herpetological contents of the Aristotelian treatises in order (1) to characterise the sources, methods and goals of their author, (2) to evaluate their contents, (3) to outline their influence upon the early history of Western herpetology. [KEYWORDS: Aristotle, frogs, history, lizards, snakes, toads, tortoises].

Bonnet & Naulleau

C13

Reproductive ecophysiology in *Vipera aspis*. XAVIER BONNET AND GUY NAULLEAU. *C.N.R.S., Centre d'Etudes Biologiques de Chizé, F-793600. Villiers en bois, France.* *Vipera aspis* was studied in the wild, in semi field conditions (outdoor enclosures) and under controlled conditions at the laboratory. Numerous observations and experiments have showed that reproduction is strongly controlled by the body reserves in females; in males body reserves are not so important, although it does play a role in the mating behaviour. Females need large body reserves for complete vitellogenesis their body condition index (BCI) must exceed a certain threshold (BCI$\geq$0.7) for reproduction to take place (fat bodies and liver are well developed). We have observed 4 females which started to reproduce with a BCI between 0.64 and 0.68, only one female gave birth to one fit young, almost all of the mass of the 4 litters was composed of residues (undeveloped eggs and stillborns). Using intracardiac punctures to obtain blood samples we have observed the mobilisation of maternal reserves (fat bodies, liver and vertebral bones) during vitellogenesis which is a very costly process in *V. aspis*. Immediately after hibernation reproductive females exhibit very high values of plasmatic components such as calcium (400 mg/l vs 100 mg/l), phosphorus (150 mg/l vs 30 mg/l), phospholipids (7 g/l vs 2.5 g/l, triglycerids (8 g/l vs 1 g/l), cholesterol (6.5 g/l vs 4 g/l) and proteins (75 g/l vs 40 g/l), relative to non reproductive females. These components are used by the growing follicles and/or by the liver to synthesise the vitellogenin, a yolk precursor. Estradiol 17-β is directly implicated in the mobilisation of maternal reserves: reproductive females show very high values of estradiol 17-β (5 ng/ml) only during the vitellogenesis period, later in the annual cycle as in non reproductive females, estradiol 17-β levels remain low (0.1 ng/ml). Furthermore silastic implants of estradiol 17-β placed subcutaneously in non-reproductive females provoked

a mobilisation of maternal reserves similar to those observed in reproductive females during vitellogenesis. Estradiol 17-β probably play a role in mating behaviour: 3 estrogenised females became more attractive and more receptive to males. Despite numerous data and experiments we are unable to explain the changes of plasmatic progesterone during the annual cycle, especially the mid-hibernation peak, nevertheless there are strong differences between reproductive and non-reproductive females. In males there is no BCI threshold which could stop spermatogenesis, all males are potentially reproductive. Body reserves (fat bodies) are used during the mating season: males starve and their sexual activity is very intensive (ritual combats, exploration trips to find reproductive females and complex mating behaviour). High plasmatic levels of testosterone are linked with the sexual behaviour: peaks are observed before mating seasons and silastic implants of testosterone reduced a typical reproduce behaviour after two weeks. [KEYWORDS: body condition, estradiol, reproduction, testosterone, vitellogenesis].

Bonnet & Naulleau

C06– 029

Influence of food intake on reproductive success in female *Vipera aspis*. XAVIER BONNET AND GUY NAULLEAU. *C.N.R.S., Centre d'Etudes Biologiques de Chizé, F-793600. Villiers en bois, France.* Only 30% of female *Vipera aspis* reproduce each year in the wild in West Central France 70% being non reproductive. Reproductive females have large body reserves such as fat bodies and liver (body condition index BCI $>$ 0.7) at the beginning of the reproductive season in March. Ovulations occur in early June and parturition from early September to late October. During vitellogenesis and gestation some females feed while others do not. Neither body length nor initial BCI influence the feeding behaviour of females *V. aspis*. Food intake during vitellogenesis and gestation positively influences reproductive success: litter mass, relative litter mass (RCM), litter size and the proportion of fit young relative to residues (undeveloped eggs and stillborns). After parturition feeding females are in a similar poor body condition (BCI = 0.51) to nonfeeding females, energy from prey being completely invested into reproductive success. *Vipera aspis* could be considered to be a true viviparous species which exhibits transfer of nutrients between mother and embryos. Feeding females give birth sooner than the others, short gestation lengths give time for animals to restore their body reserves while temperatures are still favourable in late summer. [KEYWORDS: food intake, reproductive success].

Booth

S13

The significance of unstirred layers to cutaneous oxygen exchange in submerged frogs. DAVID T. BOOTH. *Dept of Zoology, University of Queensland, St Lucia, Qld 4072, Australia.* Lung oxygen partial pressure of anaesthetised African clawed frogs, *Xenopus laevis*, was continuously monitored during simulated shallow dives in still and slow moving water by an oxygen electrode in line with an extracorporeal loop. Lung oxygen partial pressure decreased significantly faster in still water compared to slow moving water, indicating inhibition of cutaneous oxygen exchange in still water. A consequence of decreased cutaneous oxygen exchange in still water is a decrease in aerobic dive time. When dives in still water were prolonged, lung oxygen partial pressure fell to a very low level, less than 0.4 kPa. However, if water was then moved across the skin's surface, an increase in lung oxygen partial pressure was observed, indicating an increase in oxygen transport across the skin. [KEYWORDS: skin, cutaneous, gas-exchange, unstirred-layers, boundary- layers, frog].

Borkin

S07

The species and speciation in amphibians of the former USSR. LEO J. BORKIN. *Dept of Herpetology, Zoological Institute, Russian Academy of Sciences, St Petersburg 199034, Russia.* In the last two decades, extensive studies devoted to taxonomy, distribution and genetics of amphibians of the USSR territory were performed using morphometrical, biochemical (protein electrophoresis) and cytogenetic (karyotype, genome size) methods. Several kinds of species and speciation can be revealed in terms of species nature, distribution and genome composition. I) Biological species with three kinds of distribution: a) allopatric — *Bufo bufo* group and *Hyla arborea* group; b) allo-parapatric — *Triturus cristatus* group and *Bombina* species; c) allo-sympatric — *Triturus vulgaris* group and *Rana temporaria* group. II) Hybridogenic species — *Rana esculenta* group with an unusual clonal inheritance mechanism and a variety of population system structures. III) Polyploid species — *Bufo viridis* group. Natural hybridisation is recorded in Ib (narrow hybrid zones), Ic (possible occasional hybrids), II (hybrid taxa) and III (wide hybrid zone between diploid and tetraploid species). Laboratory hybridisation results don't always correlate with conventional taxonomy. Some discrepancies between biochemical and reproductive divergence of allopatric populations are found. [KEYWORDS: speciation, amphibians, USSR].

Borkin

S09

Herpetofauna of the Gobi Desert, Mongolia: differentiation and species richness. LEO J. BORKIN. *Dept of Herpetology, Zoological Institute, Russian Academy of Sciences, St Petersburg 199034, Russia.* The herpetofaunas of the Gobi Desert and remaining parts of Mongolian territory are very different (Chekanowski's similarity I=0.29-0.37 for reptiles). The Gobi is inhabited by 2 toad species (33% of Mongolian amphibians) and 16 species of reptiles (76%). The last are represented by 11 lizards (3 agamids, 3 geckonids, 5 lacertids) and 5 snakes (1 boid, 3 colubrids, 1, maybe more, pit-viper). Maximum species richness (the number of species per one grid item 100 × 100 km) reaches 7 for lizards, 5 for snakes and 10 for reptiles. Amphibians are distributed very sporadically. The lizard communities in Gobi are structurally simpler than in deserts of the former Soviet Middle Asia, and the total lizard density (per 1 hectare) seems to be 1.5 times lower. The species diversity is 0–1.15 against 1.56–2.44. The occurrence of snakes is very low. A few Gobi habitats with 6 reptilian species are recorded; some habitats, e.g. stony plains, are characterised by only one species, *Phrynocephalus versicolor*. This agamid lizard is the most typical reptile with vast distribution in arid parts of Mongolia. The averaged number of *P. versicolor* ranges from 5 to 90 specimens/hectare, and the biomass ranges from 12.8 to 166.9 g/ha. Herpetologically, the Gobi Desert seems to be separated into two distinct regions (I=0.67): the Jungar (Dzhungarian) Gobi (10 species of reptiles) and the Transaltai Gobi (14). Both regions are also inhabited by different toads of the genus *Bufo*. [KEYWORDS: herpetofauna, Gobi Desert, species richness].

Bourne

C06–030

Indirect selection of preferences and progeny performance in the selecting frog *Scinax rubra*. GODFREY R. BOURNE. *Dept of Biology, University of Missouri-St Louis, 8001 Natural Bridge Road, St Louis, MO 63121-4499, United States of America.* There is a debate about whether the evolution of mating preferences in lekking species is guided by direct selection, which benefits a female's fitness, or indirect selection where genetic benefits accrue to progeny. Thus, I evaluated the influence

of male alternative mate acquisition strategies on tadpole performance in the lekking neotropical frog, *Scinax rubra*. I conducted a series of controlled matings and reared the tadpoles to metamorphosis in the laboratory and field, to determine whether differences in paternal identity, mating status, and body size were related to differences in tadpole mass, larval period duration, metamorphic mass, and survival. Both laboratory and field rearings suggested that male and female parentage affected most progeny traits. Furthermore, unlike Mitchell's (1990) findings, data were similar for laboratory and field metamorphic mass, as well as survival of progeny sired by the same male. Paternal effects were more pronounced in the field than in the laboratory but were not statistically significant. Larger males did not sire progeny that were heavier than smaller males unless these males were 'career satellites'. [KEYWORDS: paternal identity, mating status, body size, tadpole mass, larval period duration, metamorphic mass].

Maternal care and nest defence in the agamid lizard *Uromastyx aegyptius*. AMOS BOUSKILA. *Behavioural Ecology Research Group, Dept of Biological Sciences, Simon Fraser University, Burnaby, BC, V5A 1S6, Canada.* The desert dwelling lizard, *Uromastyx aegyptius*, is a large (up to 3 kg) burrow-based herbivorous lizard. 34 marked adults were observed in a gravel plain, near Hazeva, southern Israel. Females laid eggs in special nesting burrows (about 3 m long, 1 m deep) which were blocked with dirt. The nesting burrows were usually close to the dwelling burrows of the females, and one of them has been used on previous years. Several females seemed to use nests within their dwelling burrows. During the incubation period, females spent time near the blocked nesting burrows, scent marked the soil on top of them, and maintained the site. In one case a female attacked an approaching female. Hatchlings were active near openings of both the nesting burrows and the openings of female burrows. Hatchlings climbed over females and in one case were actively defended against a large predator, *Varanus griseus*. The activities of a female during incubation and after hatching may prevent the use of the nesting burrow by another female and may reduce the risk from predators. Females that nest close to, or within their dwelling burrows may have more opportunities to defend the nesting site and the hatchlings. Maternal behaviour and nest defence similar to that shown by *U. aegyptius* have been described in Iguanids and other lizards, but this is the first account of such behaviours in an agamid lizard. [KEYWORDS: nests, nest defence, hatchling defence, predation].

Bouskila

S21

Foraging and prey capture sites of sidewinders (*Crotalus cerastes*). AMOS BOUSKILA. *Behavioural Ecology Research Group, Dept of Biological Sciences, Simon Fraser University, Burnaby, BC, V5A 1S6, Canada.* The activity of sidewinders (*Crotalus cerastes*) was observed at Kelso Dunes, Mojave Desert, and the microhabitats in which foraging and prey capture took place were recorded. 23 males and 25 females were observed during three summers for 3-11 consecutive nights, either on dark nights, or on moonlit nights. Individuals were recognised by their dorsal patterns, thereby eliminating the need to disturb the snakes and potentially affect their activity on subsequent nights. Data were collected by direct observation (with a night scope) and by recording the trails left on the sand. Ambushing sidewinders preferred bushes, and to a lesser degree, perennial grasses, over open areas. The avoidance of open areas was stronger on moonlit nights. Nevertheless, there were always some snakes ambushing in

Bouskila

C28

the open. When nocturnal rodents discovered snakes, they kicked sand on them; the snakes did not attempt to capture these rodents. Snakes were more successful capturing rodents on moonless nights, and they captured disproportionately more rodents near bushes, compared to the open and grass microhabitats. Lizards were captured during the morning hours, near entrances to burrows or under bushes. The nocturnal activity of the sidewinders differed in the third summer, in which the rodent population was denser than in the previous years. During this year, snakes avoided the open microhabitat to a lesser extent, and their ambush site selection was less affected by moonlight. [KEYWORDS: direct observation, tracking, moonlight, bush preference, prey, capture].

Bowen & Carr

S18

Evolutionary ecology and phylogeography of marine turtles. BRIAN W. BOWEN[1] AND ARCHIE CARR[2]. [1]*BEECS Genetic Analysis Core, P.O. Box 110699, University of Florida, Gainesville, Florida 32611-0699, United States of America.* [2]*Center for Sea Turtle Research, 223 Bartram Hall, University of Florida, Gainesville, Florida 32611, United States of America.* The herbivorous green turtle (*Chelonia mydas*) grazes in coastal feeding pastures and has a primarily tropical distribution, while the carnivorous loggerhead (*Caretta caretta*) feeds on molluscs and decapod crustaceans and nests almost exclusively outside the tropics. These differences in ecology and life history generate predictions about the phylogeography of marine turtles which can be tested with mitochondrial (mt) DNA data. In the green turtle, mtDNA data demonstrate a fundamental phylogenetic split between Atlantic and Indian-Pacific populations, consistent with the hypothesis that temperate conditions around southern Africa represent a prominent barrier to dispersal in recent evolutionary time. Phylogenetic analysis of Atlantic green turtle rookeries indicate that these populations may have shared a mutual common ancestor in the vicinity of tropical Brazil. This area, which contains the largest feeding pastures in the Atlantic, may function as a refuge for green turtles or as a source of colonisers. In contrast, the more temperate loggerhead is characterised by extensive sharing of mtDNA lineages between Atlantic and Indian Ocean basins, reflecting at least two colonisation events in recent evolutionary history. Both geography and mtDNA data strongly implicate a loggerhead rookery in Natal, South Africa, as the source of recent Atlantic colonisers. These data demonstrate how differences in ecology can influence the phylogeographic history of marine turtle species. [KEYWORDS: Cheloniidae, evolutionary ecology, marine turtles, mitochondrial DNA, phylogeography].

Bradford

C06–031

Development of wildlife indicators in the US environmental monitoring and assessment program. DAVID F. BRADFORD. *U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory, P.O. Box 93478, Las Vegas, NV 89193, United States of America.* States Environmental Monitoring and Assessment Program (EMAP) is a multi-agency program designed to "estimate the current status, trends, and changes in selected indicators of the condition of the Nation's ecological resources on a regional basis with known confidence". The Program is designed to sample from a uniform grid of approximately 12,200 hexagons across the U.S., with a 4-year repeat frequency for each site. Because of logistical constraints most indicators investigated to date focus on sessile features such as plants and soil. However, wildlife (i.e. vertebrates other than fishes, and terrestrial invertebrates) are of concern as potential indicators because they play significant roles in most ecosystems, they often integrate processes across a variety of habitats and regions, and they often have high public interest. In recent pilot studies with birds, metrics such as ratio or numbers of disturbance sensitive/tolerant birds, species richness, or guild structure have shown significant relationships with extent of habitat disturbance on a regional basis. An effort is underway to identify similar indicators involving amphibians, reptiles, and other animal groups. (Notice: Although the research described has been funded in part by the U.S. Environmental Protection Agency, it has not been subjected to Agency review. Therefore, it does not necessarily reflect the views of the Agency). [KEYWORDS: wildlife, indicators, monitoring, assessment].

Bradford *et al.*

C15

Acidic deposition as an unlikely cause for amphibian population declines in the Sierra Nevada, California. DAVID F. BRADFORD[1], MALCOLM S. GORDON[2], DALE F. JOHNSON[3], RUSSEL D. ANDREWS[4] AND W. BRYAN JENNINGS[5]. [1]*Environ. Science and Engineering Program, Univ. of California, Los Angeles, California 90024, United States of America. Present address: U.S. Environmental Protection Agency, Environ. Monitoring Systems Lab., P.O. Box 93478, Las Vegas, NV 89193, United States of America.* [2]*Dept of Biology, Univ. of California, Los Angeles, California 90024, United States of America.* [3]*563 Grove St., Bishop, California 93514, United States of America.* [4]*Dept of Zoology, Univ. of British Columbia, Vancouver, B.C., V6T 2A9, Canada.* [5]*Dept of Biology, Univ. of Texas at Arlington, Arlington, Texas 76019, United States of America.* The Sierra Nevada of California is one of many regions worldwide that has recently experienced dramatic declines in amphibian populations. During the past two to three decades many populations of at least two species (*Rana muscosa* and *Bufo canorus*) have disappeared in national parks and designated wilderness areas at high elevation, whereas populations of a third widespread species (*Pseudacris regilla*) have remained stable or declined to a lesser extent. Anthropogenic acidic deposition has been suggested as a cause for these disappearances primarily because most surface waters in these areas are exceptionally low in acid neutralising capacity (ANC), and thus are vulnerable to changes in water chemistry due to acidic deposition. We tested the hypothesis that acidification of habitats has adversely affected amphibian populations by eliminating populations from waters most vulnerable to acidification, i.e. low in pH or ANC, or from waters low in ionic strength, a condition that increases the sensitivity of amphibians to low pH. A survey of 235 potential breeding sites in 30 randomly selected survey areas failed to reveal significant differences in water chemistry parameters between sites with and sites without each of the three species. Moreover, the water chemistry parameters did not differ among sites inhabited by the three species in a manner paralleling their degrees of acid tolerance. These findings contraindicate acidic deposition as a cause of recent amphibian population declines in the Sierra Nevada at high elevation. (Notice: Although the research described has been funded in part by the U.S. Environmental Protection Agency, it has not been subjected to Agency review. Therefore, it does not necessarily reflect the views of the Agency). [KEYWORDS: acidic deposition, Sierra Nevada, *Bufo canorus*, *Rana muscosa*, *Pseudacris regilla*].

Bradford *et al.*

S24

Isolation of remaining populations of the native frog, *Rana muscosa*, by introduced fishes in Sequoia and Kings Canyon National Parks, California.

DAVID F. BRADFORD[1], DAVID M. GRABER[2] AND FARINAZ TABATABAI[3]. [1]*U.S. Enviromnental Protection Agency, Environmental Monitoring Systems Laboratory, P.O. Box 93478, Las Vegas, Nevada 89193, United States of America.* [2]*National Park Service, Sequoia & Kings Canyon National Parks, Three Rivers, California, United States of America.* [3]*Environmental Science and Engineering Program, University of Calif., Los Angeles, California, United States of America.* *Rana muscosa* (Mountain Yellow-legged Frog) was eliminated by introduced fishes early in this century in many of the lakes and streams in Sequoia and Kings Canyon National Parks, California. In waters not inhabited by fish, however, *R. muscosa* has disappeared from many sites within the parks during the past 30 years, and appears to have gone extinct in some drainage systems. Fragmentation of populations may have caused or contributed to these recent extinctions because *R. muscosa* populations are dramatically more isolated from one another by fish at present than in pre-stocking conditions. A total of 312 lake-sites in 95 drainage basins were surveyed for amphibians and fish in 1989-90. For the 109 sites containing *R. muscosa*, we delineated networks of sites connected to one another via fishless streams, and we compared these present fishless networks ("present networks") to those expected for the same sites assuming fish had not been introduced to the parks ("former networks"). Most present networks consist of only one site (mean = 1.4), whereas the former networks average 5.2 sites. This difference represents approximately a 10-fold difference in connectivity of populations, which is defined as the mean number of potential dispersal links (i.e. fishless streams) per network. Connectivity averages only 0.43 in present networks in contrast to 4.15 in former ones. (Notice: Although the research described has been funded in part by the U.S. Environmental Protection Agency, it has not been subjected to Agency review. Therefore, it does not necessarily reflect the views of the Agency). [KEYWORDS: California, connectivity, fish, fragmentation, isolation, *Rana muscosa*].

Bradshaw & Bradshaw

S10

Environmental endocrinology of reproduction in two sympatric species of Australian desert agamids: the impact of resource variation. S. DON BRADSHAW AND FELICITY BRADSHAW. *Dept of Zoology, University of W.A., Perth, Western Australia 6009, Australia.* Patterns of breeding of two annual species of desert agamids were studied over a 7-year period in the arid Pilbara region of Western Australia in an attempt to identify proximate factors cueing their disparate reproductive modes. *Amphibolurus* (=*Ctenophorus nuchalis* is a regular vernal breeder (Sept–Oct) in the southern parts of its range where reliable winter rainfall stimulates insect abundance sufficient to sustain its reproductive effort. In the Pilbara region, however, winter rainfall is small and erratic and total rainfall reflects the influence of summer cyclones. *A. nuchalis* breeds in spring in the Pilbara in those years in which winter rainfall is substantial, but defers breeding until after the summer cyclonic rains in very dry years. The physiological condition of *A. nuchalis* in the spring of such years is depressed, suggesting that they lack resources needed to sustain a reproductive effort, but they show no obvious signs of stress. In years in which adequate winter rainfall has been followed by early cyclonic rains, the *A. nuchalis* population breeds continuously for a 6-month period from October until March of the following year. Although circulating levels of androgens also rise significantly in spring in the second species, *A. caudicinctus*, the gonads remain regressed and it displays an apparently inflexible pattern of

reproduction, breeding only following cyclonic rain in March–April each year. *Amphibolurus nuchalis* thus appears to be an opportunistic vernal breeder, limited only by the availability of resources, whereas *A. caudicinctus* shows a typical aestival pattern of breeding which appears uniquely attuned to the enormous burst of productivity occurring in this arid region following the substantial and predictable summer cyclonic rains. Although environmental temperature has often been seen as the primary factor determining reproductive cycles in reptiles, our study suggests that temperature is a necessary but not a sufficient condition for successful reproduction, and the availability and reliability of adequate resources to sustain the reproductive effort may have overriding significance, especially in arid habitats where rainfall may be highly unpredictable. [KEYWORDS: lizards, reproduction, sex hormones, seasons, resources].

Bräutigam & Broad

S27

International trade in reptiles and amphibians — conservation issues and opportunites. AMIE BRÄUTIGAM[1] AND STEVEN BROAD[2]. [1]*IUCN/SSC Trade Specialist Group, 219c Huntingdon Road, Cambridge CB3 0DL, United Kingdom.* [2]*TRAFFIC International, 219c Huntingdon Road, Cambridge CB3 0DL, United Kingdom.* The international trade in reptiles and amphibians bridges a wide spectrum of organsims, commercial sectors and markets and serves a variety of primarily commercial uses. The vast proportion of the trade involves three major commodities: skins for the exotic leather industry, live animals for pets and herpetoculturists, and live animals and animal products for food and traditional medicines. A smaller proportion of the trade, particularly in amphibians, is aimed at scientific and educational uses. Of these trades, that in reptile skins is the best-studied: although apart from crocodilians, its conservation implications are not well-known, it appears to hold the most promise for development in the context of sustaniable use regimes. The trade in live animals is much more problematic to assess in terms of both volumes and values as well as its conservation ramifications: it involves an enormous number of species, the conservation status of which ranges from very common to very rare in the wild, and very different consumer groups, some of which are investing considerable resources into captive breeding and research and others of which appear most interested in the profit margins the trade generates. Few sustainable management regimes, based on wild populations, are known to have been developed for reptile or amphibian species figuring in this live trade. Although to be desired, such programs would be limited by the paucity of data on basic demographic parameters: the vast majority of the species utilised in this trade are very poorly known. Finally, the trade for food and medicinals, which includes freshwater turtles, frog's legs, and lizards, urgently requires attention, as a number of species believed to be over-exploited for these markets, and the factors influencing these uses, human demography and cultural traditions, are much less tractable than those bearing on the other two trades. That these trades together are estimated to value in excess of US$ 500 million per year is sufficient reason for investment to be made into management for sustainability over the long term. This must include investigation of basic parameters of wild populations and population biology and experimentation with censusing and monitoring techniques aimed at evaluating the impacts of different levels of exploitation. [KEYWORDS: wildlife trade, reptile trade, crocodilians, snakes, freshwater turtles].

Briggs

C18

Comparable demography among populations of the firebellied toad (*Bombina bombina* L.) in Denmark. LARS BRIGGS. *Biological Institute, Odense University, Campusvej 55, DK-5230 Odense M, Denmark.* *Bombina bombina* is an endangered species in DK where it only lives on 8 isolated localities (small groups of ponds). The agricultural use of the areas surrounding these localities are very different. From 1988–1992 aspects of population dynamics and demography were investigated (survival, age, length-weight and migration measurements) on 6 of these localities. The main method used was the capture-recapture method, with a high capture precentage. 94% of the eggs developed into hatched tadpoles. Survival of hatched tadpoles to newly metamorphosed frogs varied with a factor 30 (0.2–6.1%) among ponds. Survival of newly metamorphosed frogs during the first fall and winter varied with a factor 14 (5–69%) between localities. Annual survival of juvenile (1 year) and adults varied with a factor 2 (50–95%) between localities. The annual migration of the main part of the frogs are less than 300 m. The frogs were able to colonise newly made ponds in a distance of 500–1200 m. In aspects of conservation the study shows that uncultivated and grazed areas had stable populations, a very high annual adult survival and a low tadpole survival. Cultivated areas had unstable populations and a low adult annual survival and occasionally a high tadpole survival. The extremely high annual adult survival of 90–95% compared to data from *Hyla*, *Rana* and *Bufo* that was found on 2 localities. The age of the oldest specimen was at least 12 years. [KEYWORDS: *Bombina bombina*, demography, survival, age, migration].

Broderick *et al.*

S18

Genetic studies of the hawksbill turtle (*Eretmochelys imbricata*): evidence for multiple stocks and mixed feeding grounds in Australian waters. D. BRODERICK[1], C. MORITZ[1], J.D. MILLER[2], M. GUINEA[3], R.J. PRINCE[4] AND C.J. LIMPUS[5]. [1]*Centre for Conservation Biology and the Zoology Department, University of Queensland, Queensland 4072, Australia.* [2]*Dept of Environment and Heritage, Pallarenda, Queensland 4180, Australia.* [3]*Dept of Biology, University of Northern Territory, P.O. Box 40146, Casuarina, Northern Territory, Australia.* [4]*Conservation and Land Management, Western Australia Wildlife Research Centre, Woodvale, Western Australia, Australia.* [5]*Dept of Environment and Heritage, PO Box 155, Queensland 4002, Australia.* The hawksbill turtle (*Eretmochelys imbricata*) is endangered and is currently declining in many parts of its global distribution. Efforts to manage the species, in particular to investigate the effects of harvesting, are hampered by the lack of knowledge on this species biology. An urgent need is to define appropriate geographic units of managements and to investigate the relationship between breeding populations and nearby feeding assemblages. The Australian populations are among the few remaining large rookeries in the world, but may be under threat from harvesting in neighbouring countries. We use patterns of mitochondrial DNA variation to determine the geographic scale of breeding populations and to compare the genetic composition of feeding populations to nearby rookeries. Four to the major Australian rookeries were sampled, two on the west coast and two in north-eastern Australia, as were turtles at two foraging sites. The majority of the variation among breeding populations was manifest as two divergent mitochondrial DNA types. Significant frequency differences separated the major rookeries samples along the north-east versus the west coasts of Australia demonstrating that these populations are not connected by

significant amounts of gene flow and should be considered as separate entities for management. There was no significant difference between the two western rookeries 100 km apart, nor between the two north eastern rookeries separted by 750 km. This indicates that the size of the interbreeding unit for the hawksbill turtle is likely to be a region consisting of a group of islands rather than an individual island. Feeding populations were screened with a gene amplification test that dicriminates between the two major DNA types. In each case there is a significant difference in allele frequency between feeding populations and the nearest major rookery. This, together with a long distance tag return, suggests that individual feeding grounds support hawksbill turtles from a distant beeding populations and is consistent with the migratory pattern reported on other marine turtles. This study is significant for management in that it demonstrates the existence of at least two separate breeding stocks in Australian waters and it argues against the assumption that harvesting of a feeding ground population will effect only the local breeding population. [KEYWORDS: hawksbill turtles, genetic tags, mt-DNA, management, migration].

Brown

S23

Transfer of Hamilton's frog *Leiopelma hamiltoni* to a newly created habitat on Stephens Island, New Zealand. DEREK BROWN. *Nelson-Marlborough Conservancy, Department of Conservation, 13 Mahakipawa Road, Havelock, Marlborough, New Zealand.* The endangered Hamilton's frog, *Leiopelma hamiltoni*, is confined to one small, severely modified habitat (600 m^2 rock-tumble) on Stephens Island. This habitat has become susceptible to climatic extremes through loss of vegetation cover. To enhance the population, estimated to be between 120 and 150 frogs, a new habitat was created in June 1991 in a nearby forest remnant 40 m from the rock-tumble, by excavation of pits and backfilling these with rocks. A predator-proof fence was built around the new habitat to exclude tuatara, *Sphenodon punctata*, and the area 'seeded' with invertebrate prey. Twelve adult frogs were transferred to the site in May 1992. Twenty one recaptures of 7 of the transferred frogs have been recorded throughout the past year, to June 1993. Recaptured frogs showed variable weight changes with a mean increase of 23% (range = 13% loss to 71% gain) from weight of transfer; only one showed a noticeable change in total length. Localised movements of up to 6.5 m (mean = 1.9 m) were recorded between recaptures. Individual frogs appeared to spend more time on the surface of rocks in the new habitat than in the original habitat. Breeding at the new site has yet to be confirmed. [KEYWORDS: *Leiopelma hamiltoni*, habitat creation, species transfer, conservation, Stephens Island].

Brown

C18

Structure of a metapopulation in a North American pit viper, *Crotalus horridus*. WILLIAM S. BROWN. *Dept of Biology, Skidmore College, Saratoga Springs, NY 12866, United States of America.* In mountainous terrain near its northern range limits, the timber rattlesnake has been sampled by mark-recapture during the past 11 years at a series of nine communal overwintering dens spanning a N-S linear distance of 11 km. Sampling has yielded > 2300 total captures and 23–299 recaptures per den indicating a large range of den sizes within the metapopulation. Shifts (den interchanges) are entirely possible as the maximum interden distance is 3.5 km and as seasonal migrations of 2–4 km are typical. Shifts from one den to another totalled 11 per 1033 recaptures, or 1.06% of total recaptures. A shift rate of 9.7 × 104 shifts/recapture/yr

provides a measure of strong behavioural fidelity, long suggested by research on denning snake populations. Mating has been observed in late summer > 1 km from the nearest dens. A cline in colour morph ratios and slight differences in sex ratios are evident. In this long-lived species, "patchy population" and "core-satellite" metapopulation models may describe much of its distribution. [KEYWORDS: metapopulation, den shifts, *Crotalus horridus*].

Bruce

S14

Population dynamics and life-history evolution in desmognathine salamanders. RICHARD C. BRUCE. *Dept of Biology, Western Carolina University, and Highlands Biological Station, Highlands, North Carolina 28741, United States of America.* Communities of desmognathine salamanders in the Appalachian Mountains may contain three to six species of the genera *Desmognathus* and *Leurognathus*. The species sort by body size along an aquatic to terrestrial habitat gradient; the larger species are more aquatic and the smaller more terrestrial. There are additional correlations involving several life-history features. To examine relationships among body size, growth, age at maturation, survival, and longevity in *Desmognathus*, I have used temporary removal sampling over five years (1989–93) to generate life tables of two of the species, *D. monticola* and *D. ochrophaeus*. The two main objectives were (1) to test the long-standing hypothesis that the smaller, more terrestrial species (*D. ochrophaeus*) has higher survival than the larger, more aquatic species (*D. monticola*), and (2) to determine if adult body size differences are consequences of differences in hatching size, growth, age at maturation, longevity, or some combination of these factors. Results to date have shown that *D. monticola* has later maturation, higher survival, and greater longevity than *D. ochrophaeus*. Both species have stable populations and age structures. It is expected that additional data from life table evaluations will allow a reinterpretation of the relationship between life history evolution and population dynamics in these and other desmognathines. [KEYWORDS: *Desmognathus*, life history, population dynamics, salamanders].

Bruce *et al.*

S04

Lung reduction in amphibian larvae as an adaptation to flowing water. RICHARD C. BRUCE[1], CHRISTOPHER K. BEACHY[1], PAUL G. LENZO[1], SCOTT P. PRONYCH[2] AND RICHARD J. WASSERSUG[2]. [1]*Dept of Biology, Western Carolina University, and Highlands Biological Station, Highlands, North Carolina 28741, United States of America.* [2]*Dept of Anatomy & Neurobiology, Dalhousie University, Halifax, Nova Scotia B3H 4H7, Canada.* Lung reduction in stream-dwelling amphibian larvae has traditionally been explained as an adaptation to reduce buoyancy and minimise downstream displacement. A recent, alternative hypothesis of the evolution of lunglessness in plethodontid salamanders prescribes a terrestrial origin of lung loss. We have conducted an experimental test of the relationship between lung development and displacement by a stream current in an ambystomatid salamander, *Ambystoma maculatum*. Larvae raised without access to air developed significantly smaller, more solid lungs than control larvae raised with access to air. The two groups did not differ in snout-vent length, but experimental larvae were heavier than controls. When subjected to a water current in an artificial stream, larvae with reduced lungs were significantly better able to resist downstream displacement than those with unreduced lungs. The results support the hypothesis that lung reduction in amphibian larvae is an adaptation

to reduce buoyancy in streams. [KEYWORDS: *Ambystoma maculatum*, lungs, salamander larvae, streams].

Buhlmann

C34

Conservation strategies for rare freshwater turtles in Virginia, USA. KURT A. BUHLMANN. *Savannah River Ecology Laboratory, University of Georgia, P.O. Drawer E, Aiken, South Carolina 29802, United States of America.* Two species of freshwater turtles in Virginia require innovative conservation plans to insure their long term preservation. *Clemmys muhlenbergii* populations generally consist of less than 20 adults and inhabit small wetlands (1–2 ha) that are distributed along low areas bordering streams. Preservation of individual wetlands alone is unlikely to provide long term protection due to small effective population sizes, lack of dispersal corridors, and the processes of natural succession. Conservation efforts must focus on entire drainage basins rather than individual wetlands. *Deirochelys reticularia* inhabits isolated, remnant, interdunal pond habitats. Contemporary habitat has been reduced from historical based on aerial photo analysis. Natural history studies indicate that the population is small and radiotelemetry studies indicate that terrestrial movements exceed the remaining suitable habitat. Management decisions must be made concerning habitat manipulations and re-introductions. Viable conservation plans must incorporate historical distribution data and utilize aerial photography and geographic information systems. In order for these conservation plans to become reality, the general public and policy makers need to be educated about conservation needs and convinced of their necessity.

Bull

S14

Population dynamics in the Australian sleepy lizard, *Tiliqua rugosa*. C. MICHAEL BULL. *School of Biological Sciences, Flinders University, GPO Box 2100, Adelaide, South Australia, Australia.* The Australian sleepy lizard, *Tiliqua rugosa*, is a large, herbivorous, viviparous skink. A study of this species has been conducted from 1982–1992 along road transects at a semi-arid site near Mt Mary, South Australia. Data from over 20,000 random encounter captures of individually marked lizards have been used to determine population density and dynamics. The species is long lived, taking at least three years to reach maturity, and with a life span exceeding ten years. There is substantial spatial variation in population density. Population size has also followed in the 1982–83 drought, but has since climbed to a stable 2–3 per ha. Females have an average two young per clutch, but do not breed each year. The heavy mortality of juveniles over their first winter is a major factor preventing rapid population growth. [KEYWORDS: lizard, population size, Australia].

Burgin

C07

The reptile connection: Gondwana and the Australian garden. SHELLEY BURGIN. *School of Science, University of Western Sydney-Hawkesbury, Richmond, NSW 2753, Australia.* This presentation concentrates on the relationships within and among lizards of the genera *Lampropholis*, *Saproscincus* and their relatives. Despite a large amount of morphological overlap, a significant degree of genetic diversity was observed. However, electrophoretic analyses indicated that rates of evolution in some instances were very slow, for example 10% between *Lampropholis amicula* and *Lampropholis caligula*, despite available evidence (e.g. ecological, karyotype and zoogeographical information) indicating that they have been separated for a substantial time. When the results of the electrophoretic analyses were correlated with mirco-complement

fixation data and the relationships within the *Eugongylus* investigated, a Gondwanan origin was hypothesised. This is because representative skink taxa from Australia, New Zealand and New Guinea were observed to be equidistant from the Australian genera of *Lampropholis* and *Saproscincus* (e.g. 29–82 unidirectional immunological distance — UID), as was the South-East Asia genus *Mabuya* (e.g. 65 UID between antibodies of *Lampropholis guichenoti* and *Mabuya multifascata*). [KEYWORDS: *Eugongylus*, *Lampropholis*, *Saproscincus*, Gondwanan origin, electrophoresis, micro-complement fixation].

Bush S25

The amateurs' role in education: dispelling the modern myth. BRIAN BUSH. *9 Birch Place, Stoneville, Western Australia 6081, Australia.* All respective state and territory wildlife authorities allow the killing of snakes if a person considers it a threat (pers. corres.). Simultaneously all states except Tasmania recognise snakes as fauna. Statistically less people in Australia die of snakebite than do as a result of horse-riding accidents. We would not condone the killing of a horse if a person believes it to be a threat. In that situation the person, if sensible would move away. Why then do we allow the wildlife authorities to condone the killing of snakes? Is it because we have continued to foster the myth that Australia has the deadliest snake in the world, a myth that has arisen because of our lack of other dangerous animals. Government and public attitudes towards snakes have to be changed before a serious program of conservation can be initiated. The following discussion is an attempt to look at this problem objectively, something that has been missing in the past.

Bush SS

Problems with successful double clutching in captive gwardars, *Pseudonaja nuchalis* (Serpentes, Elapidae). BRIAN BUSH. *9 Birch Place, Stoneville, Western Australia 6081, Australia. Pseudonaja nuchalis* from the south-west of Western Australia display considerable sexual size dimorphism: females are much more slender than similar length males. Also there is a sexual behaviour dichotomy observed in wild caught adults maintained in captivity: males are unintimidated and feed voraciously while females are very timid and feed sparingly. This species double clutches laying a second about 45 days after the first. Its small size and timidity are believed responsible for the lack of success experienced by this breeder in obtaining viable second clutches. To date the only successful second clutch obtained is from a captive raised female collected as a hatchling. The eggs in all other second clutches recorded were not fully developed.

Buttemer S13

Cutaneous spectral reflectance and transmittance characteristics of selected *Litoria* species. WILLIAM A. BUTTEMER. *Dept of Biological Sciences, Univ. of Wollongong, Wollongong, NSW 2500, Australia.* The dorsal skin of several Australian *Litoria* species is unusual in matching the spectral reflectance of green leaves both at visible (400–700 nm) and at near-infrared (near-IR; 700–900 nm) wavelengths. Such extended colour matching would provide effective crypsis from avian and reptilian predators that are able to discriminate near IR radiation. In addition, both green *Litoria* and green leaves show a sharp rise in spectral reflectance at 650 to 700 nm; a spectral pattern also observed in avian eggs. In the latter, this pattern results from the inherently high reflectivity of eggshells in combination with the deposition of non-melanin shell pigments (e.g. protoporphyrin and bilins) which are transparent to near-IR wavelengths.

Interestingly, the green Australian tree frogs which show high near-IR reflectance are among the few vertebrates to lack melanin in their melanophores. The melanophores of these frogs instead contain pterorhodin which, unlike melanin, is nearly transparent to wavelengths above 600 nm. Those *Litoria* species having cutaneous melanin do not show a pattern of high near-IR reflectance. Pterorhodin, however, is much less effective at absorbing ultraviolet (UV) radiation than is melanin. Thus, the extended spectral range of crypsis found in frogs lacking melanin may be associated with greater UV penetration through their skin. Cutaneous spectral transmittance and reflectance values will be presented for selected *Litoria* species to show the effects of melanophore pigment type on UV cutaneous penetration. [KEYWORDS: spectral reflectance, near-infrared radiation, UV radiation, colour-matching].

Bywater C15

Sensitivity of some northern Australian floodplain biota, including the tree frog *Litoria dahlii*, to a herbicide, glyphosate 360. JOHN F. BYWATER. *Environmental Laboratory, Energy Resources of Australia Ltd, Ranger Mine, Jabiru East, Northern Territory 0886, Australia.* The toxicity of Glyphosate 360 to a frog, *Litoria dahlii*, a fish, *Melanotaenia splendida inornata*, a cladoceran, *Moinodaphnia macleayi*, and an hydra, *Hydra viridissima*, was assessed under laboratory conditions. The results show a range of sensitivities.

Cabral-Perdomo *et al.* C06–032

The southernmost record of Cretaceous pterosaurs in North America. MIGUEL ANGEL CABRAL-PERDOMO, SHELTON P. APPELGATE AND FRANCISCO SOBERÓN-MOBARAK. *Depto de Paleontologia, Instituto de Geologia, UNAM, Circuito Exterior, C.U. Deleg. Coyoacán, 04510, Mexico, D.F. Mexico.* The southernmost evidence of Cretaceous pterosaurs in North America has been found in the laminated limestone quarries of Tlayúa (Albian age) in Tepexi de Rodriguez, Central Mexico. From these rocks, we have collected and identified 10 isolated bones: a humerus and a femur, which we can refer to the gigantic genera *Nyctosaurus* and *Pteranodon*. The rest of the specimens are smaller in size and consist of fragments and complete phalanxes from digit V, metacarpals and a fragment of a pteroid bone. All these elements are under study, in order to establish their relationships with other New World's pterodactiloids, like those from the Santana Formation in Brazil. If this is the case, this part of North America was a coexistence point of these two groups of pterosaurs. [KEYWORDS: Cretaceous, Albian, Tlaya, pterosaur, femur, scapulocoracoid, metacarpals, phalanxes, pteroid].

Caldwell S20

Foraging strategies of larval dendrobatid frogs. JANALEE P. CALDWELL. *Dept of Zoology and Oklahoma Museum of Natural History, University of Oklahoma, Norman, OK 73019, United States of America.* Poison frogs of the family Dendrobatidae are unusual in many respects. They deposit small terrestrial egg clutches, which are tended by one of the parents. After hatching, tadpoles are transported on the back of the parent frog to an aquatic site where they undergo the remainder of their development. In the genera *Dendrobates* and the closely related *Minyobates*, tadpoles are frequently deposited in small phytotelmata, such as bromeliads, fruit husks, or leaf axils. Anecdotal reports on observations indicate that some species (*D. castaneoticus*, *D. auratus*, *M. minutus*) are predaceous and feed on mosquito larvae or other macro-invertebrates in these small containers. Preliminary observations of tadpoles of

D. auratus from Nicaragua revealed that these tadpoles readily capture and feed on mosquito larvae. Using two sizes of mosquito larvae, I conducted a series of experiments to determine (1) if tadpoles preferred large or small mosquito larvae; (2) the handling time for these two prey types; and (3) how many of each size were killed during a specific time period. Although handling for the small larvae was approximately one minute, that of the large larvae was longer than one hour, and consisted of many short feeding bouts. Of tadpoles fed *ad libitum* on rabbit chow, 55% killed from 2 to 5 large mosquito larvae within a three-hour period and usually consumed only small portions of these. Tadpoles share their habitat with several species of predaceous insect larvae (giant damselflies in the family Pseudostigmatidae, dragonflies, and mosquitoes in the genus *Toxorhynchites*). I hypothesise that these tadpoles engage in wasteful killing in order to eliminate insect larvae from their habitat before the insect larvae grow large enough to become predators on the tadpoles themselves. [KEYWORDS: foraging, amphibians, dendrobatids, tadpoles, ecology].

Callard *et al.*

S10

External and internal environmental cues and the regulation of reptilian vitellogenesis. IAN P. CALLARD[1], D. STEPHEN CHARNOCK-JONES[2], MARINA PAOLUCCI[1] AND GEORGIA GIANNOUKOS[1]. [1]*Dept of Biology, Boston University, 5 Cummington St., Boston, MA 02215, United States of America.* [2]*Dept of OBGYN, Cambridge University, Cambridge CB2 2SW, United Kingdom.* Environmental signals provide cues for appropriate levels of gonadal function and growth as determined by circulating steroid levels, growth and ovulation. At the cellular and molecular levels, steroids co-ordinate vitellogenesis and reproductive tract growth to ensure egg development and processing. We will focus on steroid-receptor interactions in the regulation of vitellogenesis in oviparous and viviparous species. We have shown that estogen/progesterone (E/P) ratios vary during the reproductive cycle and differ in egg- laying versus live-bearing species. Yolk protein deposition in oocytes is directly related to the induction of the vitellogenesis gene and its transcription; and, in turn, these processes depend on the relative amounts of E and P since E is stimulatory and P inhibitory to vitellogenin gene expression. Thus, the interplay between the steroids and their hepatic receptors in the regulation of the vitellogenin gene(s), ultimately determines the accumulation of vitellogenin by oocytes and modulates appropriate patterns of follicular development in egg laying and live-bearing species. [Supported by NIH R01 RR06633 to IPC]. [KEYWORDS: steroids, vitellogenesis, turtle].

Callister *et al.*

S04

Neuromuscular strategies underlying the control of head retraction in the turtle. ROBERT J. CALLISTER[1], ROBIN CALLISTER[2] AND ELLENGENE H. PETERSON[3]. [1]*Neuroscience Group, Faculty of Medicine, University of Newcastle, Callaghan, NSW, 2308, Australia.* [2]*Discipline of Human Physiology, Faculty of Medicine, University of Newcastle, Callaghan, NSW, 2308, Australia.* [3]*Dept of Biological Sciences, Ohio University, Athens, Ohio, 45701, United States of America.* A central issue in the study of motor control is how animals vary the force, timing and geometry of their movements. We are addressing this question using the head retractor muscle (RCCQ) in the turtle, *Pseudemys scripta elegans*, as a model. RCCQ consists of four successively longer bellies that extend from the caudal carapace to cervical vertebrae 4–6 and the skull. Each belly is composed of three histochemically defined fibre types: slow oxidative (SO), fast oxidative glycolytic (FOG) and fast glycolytic (Fg). Single muscle fibres in RCCQ exhibit an order of magnitude variation in length (4–60mm), with over 40% spanning the muscle length. Almost all the remaining fibres attach to bone or tendon at one end and the other end tapers intramuscularly. The diameters of muscles fibres are bimodally distributed and form two diameter classes. The large diameter class is composed almost exclusively of Fg fibres, which account for over 60% of the fibres in RCCQ, and are generally longer and have short blunted tapering regions. In contrast, small diameter fibres are composed of all three fibre types, tend to be short, and taper gradually over a large fraction of their total length. Three of the four bellies are innervated by multiple segmental nerves and the intramuscular territories of these nerves are separated rostrocaudally within the muscle belly. Thus, long muscle fibres cross the territories of two or more segmental nerves. Each muscle fibre bears 2–14 evenly spaced (approx. 5 mm) motor endplates along its length. Thus, all single fibres in RCCQ are multiterminally innervated and long fibres are multisegmentally innervated. Application of neuronal tracer (horseradish peroxidase) to individual segmental nerves revealed that the axons of each segmental nerve arise from motor neurons in different spinal segments. Together, these data suggest that single muscle fibres in RCCQ are histochemically as well as architecturally specialised for generating different movement profiles. Small diameter fibres appear best suited for the control of ongoing head movements requiring low forces during behaviours such as feeding and exploration. In constrast, large diameter fibres are specialised for producing rapid, phasic head retraction during the turtle escape response. In addition, the results of this study raise questions about the neural control mechanisms within the spinal cord that coordinate recruitment of motor neurons innervating rostral and caudal ends of long muscle fibres in RCCQ. [KEYWORDS: motor control, muscle mechanics, startle response, motor neurons, neck muscle].

Campbell *et al.*

C09

Elimination of the brown tree snake (*Boiga irregularis*) in small plots. EARL W. CAMPBELL III[1], GORDON H. RODDA[2], AND THOMAS H. FRITTS[3]. [1]*Ohio Coop. Fish and Wild. Res. Unit, The Ohio State University, 1735 Neil Ave., Columbus, Ohio 43210, United States of America.* [2]*National Biological Survey, National Ecology Research Center, 4512 McMurry Ave., Ft. Collins, Colorado 80525-3400, United States of America.* [3]*National Biological Survey, National Museum of Natural History, Washington DC 20560, United States of America.* While it is presently not practical to eliminate introduced populations of the Brown Tree Snake on Guam, it may be possible to control this species on a smaller scale. Snake densities in an area can be lowered if resident snakes are removed and dispersal into the site is eliminated. Recent developments in trap and barrier technology have made this practical in small forested areas on Guam. Record advances in capture technology have yielded capture rates that exceed 10% of the population per night (in one case a sustained rate of 28%). Eighteen months were spent testing 18 different fencing designs and a 1.1 m high, five wire alternately charged electrified netting fence was found to have no snake escapes. We have constructed two 1 ha snake exclosures using electrical fencing designed to exclude Brown Tree Snakes. Snakes are being eradicated from these exclosures using a combination of hand capture, trap capture, and natural emigration over the barrier (which snakes can climb from the inside only). Lizard, bird, rat and snake populations

are being monitored in two control plots and the two snake exclosures and to evaluate the effect of predator removal on prey populations. If practical, snake-free and snake-reduced sites could be used to reduce the extralimital spread of the Brown Tree Snake and provide habitat for endemic wildlife on Guam which has declined or disappeared as a result of predation by the Brown Tree Snake. [KEYWORDS snake exclosures, predator/prey interaction, electric barriers, snake trapping, brown tree snake, *Boiga irregularis*, Guam].

Camper & Hanks

C08

Variation in the nucleolar organiser region in North American snakes with comments concerning chromosomal evolution in snakes. JEFFREY D. CAMPER[1] AND BRIAN G. HANKS[2]. [1]*Dept of Biology, Austin College, Sherman, TX 75091-1177, United States of America.* [2]*Dept of Wildlife & Fisheries Sciences, Texas A&M University, College Station, TX 77843, United States of America.* The chromosomal nucleolar organiser regions (NORs) of 20 species of North American snakes were examined using the silver nitrate staining method. The karyotype of *Boa constrictor* (2n=36) had a single microchromosomal pair of NORs. Karyotypes of five species of natricines, all 2n=36, contained a single pair of NORs located terminally on the long arm of the second largest pair of chromosomes with one specimen of *Thamnophis proximus* containing an additional pair on chromosome 18. A single microchromosomal pair of NORs was found in eight species of colubrines and three species of xenodontines, all 2n=36. The colubrines, *Bogertophis subocularis* (2n=40) and *Salvadora grahamiae* (2n=36), had a single pair located terminally on the long arm of the second largest pair of chromosomes. The pitviper, *Agkistrodon contortrix* (2n=36), had NORs located terminally on the fourth largest pair of chromosomes. These data and published data on secondary constrictions will be used to infer chromosomal evolution among snakes. [KEYWORDS: chromosomal evolution, NORs, cytosystematics, snake systematics].

Cannatella

S04

Phylogenetic aspects of feeding and respiration in tadpoles. DAVID C. CANNATELLA. *Texas Memorial Museum, 2400 Trinity, University of Texas, Austin, Texas, United States of America.* Both the tadpoles and adult life-stages of frogs are striking in the degree of morphological divergence from other amphibians. One of the most striking features of tadpoles is the suite of characteristics associated with the re-orientation of the jaw suspension apparatus, which is involved in both feeding and respiration. These caenogenetic modifications represent subterminal additions of new states to the ontogenetic sequence. Morphological variation among the larvae of basal anurans (*Ascaphus*, *Leiopelma*, *Bombina*, *Discoglossus*, etc.) makes the reconstruction of the ancestral morphology of the larva of Anura difficult. Within frogs, the larvae of pipoid frogs have been regarded by some workers as primitive. Phylogenetic analysis indicates that the apparent plesiomorphy of pipoid larvae is due to the loss of caenogenetic features, producing reversals that resemble the plesiomorphic condition in salamanders. [KEYWORDS: tapoles, feeding, respiration, evolution, functional morphology].

Carey

C32

Role of stress in amphibian declines and extinctions. CYNTHIA CAREY. *Dept of EPO Biology, University of Colorado, Boulder, CO 80309, United States of America.* Considerable interest has recently been generated concerning the world-wide decline or extinction of amphibian populations. No causes have yet been conclusively been

identified, though many correlative observations exist. The presence of disease in declining population of *Bufo boreas boreas* in the Rockies of western Colorado is used on conjunction with data from the literature to formulate a working hypothesis to explain the decline and extinction of this group throughout most of its former range. The hypothesis is: some environmental factor or synergistic interaction of more than one factor have changed sufficiently to cause sublethal stress to amphibians. This stress directly causes immunosuppression or indirectly causes immunosuppression by effecting elevated secretion of adrenal cortical hormones. Immunosuppression, coupled with the apparent debilitating effect of cold body temperatures on the abilities of immune systems of ectothermic animals to fight disease, leads to infection by *Aeromonas* or other infectious agents, and subsequent death of individuals and extinction of populations. Immune characteristics of amphibians in the laboratory are measured with differential cell counts and responses of mixed lymphocyte cultures to mitogens (chemicals that stimulate cell division). Handling, rapid changes in pH, dehydration, pesticides, heavy metals, UV light are all factors that could cause immunosuppression. Even toe-clipping or blood sampling could cause sufficient stress on field-caught animals that such perturbations could drive a population extinct. [Supported by: National Science Foundation (IBN-9201396), Declining Amphibian Population Task Force, and American Philosophical Society.] [KEYWORDS: immunosuppression, *Bufo boreas*, stress, adrenal cortical hormones].

Carmel

S26

Preventative health care for captive reptiles. BRENDAN P. CARMEL *WildVet (Coldstream), P.O. Box 626 Lilydale, Vic. 3140 Australia.* A preventative program for captive reptiles centres on correct quarantine and record taking procedures. If properly instituted, such a program will minimise the risk of introducing disease into a reptile collection and enables a rapid detection and response to illness. An outline of the major considerations for a preventative health program is provided. Emphasis will be on quarantine procedures, tests to screen pathogens, and record taking. [KEYWORDS: reptiles, preventative care, husbandry, disease].

Carter

C22

A novel reproductive strategy by a monitor lizard. DAVID B. CARTER. *Australian Nature Conservation Agency, PO Box 119, Yulara NT 0872, Australia.* Results of a three year study into reproduction by the lace monitor *Varanus varius* in southeastern Australia reveal a novel strategy involving elements of parental care and parasitism on termite mounds. The ovarian cycle of female lace monitors follows the consistent pattern of most temperate oviparous squamates. Vitellogenesis begins in early spring following a period of winter quiescence. Ovulation occurs in late spring and eggs are laid in early summer. Nests were found only within the central nursery of a termite mound, protected by the hard inner casing. Eggs overwinter in the mounds and hatch after about 290 days of incubation. All hatched nests were found to have burrows dug by adult goannas leading from the surface of the mound to the nest. The following descriptive model of the reproductive strategy of lace monitors is proposed. After the winter recess females begin vitellogenesis during spring when food is plentiful. Eggs are laid in summer in termite mounds where they are housed in a safe, warm environment. The female has no further responsibilities towards the brood until they hatch nine months later. Then she returns to the nest and digs a tunnel to release the young. This strategy appears to retain the relatively lower energetic costs of ovipary and ob-

tain the benefits of higher investment strategies like vivipary or parental care with a very small additional investment (burrowing into the mounds). The key is a form of parasitism on termite colonies.

Cartland & Grimmond

C06–034

The effect of temperature on the metabolism of juvenile tuatara, *Sphenodon punctatus*. LINDA K. CARTLAND AND NICOLA M. GRIMMOND. *Dept of Zoology, University of Otago, PO Box 56, Dunedin, New Zealand.* Resting metabolic rates of juvenile tuatara were measured when they were one and two years old. Metabolism was found to be significantly affected by ambient temperature over a range from 5–22.5°C. The younger, smaller animals had higher rates of metabolism than the older and larger of the juveniles, being significant at the lower and higher experimental temperatures. There is evidence of a compensatory, temperature- independent metabolic decline in the two year old tuatara in the mid-temperature range, i.e. between 15 and 20°C, which is similar to that found in other cool temperate reptiles. The mass-specific metabolic rates of juvenile tuatara are high when compared with a small data sample of metabolic rates for adult tuatara, but are quite closely comparable with some small New Zealand lizards. [KEYWORDS: metabolism, temperature, juvenile, tuatara].

Cartland *et al.*

S23

Nutrition and stress in wild and captive juvenile tuatara (*Sphenodon punctatus*). L.K. CARTLAND[1], C. TYRRELL[1], A. CREE[1], N.M. GRIMMOND[1], C.M. SKEAFF[2] AND W.H.F. SUTHERLAND[3] [1]*Dept of Zoology, University of Otago, Box 56, Dunedin, New Zealand.* [2]*Dept of Human Nutrition, University of Otago, Box 56, Dunedin, New Zealand.* [3]*Dept of Medicine, University of Otago, Box 56, Dunedin, New Zealand.* Current management of tuatara (*Sphenodon*) includes captive rearing of more than 200 juveniles. However, despite attempts for over 100 years, no captive-bred tuatara have yet reproduced. We hypothesised that poor growth and survivorship in captive juvenile tuatara could be due to improper nutrition and/or chronic stress (activation of adrenal axis). We compared plasma concentrations of lipids (cholesterol and triacylglycerol) and corticosterone (B) in wild juvenile *Sphenodon punctatus* on Stephens Island and captive juveniles in New Zealand zoos. No significant seasonal variation in plasma cholesterol or triacylglycerol (TAG) concentrations was found for captive or wild juvenile tuatara. Mean concentrations of cholesterol and TAG were 3–5 times higher in captive juvenile tuatara than in wild juveniles in the same month ($P < 0.001$). As there are known differences between the diets of wild and captive tuatara, these results indicate a nutritional basis to the growth problems of captive juvenile tuatara. There were no seasonal variations in plasma B in wild males, whereas there were variations in wild females and in the captive males and females ($P < 0.05$). In the two months compared (February and August), there was no difference in plasma B between wild and captive juvenile males. In captive females, mean concentrations were almost twice those in wild females in February ($P < 0.05$), but there was no difference in August. These results show that captive juveniles are not continuously suffering from chronic stress and therefore growth problems are probably not corticosterone-related. Nutrition, rather than chonic stress, appears to be a major factor in the abnormal growth and survivorship of juvenile tuatara in captivity. [KEYWORDS: captive breeding, cholesterol, corticosterone, juvenile, *Sphenodon*, triacylglycerol, tuatara].

Casares *et al.*

C06– 035

Faecal steroid measurements in chelonian species. M. CASARES[1], M. DÖBELI[2], A. RÜBEL[3], R.E. HONEGGER[3] AND E. ISENBÜGEL[1]. [1]*Dept of Zoo Animals and Exotic Pets, University of Zürich, 8057 Zürich, Switzerland.* [2]*Dept of Theriogenology, University of Zürich, 8057 Zürich, Switzerland.* [3]*Zürich Zoological Garden, 8044 Zürich, Switzerland.* Faecal steroid hormones were measured in order to monitor the reproductive function in both males and females of several chelonian species: Galapagos Giant tortoise (*Geochelone elephantopus*) (n=4), Aldabra Giant tortoise (*G. gigantea*) (n=6), spur-thighed tortoise (*Testudo graeca*) (n=4) and Hermann's tortoise (*T. hermanni*) (n=8). In females the hormone levels were correlated with ultrasound imaging. Steroid hormones are excreted through the gut or kidney and are found in the excreta as specific and identifiable metabolites of their respective parent compounds. Individual faeces samples were collected routinely from *Geochelone* spp. for 1 year and from *Testudo* spp. for 4 months (June–September) prior to hibernation. Testosterone (T), oestradiol-17β (E2) and oestrone (E1) were measured in both sexes by radioimmunoassay (RIA). In females pregnanediol-glucuronide (PdG) was also quantitated. Initially the samples were lyophilized to make allowance for their variable water content. Due to the heterogeneity of the faeces, a special mechanical treatment was necessary to obtain the final faecal powder. The steroids were isolated by extraction of the conjugates, enzymatic hydrolysis and selective extraction before performing the assay. Otherwise, PdG was measured directly as the conjugated form without hydrolysis and extraction. In the presented data, a high variability in the faecal steroid content and a considerable difference between the individual profiles were found. Between August and September, E1 increased during the development of the follicles in 4 of 6 *Testudo* spp. females and 2 of these showed simultaneous surges of both E1 and E2. From August to September E1, E2 and T rose simultaneously in 3 of 6 *Testudo* spp. males. From March to May PdG, E1 and T increased in the 4 *Geochelone* spp. females. E2 surged in 2 *G. gigantea* females between April and May and 1 animal showed a further surge in October. (Supported by the Swiss National Foundation, Project No. 831-29970.90). [KEYWORDS: tortoises, sex steroid, faeces, reproduction].

Casares *et al.*

S26

Long term ultrasound scanning of reproductive patterns in female tortoises (*Testudo* spp. and *Geochelone* spp.). M. CASARES[1], A. RÜBEL[3], M. LANG[3], R.E. HONEGGER[2] AND E. ISENBÜGEL[1]. [1]*Dept of Zoo Animals and Exotic Pets, University of Zürich, 8057 Zürich, Switzerland.* [2]*Zürich Zoological Garden, 8044 Zürich, Switzerland.* [3]*Dept of Theriogenology, University of Zürich, 8057 Zürich, Switzerland.* Long-term ultrasound scanning was used to identify and measure developing, preovulatory, and atretic follicular structures, as well as eggs at various stages of albumin secretion and shell deposition, in 1 Galapagos Giant tortoise (*Geochelone elephantopus*), 3 Aldabra Giant tortoises (*Geochelone gigantea*), 4 spur-thighed tortoises (*Testudo graeca*) and 2 Hermann's tortoises (*Testudo hermanni*). All procedures were accomplished without anesthesia or fasting prior to the examination. The Mediterranean tortoises (*Testudo* spp.) were manually restrained. For the examination of the giant tortoises a cooperative posture of the animal was obtained with a technique of tactile stimulation, without the necessity of using restraining procedures. After a few examinations the animals became accustomed and therefore more tranquil (specially the giant tortoises) during the procedure. The diameter of the largest size class of follicles of

Testudo spp., just before hibernation, ranged from 16 to 20 mm. Freshly-ovulated ova were detected sonographically in two *T. hermanni* 19 and 21 days after waking from hibernation, resulting in one clutch of eggs each 39 and 37 days later, respectively. One *G. elephantopus* (in Zürich Zoo since 1946) laid two clutches of eggs 34 and 41 days after soft-shelled oviductal eggs were detected, and developed normally. The new clutches of forming eggs of *G. elephantopus* were visible 1 and 9 days after the preceding clutch was laid. Diameter of preovulatory follicles reached 22 mm in *T. hermanni* and 42 mm in *G. elephantopus*. No eggs have been produced by *G. gigantea* during their stay in Zürich Zoo (one since 1955, two since 1984) although follicles of 38–40 mm are frequently observed in two animals. (Supported by the Swiss National Foundation, Project No. 31-29970.90). [KEYWORDS: tortoises, ultrasonography, reproduction].

Castanet *et al.*

C06–036

Age estimation in desmognathine salamanders (Plethodontidae) assessed by skeletochronology. JACQUES CASTANET[1], HÉLÈNE FRANCILLON-VIEILLOT[1] AND RICHARD C. BRUCE[2]. [1]*Lab. Anatomie Comparée, Université Paris 7 & URA CNRS II 37, 2, pl. Jussieu, 75251 Paris, France.* [2]*Dept of Biology, Western Carolina University, and Highlands Biological Station, Highlands, North Carolina 28741, United States of America.* Bone growth marks (LAGs), presumably annual, were analysed in cross sections of the femoral diaphysis of three species of *Desmognathus* from southern Appalachian Mountain populations. In 100 *D. quadramaculatus* of all size groups, including larvae, LAGs were well defined. The largest larva showed three LAGs, confirming earlier studies that in this population larvae may spend at least 3 years before metamorphosis. There is no clear LAG linked to this event, but in adults some of the first LAGs may be resorbed requiring a back calculation for the final age estimation. Growth reached a plateau at 9–10 years, and the oldest individual was at least 13 years. Taking into account the pattern of LAG deposition, sexual maturity was not reached before 6–7 years. In *D. monticola* and *D. ochrophaeus* LAGs are more difficult to read. In both species larvae spend one winter before metamorphosis, corresponding to one LAG in most. No metamorphic LAG can be deciphered and no more than two LAGs are lost in adults. In a sample of 92 *D. monticola*, 83 were accurately aged. Sexual maturity was reached at 4–5 years. Growth reached a plateau at 8–9 years and the oldest, a male, was 11 years. For 87 *D. ochrophaeus* the oldest individuals were 7–8 years. Skeletochronology is more difficult in Plethodontidae than Salamandridae; nevertheless, in desmognathines, bone growth mark analysis can be used to separate age groups and provide estimates of longevity. It is especially valuable for aging mature individuals where age classes overlap in size. [KEYWORDS: age estimation, Desmognathinae, longevity, salamanders].

Cayot

C06–038

Genetic studies of reptiles in the Galapagos Islands. LINDA J. CAYOT. *Charles Darwin Research Station, Casilla 17-01-3891, Quito, Ecuador.* In 1992, a Galapagos Reptile Genetics Group was established to coordinate the various studies in the Achipelago, to facilitate cooperation among researchers, and to coordinate the research with the management of the Galapagos National Park Service. Current studies include: determination of the taxonomic relationships among the subspecies of Galapagos giant tortoises (*Geochelone elephantopus*); an analysis of the genetic variability within and between populations of tortoises; and molecular differentiation of the Galapagos iguanines on the islands as well as their phylogenetical relationship to mainland species. Results from these studies will be incorporated into the conservation and management programs of the Galapagos National Park Service and the Charles Darwin Research Station. Genetic studies of lava lizards (*Tropidurus* spp.), Galapagos snakes (taxonomy uncertain), and Galapagos geckos (*Phyllodactylus* spp.) are being promoted. [KEYWORDS: systematics, Galapagos, DNA, management].

Cayot & Izurieta V.

C10

The Baltra Island land iguana: the disappearance and re-establishment of a population. LINDA J. CAYOT[1] AND ARTURO IZURIERTA V.[2]. [1]*Charles Darwin Research Station, Casilla, 17-01-3891, Quito, Ecuador.* [2]*Galapagos National Park Service, Santa Cruz, Galapagos, Ecuador.* The land Iguana (*Conolophus subcristatus*) population of Baltra Island, Galapagos, disappeared in the late 1940s, principally due to habitat destruction. In 1932–33, prior to their disappearance on Baltra, approximately 70 iguanas were transferred to North Seymour, a small nearby island, as a psuedo-experiment. In the 1980s, some of these iguanas were included in a captive breeding program. In 1991, an agreement was signed between the Ecuadorian Armed Forces which has jurisdiction over Baltra, the Galapagos National Park Service and the Charles Darwin Foundation, permitting the repatriation of land iguanas to Baltra. Between 1991–93, a total of 79 land iguanas were repatriated. Initial follow-up studies indicate a minimum survivorship of 30%. [KEYWORDS: Iguana, Galapagos, captive breeding].

Cei

S13

Anuran skin peptides and their comparative biochemical screening: an interesting auxiliary tool in evolutionary systematics. JOSÉ CEI. *Depto Ciencias Naturales, Universidad Nacional de Rio Cuarto, 5800 Rio Cuarto, Córdoba, Argentina.* Spectra of biogenic peptides occurring in the amphibian skin may vary not only among the representatives of different families, but also among those of different genera and species. Thus these spectra may be suitably used in biochemical taxonomy and in several cases for assessing evolutionary or intergeneric relationships. More than 40 peptide molecules, structurally belonging to at least ten "families" have been isolated and sequenced in modern or primitive forms. It appears likely that their relatively small molecules so far taken into consideration are synthesised within and released from larger precursor molecules. Among the most important peptide groups so far detected are: the takykinins occurring in some neotropical leptodactylids and Australian myobatrachids, in some African hyperoliids and in the very specialised phyllomedusid stock, all lines having a probable common Gondwanian ancestry; the bradykinins likely among the phylogenetically oldest peptides thus far identified because of their generalised distribution; the caeruleins widely distributed in Australian pelodryadids, in some South American leptodactylids or African pipids and — as phyllocaeruleins — in phyllomedusid and hyperoliid frogs, thus also a primary occurrence in southern families of probable Gondwanian ancestry; the bombesins isolated as bombesin/alytesin subfamily from Eurasiatic discoglossid genera, as litorin/ranatensin subfamily from austral pelodryadids and myobatrachids as well as from American and Australasian ranids, as phyllolitorin subfamily again from South American phyllomedusids; the potent sauvagine and dermomorphins at last, both groups apparently not so far traced outside the strange neotropical phyllomedusine frogs. At a more detailed level the striking peptide specificity may act as a very useful tool to discriminate a discussed

generic status of Anuran taxa, such as, i.e. the kassinin or (Glu, Pro5) kassinin and the hyambatin from the African hyperoliid frogs *Kassina* and *Hyambates*. [KEYWORDS: anuran skin peptides, Gondwanian anurans, Pelodryadids, Myobatrachids, Hyperoliids, Phyllomedusids, Ranids, tachykinins, bradykinins, caeruleins, bombesins, sauvagins, dermomorphins].

Chang & Yang

C06– 039

Populational variation of advertisement call in *Rhacophorus taipeianus*. JOANN C. W. CHANG[1] AND YI-JU YANG[2]. [1]*Dept of Zoology, Kyoto University, Kitashirakawa-oiwakecho, Sakyo-ku, Kyoto, Japan.* [2]*Dept of Zoology, National Taiwan University, Taipei, Taiwan, R.O.C.* *Rhacophorus taipeianus*, an endemic species of Taiwan, distributes in the mountain area under 1000 m, north and central Taiwan. The advertisement call of 4 north populations and 1 central population were recorded. The call note duration time, inter note time interval and number of pulses per note of the north and central populations are the same. However, the pulse rate and the fundamental frequency of the central population are significantly lower than the northern populations. The body length and body weight of central population are also smaller than the northern populations. These findings shows that *R. taipeianus* could be divided into two groups, distributing in two geographic regions. And this is consistent with the grouping analysis based on mitochondria DNA (Yang, unpublished data). [KEYWORDS: advertisement call, fundamental frequency, note, pulse rate, duration].

Chen *et al.*

C06–040

A survey of amphibians in Leigong mountains. CHEN XUEFENG, ZHANG XUAN AND MO WENLI. *The Management of Leigong Mountain Nature Reserve, Forest Bureau of Southeast Guizhou Prefecture, China.* Leigong Mountain locates 108°5'–108°24'E, 26°15'–26°32'N. There are 36 species of amphibians in the area, belonging to 2 orders, 8 families and 14 genera, accounting to 56.3% of the number of amphibian species in Guizhou (64 species). Among the 36 species, *Trituroides caudopunctatus* and *Vibris saphora leishanensis* and *Rhacophorus nigropunctatus* are endemic species in Guizhou, the type locality of the former two species are in Leigong mountain. The paper reports the vertical distribution of amphibians in the area and compares the species diversity of Leigong mountain with those of the Fangjing mountain and analyses the relations between fauna and temperature, rain falling.

Cherry *et al.*

C04

Mating behaviour determines the direction of introgression between two hybridising African toad species: a test using mitochondrial DNA analysis. MICHAEL I. CHERRY[1], W. STEWART GRANT[2] AND ERIC H. HARLEY[3]. [1]*South African Museum, P O Box 61, Cape Town 8000, South Africa.* [2]*Dept of Genetics, University of the Witwatersrand, P.O. Wits 2050, South Africa.* [3]*Dept of Chemical Pathology, University of Cape Town Medical School, Observatory 7925, South Africa.* We investigated the role of mating behaviour in hybridisation between two sympatric species of African toads, *Bufo rangeri* and *B. gutturalis*. The two species display different patterns of mating behaviour. Mate choice is solely by females in *B. rangeri*, which approach calling males and initiate amplexus. *Bufo gutturalis* females, by contrast, have limited opportunity for mate choice, as males are "scramble competitors", actively searching for females and displacing other males already in amplexus. It seems likely, therefore, that hybridisation between these two species is a consequence of *B. gutturalis* males

initiating amplexus with *B. rangeri* females, and not vice versa. As mitochondrial mtDNA is maternally inherited, this hypothesis can be tested by analysing the restriction fragment length polymorphisms of mitochondrial DNA in hybrid individuals. Hybrids have mitochondrial genotypes similar to those of *B. rangeri*, indicating that they are a consequence of matings between male *B. gutturalis* and female *B. rangeri*. The role that different mating systems play in determining directionality in hybridisation clearly merits further investigation, as this may be an important factor shaping evolutionary processes in hybrid zones. [KEYWORDS: toads, hybridisation, introgression, mitochondrial DNA].

Christensen-Dalsgaard & Jørgensen

C25

Directional responses of VIIIth nerve fibres in the grassfrog, *Rana temporaria*. JAKOB CHRISTENSEN-DALSGAARD AND MORTEN BUHL JØRGENSEN *Institute of Biology, Odense University, Campusvej 55, DK-5230 Odense M, Denmark.* Recent research has shown that the acoustics of the anuran auditory periphery is very complicated. Not only is the crosstalk between the two eardrums considerable, but sound also is received through the mouth floor, through the lungs and through 'extratympanic' inputs that are more efficient than the tympanic input at low frequencies. It is still not understood how all these inputs interact to provide the frog with the directional information that is important, for example in mate localisation. The high sensitivity of low-frequency auditory fibres to vibration (Jørgensen & Christensen-Dalsgaard, JCP A 169: 341-34, 1991; Christensen-Dalsgaard & Narins, JCP A 172, in press) is a problem when free-field stimulation is used, since the sound-induced vibrations in the setup can be considerable. The directional characteristics of the induced vibrations are difficult to predict and may obscure the directional characteristics of the fibres. We have started a detailed investigation of directional characteristics of VIIIth nerve fibres in a setup where the sound-induced vibrations can be strongly reduced. We present results from single-unit recordings using a dorsal approach to the VIIIth nerve with the frog sitting in a normal posture with its lungs inflated. The results show that the directionality of the VIIIth nerve fibres is considerable, also at low frequencies where the eardrum vibrations are small. The difference between ipsi- and contralateral responses corresponds to an intensity difference of up to 8 dB. Also, we find a marked difference in responses to sound coming from anterior and posterior directions. The latencies of the neural responses vary systematically with sound direction. [KEYWORDS: frog, ear, VIIIth nerve, sound localisation, *Rana temporaria*].

Christian

S12

Ground reaction forces and economy in lizard locomotion. ANDREAS CHRISTIAN. *Dept of Medicine, Ruhr-Univ. Bochum, 44780 Bochum, Germany, c/- Prof. H. Preuschoft.* Lizards from different groups were filmed from different angles during their locomotion. In some varanids, simultaneously the ground reaction forces were measured. In all lizards examined, the lateral bending of the longitudinal axis of the body formed a standing wave in a frame of coordinates that travels with the reptile. During the support phase of a limb, hip and shoulder joint moved towards the foot on the ground. The ground reaction forces were composed of a medial and a vertical component, both, as well as the medial inclination of the resulting force, increased with the speed of locomotion. The movements of the longitudinal axis of the body can be understood as the consequence of internal and external forces. The lateral movements

of the hip and shoulder are due to the medial components of the ground reaction forces. In combination with the lateral inclination of the ground reaction forces, they lead to a decrease of the sum of the forces that are necessary to stabilize hip and knee joints and shoulder and elbow joints respectively [KEYWORDS: locomotion, lizards, functional morphology, forces].

Christian S29

Tropical vs temperate thermoregulators: are there differences? KEITH CHRISTIAN. *Northern Territory University, P.O. Box 40146, Casuarina, NT 0811 Australia.* Are there characteristics of thermoregulation unique to either tropical or temperate species? By using a combination of microclimatic data, biophysical models and body temperature (Tb) data it has been demonstrated that *Conolophus pallidus* and *Chlamydosaurus kingii* have seasonal shifts in preferred Tb's. This has not been conclusively demonstrated for any temperate lizards, but this may reflect incomplete data rather than reality. *C. kingii* conserves energy and water in the dry season by remaining 4°C cooler, but they bask early and late to carefully thermoregulate at 33°C, suggesting that the Tb selected is a compromise between conservation of resources and other ecophysiological demands. The seasonal shift in Tb's was also evident in lab experiments. Using a variety of thermoregulatory indices 1 temperate and 3 tropical species of varanids were compared. When the thermal environment is not limiting, the temperate species is a more careful thermoregulator than 2 of the tropical species, but similar to the third. An index (exploitation of the available thermal environment) based on a graphical technique that includes Tb's, the limits of the thermal environment (operative temperatures in the coolest and hottest microenvironments) and laboratory measurements of the set-point range of Tb's is an intuitive, effective way to evaluate thermoregulation. [KEYWORDS: seasonal activity, shifts in thermal preference, temperate vs tropical environments, biophysical models, extent of thermoregulation].

Christian *et al.* S17

Seasonal activity and energetics of two species of tropical varanid lizards. KEITH CHRISTIAN[1], BRIAN WEAVERS[2], BRIAN GREEN[3], AND L.K. CORBETT[4]. [1]*Northern Territory University, P.O. Box 40146, Casuarina, NT 0811, Australia.* [2]*Australian Heritage Commission, GPO Box 1567, Canberra, ACT 2601, Australia.* [3]*Division of Wildlife and Ecology, CSIRO, P.O. Box 84, Lyneham, ACT 2602, Australia.* [4]*Division of Wildlife and Ecology, CSIRO, PMB 44, Winnellie, NT 0820, Australia.* Field metabolic rates (FMR) were measured in 2 species of varanid lizards over 5 periods of the year in tropical Australia. Their energetics were further investigated by measuring field activity and body temperatures by telemetry along with standard and activity metabolism in the lab. Periods of inactivity were associated with the dry season, but the onset of inactivity differed with respect to habitat. *Varanus gouldii*, which inhabits woodlands, were inactive during the dry and late dry seasons. *V. panoptes* that live in the woodland had a similar seasonal pattern, but *V. panoptes* living near the floodplain had their highest levels of activity during the dry season. But during the late dry they too became inactive. For *V. gouldii* the FMR of active animals was 196 kJ $kg^{-1}day^{-1}$ (inactive: 66 kJ kg^{-1} day^{-1}). For *V. panoptes* the FMR of active animals was 143 kJ kg^{-1} day^{-1} (inactive: 56.3 kJ kg^{-1} day^{-1}). The FMR was divided into the proportion of energy spent in burrows, out of burrows but inactive, and in activity. The time spent in activity by *V. panoptes* during the dry season is extremely high for a reptile (mean

of 3.5 h/d spent walking), providing an ecological correlate to the high aerobic capacity found in laboratory measurements of some species of varanids. [KEYWORDS: varanid lizards, ecological energetics, seasonal activity].

Chugunova C21

How long do they live? TATIANA Y. CHUGUNOVA. *A.N. Severtzov Ins. Evolution Animal Morphology and Ecology, Russian Acad. Sci , Leninsky Pr. 33, Moscow, 117071, Russia.* The mean functional life span of lizard's teeth is interrelated with such serious parameters as feeding adaptation, ratio of lizards growth, speed of tooth replacement. There are very few data about the duration of functional life span of teeth. The long-term study (2.7 years) of *Iguana iguana* (Kline, Cullum, 1984, 1985) shows the following means of functional life span: in adult animals from 10.2 to 13.6 weeks, in the young iguana: 6.4 ± 0.12 weeks; in *Heloderma suspectum*: 3 month, in *Alligator missisipiensis*: 8 month (Edmund, 1962, 1969). Study of tooth replacement in alizarin red S stained *Tenuidactylus caspius* and *Lacerta armeniaca* reveals the mean functional life span of Geckota anterior teeth (N 2, 3, 4, 5, 6) to vary from 3 to 6 weeks; posterior teeth (N 17, 19, 21, 23) from 6 to 12 weeks, but in lizard the life of anterior teeth (N 1, 3) varies from 7 to 8 weeks, and posterior from 12 weeks and more. It is shown, that the mean functional life span of teeth differs in different generation of the same tooth and depends upon the laboratory conditions; the regularity of tooth replacement distorts because the new teeth may arise in inter-dental position. [KEYWORDS: lizards, teeth, functional life].

Church *et al.* C06–042

Keelback snake, cane toad and native frog interactions in north Queensland. ADELAIDE CHURCH, GABRIEL CODINA AND JEAN-MARC HERO. *Dept of Zoology, James Cook University, Townsville, Qld 4811, Australia.* The interactions between Keelback snakes (*Tropidonophus mairii*) and the introduced Cane Toad (*Bufo marinus*) was investigated at two waterbodies on the Burdekin River flood-plain south east of Townsville, Queensland. Keelback snakes were found to prey readily upon juvenile Cane Toads even when alternative food (native frog species) was available. The density of keelback snakes was highly seasonal, whereas juvenile Cane Toads were sporadically available throughout the year. The presence of adult toads depended on the availability of water. Keelback snakes may influence Cane Toad populations surrounding some waterbodies in northern Australia. [KEYWORDS: keelback snake, *Tropidonophus*, cane toad, *Bufo*, biological control, predation, diet.].

Clack S02

The evolution of the fenestra ovalis and stapes in early tetrapods. JENNIFER A. CLACK. *University Museum of Zoology, Downing St., Cambridge CB2 3EJ, United Kingdom.* The fenestra ovalis, defined as a hole in the braincase bordered by bones of the otic capsule, basisphenoid/parasphenoid and basioccipital, into which the footplate of the stapes fits, is universally present in modern tetrapods and in many fossil ones, so that its presence has been used as a defining synapomorphy of the group. However, in the earliest tetrapods, the evidence for the fenestra ovalis is often scanty, and the margins reconstructed. In *Acanthostega gunnari*, the ventral cranial fissure was still evident and the basiparasphenoid did not contribute to the margin of a true fenestra ovalis. *Acanthostega* essentially retained a fish-like vestibular fontanelle. The two holes probably have similar embryological origins, but the derived tetrapod condition was a

later development, correlated not only with the sealing of the ventral cranial fissure, but with elaboration of the otic region for hearing. The possibility remains that rather than this condition being achieved by basal tetrapods only once as usually assumed, it was developed separately in amniote and anamniote lineages. In *Acanthostega* specimens in which the braincase is preserved, the stapes are almost always present and approximately in life position, suggesting they were firmly held in the living animal. They may have been as much supportive as auditory structures. A hole in the braincase wall may have given a firmer support for the head of the stapes than a facet, the fenestra serving this function before it became strictly auditory. The footplate of the stapes has long been homologised only with the ventral head of the osteolepiform hyomandibula. Evidence from *Acanthostega* implies instead that both hyomandibular heads contribute to the stapedial footplate, which consists of two facets separated by a notch. This suggests the mode of formation of the stapedial foramen from its homologue the jugular canal which houses the orbital artery. [KEYWORDS: fenestra ovalis, stapes, tetrapods, evolution].

Clerke

C06–043

Cane toad ecology in Darling Downs, southern Queensland. ROBERT CLERKE. *School of Life Science, Queensland University of Technology, GPO Box 2434, Brisbane, Qld 4001, Australia.* The introduced cane toad, *Bufo marinus* is still undergoing considerable range expansion in northern and eastern Australia. One possible route of the southwards and westward range expansion of *B. marinus* is *via* the Murray-Darling drainage basin in Darling Downs area of southern Queensland. Movement down drainage systems may be rapid and penetration of the Darling River catchment, only 100 km west of Brisbane, may greatly increase the toads potential to expand its range into western NSW, Victoria and South Australia. Reported here are early results of a study of cane toad ecology on the Darling Downs area of Southern Queensland. Comparisons of current distribution data with earlier published surveys suggests that either: (a) previous interpretation of survey data is incorrect or (b) cane toad distribution has contracted over the last 10 years. Habitats on the Darling Downs show similar vegetation attributes to the habitats favoured by toads in coastal southern Queensland and vegetation attributes are unlikely to restrict distribution. There did not appear to be a shortage of breeding sites and successful breeding occurred in all types of water body (creeks, dams, swamps and ephemeral pools). Largest breeding aggregations were found around dams and breeding rarely occurred in creeks. Breeding occurred from September to late February and metamorphosis was observed from November to April. Survival varied with time and site of egg laying. Survival of metamorphs varied between water bodies. Ant predation and desiccation caused high mortality at some sites. [KEYWORDS: cane toad, Australia, range expansion, southern distribution].

Coddington & Cree

C06– 044

Effects of capture on plasma steroid concentrations in the whistling tree frog (*Litoria ewingi*). EMMA CODDINGTON AND ALISON CREE. *Dept of Zoology, University of Otago, P.O. Box 56, Dunedin, New Zealand.* In many vertebrates, short-term capture leads to an increase in corticosteroid concentrations and a decrease in plasma concentrations of reproductive hormones. This endocrine response to capture may contribute to the low reproductive output that has been observed in many captive animals. Studies addressing the endocrine responses of adult amphibians to

captivity do not always reveal consistent trends. In this investigation, plasma concentrations of corticosterone (B) and sex steroids were examined in vitellogenic whistling tree frogs, *Litoria ewingi*, during the first 24 h after capture. Animals were held in captivity for either 0 h, 0.5 h, 3 h, or 24 h before being blood-sampled. All animals were bled at 2230 h to remove the effects of any daily cycles in hormone concentrations. Plasma B concentrations were non-detectable at capture but rose significantly as time in captivity increased ($F=5.21$, $p=0.006$). Plasma concentrations of estradiol (mean±SE, 1001.4±12.9 pg/ml), testosterone (3.97±0.71 ng/ml) and progesterone (1.88±0.49 ng/ml) were detectable at capture, but did not change after capture ($p > 0.05$). Concentrations of B did not correlate significantly with estradiol, testosterone or progesterone concentrations. Vitellogenic whistling tree frogs have very low basal concentrations of B compared to other female amphibians during their activity period. However, the rapid increase in B in response to capture does not significantly affect the sex steroid concentrations, an unusual result compared with the few previous studies made on female frogs. [KEYWORDS: capture, stress, corticosterone, sex steroids, Whistling tree frog, *Litoria ewingi*].

Cogger

S06

Conservation issues and problems in the Australian reptile fauna. HAL COGGER. *Australian Museum, 6–8 College St., Sydney, NSW 2000, Australia.* Despite Australia's size and relatively small population, anthropogenic impacts on all of its ecosystems have ranged from moderate to severe. In areas of major European settlement, clearing of native vegetation for agriculture, grazing and urban growth have been the major impacts. In more remote areas, exotic plants and animals have dramatically modified native habitats. Approximately 88% of Australia's 750 species of reptiles are endemic; basic knowledge of the biology and ecology of most of these species is fragmentary. While no Australian reptile is known to have become extinct, many are severely threatened. This paper describes the development of an Australian REPTILE ACTION PLAN, including a dynamic ranking system utilising a computer database. Based on a modified version of that proposed for Florida wildlife by Millsap *et al.* (1990), this system automatically changes the ranked threatened status of a species as new information becomes available. The challenge to conservation agencies and their legislators will be to ensure that such changes, where they significantly alter the status of the given species, are quickly reflected in relevant protective legislation and regulations.

Congdon et al.

S15

Parental investment in reptiles. J.D. CONGDON[1], L.J. VITT[2] AND J.W. GIBBONS[1]. [1]*Savannah River Ecology Laboratory, P.O. Drawer E, Aiken, South Carolina 29802, United States of America.* [2]*Oklahoma Museum of Natural History and Dept of Zoology, University of Oklahoma, Norman, Oklahoma 73019, United States of America.* Parental investment is any investment allocated to individual offspring. In oviparous reptiles all parental investment is in eggs, consequently egg size can be used as an estimate of parental investment. Among those reptiles that have matrotrophy, parental investment must include investment in the egg and any subsequent investment by the female. Among reptiles, trophic parental investment appears to be rare, however, if the concept of preovulatory parental care is considered, then trophic investment in offspring care may be universal. Care of neonates is primarily restricted to attendance.

We consider several examples among reptiles to illustrate these concepts.

Conroy

C30

Lizard community response to an abrupt vegetation discontinuity. SIMON CONROY. *Zoology Department, James Cook University, Townsville, Qld 4811, Australia.* The responses of a lizard community to an abrupt vegetation discontinuity were assessed at the ecotone between rainforest and tall open forest near Paluma in northeast Queensland using a gradsect strategy. Gradsect comprised five grids of pitfall traps at 100 m intervals, with the middle grid at the boundary between the closed and open forests. Eight species were captured in sufficient number to be included in the analysis. The three most abundant species, *Carlia rubrigularis*, *Saproscincus basiliscus*, and *Varanus timorensis*, were ubiquitous. *Hypsilurus boydii*, *Lampropholis coggeri*, and *Saproscincus tetradactylus* were captured in closed forest and at boundary sites, while *Ctenotus terrareginae* and *Lygisaurus zuma* were only captured in open forest. The absence of open forest 'specialists' at the boundary sites indicates that these sites may be more similar to closed than to open sites, and environmental and vegetative structural data support this conclusion. Species richness and species diversity (H) varied in parallel, exhibiting 'W' shaped diversity curves across the ecotone mean values were highest for the 200 m open and closed forest sites, intermediate for the boundary sites, and lowest for the 100 m open and closed forest sites. These data indicate that there may be an 'edge effect' resulting in reduced diversity in lizard assemblages close to the boundary. The closed forest sites exhibited the highest (200 m sites) and lowest (100 m sites) diversity values. Thus it appears that the edge effect may be greater in the closed forest than in the open forest. Detrended correspondence analysis (DCA) was used to ordinate lizard assemblages from 30 sites. Six distinct groups were apparent, each of which is characterised by the dominance of one of the ubiquitous species as well as the presence of unique specialist species. The groupings correspond closely to a closed/open dichotomy, with only one grouping containing both closed and open sites. [KEYWORDS: community structure, ecotone, edge effect, lizards, Reptilia].

Coulson *et al.*

C11

Conservation biology of the striped legless lizard, *Delma impar*. GRAEME COULSON[1], KRUNO KUKOLIC[2], CHRIS BANKS[3] AND ALEX KUTT[4]. [1]*Dept of Zoology, University of Melbourne, Parkville, VIC 3052, Australia.* [2]*ACT Parks and Conservation Service, P.O. Box 1119, Tuggeranong, ACT 2901, Australia.* [3]*Melbourne Zoo, P.O. Box 74, Parkville, VIC 3052, Australia.* [4]*Biosis Research, 51 Camberwell Road, Hawthorn East, VIC 3123, Australia.* The Striped Legless Lizard, *Delma impar* (Lacertilia: Pygopodidae), is listed as Vulnerable in Australia. It occurs almost exclusively in temperate lowland grasslands, typically dominated by *Themeda triandra*, and has declined in abundance through loss and fragmentation of grassland habitat. Populations are threatened by cultivation, heavy grazing, rock removal, frequent fire, and urban and industrial development. Most populations occur in western Victoria, but none has been systematically surveyed, few are secure and only one is in a conservation reserve. There are only three isolated populations in the Australian Capital Territory; two are under threat and none is reserved. The status of the species in New South Wales and South Australia is uncertain. Pitfall trapping studies conducted since 1989 show that the species has a limited activity period; animals are most readily caught in November and December. Movements up to 56 m have been recorded over

several months. Diet consists of a range of small invertebrates, particularly jumping spiders, lepidopteran larvae and young crickets. Two eggs are laid in December, and young hatch after 38–50 days, depending on temperature. A captive colony has been established at Melbourne Zoo with animals translocated from sites under immediate threat. Reintroductions are planned for sites of former occurrence following habitat restoration work. Research, management and education actions are co-ordinated by an inter-agency working group, representing faunal authorities, zoos, universities and community groups. [KEYWORDS: Pygopodidae, *Delma impar*, grassland conservation, habitat loss, reintroduction].

Couper & Covacevich

S06

New data on the Australian rainforest leaf-tailed geckos. PATRICK COUPER AND JEANETTE COVACEVICH. *Vertebrate Section, Queensland Museum, P.O. Box 3300, South Brisbane, Qld 4101, Australia.* *Saltuarius* gen. nov. is separated from *Phyllurus* by external and internal characters, and by karyotype. To it are assigned *S. cornutus* (Ogilby, 1892), *S. salebrosus* (Covacevich, 1975), *S. swaini* (Wells and Wellington, 1985) and *S. occultus* sp. nov. To *Phyllurus sensu stricto* are assigned *P. caudiannulatus* Covacevich, 1975; *P. platurus* (White, 1790); *P. isis* sp. nov.; *P. nepthys* sp. nov. and *P. ossa* sp. nov. The Leaf-tailed Geckos are confined to narrow, isolated patches of rainforest or heathlands in coastal Australia between the McIlwraith Range, far northeastern Queensland (13°45', 143°19') and the Hawkesbury Sandstone area near Sydney (33°55', 151°13'), mideastern New South Wales. Endemic species lists and "rare, endangered or vulnerable" species ratings have been changed by this work. *P. occultus* is recognised as the first reptile species endemic to rainforests of the McIlwraith range, far NE.Q.; *S. cornutus* is no longer a wide-ranging species, but is confined to the Wet Tropics Management Area, NE.Q.; and *P. isis*, *P. nepthys*, *P. ossa* spp. nov. and *P. caudiannulatus* join lists of very narrowly endemic rainforest species. [KEYWORDS: moist rainforest, leaf-tailed geckos, endemism, *Saltuarius*, *Phyllurus*].

Covacevich & Couper

C16

A new genus and species of skink (*Sphenomorphus* group) from Australia's dry rainforest. JEANETTE COVACEVICH AND PATRICK COUPER. *Vertebrate Section, Queensland Museum, P.O. Box 3300, South Brisbane, Qld. 4101, Australia.* *Nangura spinosa* gen. et sp. nov. is a very distinct member of the *Sphenomorphus* group. It is the only member of this group to have parietal scales totally separated by the interparietal. (This character is unusual in Australian skinks, being present in only some of the *Mabuya* group, apart from *Nangura spinosa*). *Nangura spinosa* resembles *Gnypetoscincus queenslandiae* superficially, but is much larger than *Gnypetoscincus queenslandiae*. Further, it has a supratemporal fossae (absent in *G. queenslandiae*), and a karyotype 2n=28 (vs 30). *Nangura spinosa* is very narrowly distributed and is the first reptile known to be confined to the remnant dry rainforests (= semi evergreen vine thickets) of south eastern Queensland. It is known only from Nangur State Forest, which is now, like all semi evergreen vine thickets, on Crown Land in south eastern Queensland, totally protected under Queensland Forest Service legislation. [KEYWORDS: dry rainforest, *Sphenomorphus* group, *Nangura* gen. nov., endemism].

Cracraft

P2

Biogeographic patterns and the history of the Australasian biota. JOEL CRACRAFT. *Dept of Ornithology, American Museum of Natural History, Central Park*

West at 79th St., New York, New York, United States of America. The observation that the terrestrial vertebrates of Australia show a high degree of congruence in their patterns of endemism implies that common historical events have influenced the origin and maintenance of these patterns. Although phylogenetic studies of clades having representatives in multiple areas of endemism are still not sufficiently numerous to corroborate a well resolved cladistic history for these areas, those that are available suggest a number of common patterns. In addition, a cladistic analysis of raw distributions, coded as to presence or absence in areas of endemism, provides a much stonger historical signal. This is particularly true for birds and mammals, but all vertebrates share a number of cladistic components. These data can be interpreted in three ways. First, they actually are recognising a true pattern of vicariance for the areas of endemism; or second, the signal represents an historical pattern of biotic dispersion that involved large segments of the vertebrate biota; or finally, the pattern represents both of these. There are a number of observations that complicate this picture. Some vertebrates, especially lizards, exhibit much more complex, and less congruent, patterns of endemism than do most species of birds, mammals, and many snakes. This seems to reflect the fact that lizards are generally more narrowly distributed, and that the spatial history of lizards in the arid region of Australia may be fundamentally different from other vertebrates. Even for groups that show strong historical congruence, particularly among the more mesic areas of endemism, it is clear that some areas are "hybrids", that is, some species in the hybrid area show relationships to one area, whereas other species show relationships to other, historically incongruent areas. This talk will review some of these patterns and will attempt to resolve some of these complexities by presenting new analyses of lizard areas of endemism, as well as a more detailed consideration of the history of some hybrid areas. Finally, molecular data offer the potential for providing a relative time scale for areas of endemism and vicariance events, and preliminary data in this direction will also be discussed.

Cree

S23

Low reproductive rates and their implications for conservation of New Zealand reptiles. ALISON CREE. *Dept of Zoology, University of Otago, Box 56, Dunedin, New Zealand.* New Zealand has a large fauna of extant land reptiles, including 23 species of skinks, 16 species of geckos and two species of tuatara. Ovarian cycles of most species are poorly known. Recent work has revealed a prolonged ovarian cycle in tuatara (*Sphenodon punctatus*) on Stephens Island; this cycle is apparently unique among reptiles. In an average ovarian cycle, females nest about once every 4–5y, with vitellogenesis taking at least 3 y and shelling about 8 mo. Less than annual reproduction is also evident in other taxa of tuatara (*S. p. punctatus*, *S. guntheri*). Although it could be hypothesised that this prolonged cycle is a phylogenetically primitive trait in sphenodontidans, recent work on viviparous New Zealand geckos does not support this hypothesis. At least two species of *Hoplodactylus* also have ovarian cycles lasting more than 1 y. In *H. maculatus*, the ovarian cycle may be either annual or biennial and this is correlated with environmental temperature. However, two large diurnal skinks (*Leiolopisma grande*, *L. otagense*) have annual ovarian cycles. Ovarian cycles lasting more than a year are associated in New Zealand reptiles with nocturnality, cool environmental temperatures, and in some cases large body size. Low reproductive rates and/or small clutch sizes predispose several New Zealand reptiles to low ability to recover from environmental disturbance. [KEYWORDS: ovarian cycle, reproductive rate, *Sphenodon*, *Hoplodactylus*, *Leiolopisma*].

Applications of reproductive endocrinology to captive breeding of tuatara (*Sphenodon*). ALISON CREE AND CLAUDINE TYRRELL. *Dept of Zoology, University of Otago, Box 56, Dunedin, New Zealand.* Endocrine techniques for non-lethally assessing reproductive condition have a valuable role to play in the conservation of rare reptiles. The tuatara (*Sphenodon*) is the only surviving genus in the Order Sphenodontida and is restricted to 30 offshore islands of New Zealand. There have been many attempts at captive breeding, but with little success. We monitored ovulation rates in captive female *S. p. punctatus* by measuring plasma concentrations of testosterone (T) and progesterone, and by laparoscopy. The very low ovulation rates observed are associated with a high frequency of atresia, but not with elevated plasma corticosterone concentrations. Possible causes of poor ovulation rates in captive *S. p. punctatus* include age (senescence) and/or improper diet. In a second study, we examined plasma T and estradiol (E_2) concentrations in juvenile and adult *S. punctatus*, comparing both wild and captive populations originating from Stephens Island. Captive adult males and captive-reared "juvenile" males that have reached the expected size of sexual maturity have seasonally elevated plasma T concentrations typical of wild adult males, suggesting that they are reproductively active. Overall, it seems that female tuatara are less likely to show normal reproductive activity in captivity than are males, and the reasons for this must be addressed. [KEYWORDS: Tuatara, *Sphenodon*, captive breeding, ovulation, atresia, sexual maturity].

Cree & Tyrrell

S10

Interspecific differences in the palatability and toxicity of *Bufo marinus* eggs and tadpoles to aquatic predators. MICHAEL R. CROSSLAND[1] AND CLAUDIA AZEVEDO-RAMOS[2]. [1]*Dept of Zoology, James Cook University of North Queensland, Townsville, Qld 4811, Australia.* [2]*Dept de Zoologia, Museu P.E. Goeldi, C.P.399, Belem, PA, Brazil.* The eggs and larvae of the cane toad *Bufo marinus* contain noxious chemicals to deter potential predators. Within the toad's native range, aquatic predators have been exposed to these chemicals for long periods of time and may have evolved mechanisms to nullify them. In areas to which toads have been introduced, aquatic predators have had no similar evolutionary experience of bufotoxins and may be vulnerable to such chemical defences. We tested the palatability and toxicity of *B. marinus* eggs, hatchlings and tadpoles to a variety of invertebrate and vertebrate predators. Toad eggs and tadpoles were palatable and non-toxic to some predators, yet were unpalatable and/or highly toxic to others. The differences in palatability and toxicity to predators could not be explained by predator phylogeny or method of ingestion. [KEYWORDS: Amphibia, *Bufo marinus*, eggs, tadpoles, toxicity, palatability, predation].

Crossland & Azevedo-Ramos

S16

The Yucatan bolide impact and Caribbean biogeography. BRIAN I. CROTHER[1] AND CRAIG GUYER[2]. [1]*Dept of Biology, Southeastern Louisiana University, Hammond, La., 70401, United States of America.* [2]*Dept of Zoology and Wildlife Science, Funchess Hall, Auburn University, Auburn, Al., 36849, United States of America.* Recent geological work suggests that an extraterrestrial bolide impacted on the northern coast of the Yucatan at the Cretaceous-Tertiary (K-T) boundary. The location, timing and magni-

Crother & Guyer

S08

tude of the impact have been used to support a dispersal explanation for the Caribbean herpetofauna. A recent study based on immunological distances and clocks supports this hypothesis. We re-examine in detail the immunological and geological data, and present new phylogenetic data analysed by Brooks Parsimony Analysis (BPA). Our overall results do not support the hypothesis that the bolide erased vicariant patterns of biogeographic history in the Caribbean. In association with expanded geological information, immunological data support the vicariance timing for Puerto Rico, Cuba, and Hispaniola and indicates dispersal to Jamaica. The BPA also supports the vicariance pattern for the former three islands. We conclude that 1) vicariance explains most phylogenetic and immunological data, 2) dispersal is rejected as a general explanation for the current herpetofaunal distribution (except for Jamaica) and, 3) based on conclusion 1 the bolide impact did not eliminate the Caribbean biota, forcing recolonisation. [KEYWORDS: K-T bolide, extinctions, vicariance, dispersal, immunological distance clock, Caribbean tectonic history, cladistic biogeography].

Cullum C04

Physiological consequences of asexuality in *Cnemidophorus*: locomotor and metabolic traits. ALISTAIR J. CULLUM. *Dept of Ecology and Evolutionary Biology, University of California, Irvine, CA 92717, United States of America.* The lizard genus *Cnemidophorus* contains a large number of parthenogenetic "species" which have been unusually successful for asexual vertebrates. These species arose from hybridisation events between sexual species of the genus, and consist of all-female clonal lineages. This study examines some of the consequences of hybrid origin and asexual reproduction on a number of whole-organism performance traits which physiological ecologists have traditionally associated with fitness. The following two questions are addressed: i) Is phenotypic variation within populations lower in asexual species than sexual species? The lack of genetic diversity within clonal lineages suggests that this may be the case. If so, asexual species could be at a disadvantage due to increased intra-specific competition and reduced ability to survive strong selection events. ii) Do members of asexual species exhibit some form of heterozygous advantage, or "hybrid vigor"? Asexual species have high levels of heterozygosity, which may result in trait values superior to those predicted from parental species values. Any such advantage would be maintained through asexual reproduction, since recombination does not take place. These hypotheses are tested using a set of locomotor and metabolic traits measured on freshly-caught animals: burst speed, aerobic endurance (time on a motorised treadmill), anaerobic endurance (distance run at full speed before exhaustion), standard metabolic rate (oxygen consumption), and evaporative water loss. Effects of body size on these traits, when present, are controlled for by analysing residuals of allometric scaling equations. Work to date, on the asexual species *Cnemidophorus neomexicanus* and its parental species *C. inornatus* and *C. tigris*, suggests that the low genetic variation in asexual populations does not necessarily translate into lower phenotypic variation for any of the traits measured, possibly due to greater sensitivity of the hybrid genome to environmental differences. There is no strong indication of heterozygous advantage in *C. neomexicanus*, with evaporative water loss and possibly burst speed showing slightly superior values, but aerobic endurance being lower than expected. [KEYWORDS: *Cnemidophorus*, parthenogenesis, hybridisation, locomotion, metabolic rate].

Cunningham *et al.* C32

Substitutions, transitions and translocations: a survey of genetic variation for the active management of declining frog populations. MICHAEL CUNNINGHAM[1], CRAIG MORITZ[1] AND KEITH MACDONALD[2]. [1]*Dept of Zoology, University of Queensland, St Lucia, Qld 4067, Australia.* [2]*Queensland Dept of Environment and Heritage, Atherton Courthouse, Atherton, Qld 4883, Australia.* Several rainforest animals from the Wet Tropics of Northern Queensland have shown intricate patterns and strong spatial structure in the distribution of genetic diversity. On a coarse scale, most of these patterns are congruent and show a large genetic disjunction between the Northern Wet Tropics and rainforests further south in the Wet Tropics. These patterns differ between species in the degree of divergence and in the fine scale biogeography of genetic diversity. In this paper we present the preliminary results of a genetic survey of DNA sequence variation at the mitochondrial Cytochrome-b gene in four species of rainforest frogs from the Wet Tropics. Three of these species — The Sharp-snouted Dayfrog, *Taudactylus acutirostris*, Common Mistfrog, *Litoria rheocola*, and the Waterfall Frog, *Litoria nannotis* — have recently disappeared over much of their range. No such decline has been detected in the fourth species *Litoria genimaculata* the Green-eyed Treefrog. The differences in genetic structure between these four species are discussed with particular reference to strategies for translocations and captive breeding. [KEYWORDS: declining frogs, *Litoria*, *Taudactylus*, mitochondrial DNA, genetic structure, translocation].

Daltry *et al.* C08

Population systematics of the Malayan pit viper, *Calloselasma rhodostoma*. JENNIFER C. DALTRY, ROGER S. THORPE AND WOLFGANG WÜSTER. *Dept of Zoology, University of Aberdeen, Aberdeen AB9 2TN, Scotland, United Kingdom.* The relative importance of ecogenetic versus phylogenetic factors in driving the microevolution of a crotalid snake are assessed by means of advanced statistical and molecular techniques. *Calloselasma rhodostoma* is the leading cause of snakebite morbidity in several countries, and an understanding of its population systematics could have medical implications. Geographic variation in venom and morphology (scalation, dentition, internal anatomy, body proportion, colour hue and pattern) is demonstrated across Southeast Asia. The phenotypic variation is statistically compared to environmental factors to help determine the influence of the environment (ecogenesis). The phylogenetic history of the species is investigated by PCR-based direct sequencing of mitochondrial DNA. [KEYWORDS: *Calloselasma rhodostoma*, geographic variation, venom, multivariate analysis, snakebite].

Daniels *et al.* S04

The evolution of surfactant composition and function in vertebrate lungs. CHRISTOPHER B. DANIELS[1], SANDRA ORGEIG[1], ALLAN W. SMITS[2] AND TERENCE E. NICHOLAS[1]. [1]*Dept of Human Physiology, School of Medicine, Flinders University, Bedford Pk 5042, Australia.* [2]*Dept of Biology, Box 19498, University of Texas, Arlington, TX 76019-0498, United States of America.* The evolution of lungs was a critical determinant for the evolution of the tetrapods. Concomitant with lung evolution was the development of the surfactant system which modifies the surface tension of the fluid lining the lung. We examined the composition and function of lung surfactant in actinopterygiian (Cladista, Gingymodi and Teleosti) and sarcopterygiian (Dipnoi) fishes, amphibians (Gynnophiona, Anura and Caudata), reptiles (Ophidia,

Lacertilia), and eutherian mammals. The primitive function of surfactant appears to be as an "anti-glue" acting to prevent apposing epithelial surfaces from adhering at low lung volumes in lungs with high inflation compliance. The anti-glue function was quantified as the increase in opening pressure (O.P.) after lung lavage. A 50–100% increase in O.P. occurred in all air-breathing vertebrates except mammals and rattlesnakes. The active ingredients of surfactant are Disaturated Phospholipids (DSP's) which are mainly responsible for the very low surface tensions that can be obtained, and cholesterol (Chol), which aids adsorption and fluidises the DSP's. Whereas the total amount of PL/gram wet lung (gWL) increased from the Osteichthyes (155μg/gWL) through the Amphibia (625μg/gWL) and the Reptilia (2363μg/gWL) before decreasing in the Mammalia (1640μg/gWL), the amount of cholesterol, expressed as a percentage of DSP, progressively decreased (fish: 205%, amphibians: 21–35%, reptiles: 18%, mammals: 16%). %DSP/PL was lowest in fish swimbladders and fish lungs (9.5%), intermediate in lungfish and amphibian lungs (14–20%) and highest in 36°C lizards, snakes and humans (46–48%). Within the Amphibia however, greater terrestriality and increasing lung complexity was correlated with decreasing %DSP/PL (20–14%) and increasing %Chol/DSP (20–35%), implicating land habitation and low body temperature as strong selective forces on surfactant composition. The evolution of the surfactant system is discussed with regard to function, lung structure, body temperature, terrestriality and phylogeny. [KEYWORDS: surfactant, antiglue, evolution, vertebrate, phylogeny, cholesterol, phospholipids].

Darevsky S08

All-female lizard species on the offshore island of Vietnam. ILYA S. DAREVSKY. *Zoological Institute, Russian Academy of Sciences, 199034, St. Petersburg, Russia.* The unisexual lizard species, *Hemidactylus steinegeri*, *Lepidodactylus lugubris*, *Leiolepis guntherpetersi*, have been first found by the author on the small offshore islands lying along the South China Sea coast of Vietnam, respectively, Cu Lao Ba Mun, Cu Lao Panjang, and Cu Lao Cham. The two former species are not commonly found in the mainland territory of Vietnam, and their occurrence in the islands may be due, presumably, to their accidental penetration there. The island populations of these geckos display certain morphological peculiarities clearly distinguishing them from the individuals living in other parts of the area beyond Vietnam. These distinctions may be accounted for by the so called "founder principle", and by a further divergence of characters, with the clonal reproduction under condition of island isolation. The island population of the large triploid agamid lizard *Leiolepis guntherpetersi* is separated from the mainland part by a sea strait about 16 km wide, which may have occurred after the last sea transgression about 10–12 thousand years ago. The presence of this isolate makes it possible to presume, indirectly, the age of this hybridogenous species which may have originated not later than the strait separating the island Cu Lao Cham had appeared. [KEYWORDS: lizard, offshore island, unisexuality, Vietnam].

Daugherty et al. S23

Conservation of the Brothers Island tuatara, *Sphenodon guntheri*. CHARLES H. DAUGHERTY[1], W. F. CASH[2], SUSAN N. KEALL[1], SUSAN F. SCHAFER[3] AND TOM SCHULTZ[3]. [1]*School of Biological Sciences, Victoria University of Wellington, P.O. Box 600, Wellington, New Zealand.* [2]*New Zealand Dept of Conservation, P.O. Box 161, Picton, New Zealand.* [3]*The Zoological Society of San Diego, P.O. Box 551, San Diego, California 92112-0551, United States of America.* Full species status of the Brothers Island tuatara, *Sphenodon guntheri*, was confirmed in 1990 on the basis of genetic distinctiveness. The entire species consists of about 300 adults on a single 4 ha island. Its vulnerability increased in 1990 through automation of the lighthouse, whose keepers had provided security for the population for over a century. Within the framework of a formal Dept of Conservation (DoC) Recovery Plan, management of *S. guntheri* now aims to secure the future of this species through (1) increased security for the single wild population and (2) establishment of one or two new wild populations. The first goal is being achieved through regular patrols of the island and detailed monitoring of the demography, numbers, and ecological well-being of the population by DoC staff. The second goal is being achieved through a captive incubation programme intended to produce young for translocation to one or two nearby islands that tuatara would once have occupied. Eggs for artificial incubation were collected during nesting seasons in 1989, 1990, and 1991; 171 of 209 (82%) hatched, and 157 of those (92%) survived to enter "head-start" programmes at 6 months of age. Attempted establishment of the first of these juveniles on a rat-free island will be made in 1995/96. One or two captive colonies will be maintained as further security. The interests of the indigenous Maori people are also being addressed in the management process. [KEYWORDS: *Sphenodon guntheri*, conservation, captive incubation, translocation].

Daugherty et al. S23

Taxonomic and conservation review of the New Zealand herpetofauna. CHARLES H. DAUGHERTY[1], G.B. PATTERSON[2], AND R.A. HITCHMOUGH[1]. [1]*School of Biological Sciences, Victoria University of Wellington, P.O. Box 600, Wellington, New Zealand.* [2]*New Zealand Dept of Conservation, P.O. Box 161, Picton, New Zealand.* The New Zealand herpetofauna consists of at least 62 species of terrestrial reptiles and amphibians, an increase of about 70% in the size of the known fauna since 1980. These include 4 species of *Leiopelma*, 2 species of *Sphenodon*, 10 *Naultinus*, 15 *Hoplodactylus*, 8 *Cyclodina*, and 23 *Leiolopisma*, all endemic to New Zealand. Discoveries in the past decade include many cryptic species identified using allozyme data, but also some morphologically well-differentiated forms not previously known. At least 21 species (34%) are rare, threatened, or endangered, and 19 species (31%) are restricted largely or entirely to offshore islands. All but 4 species are protected. The New Zealand Dept of Conservation has developed a comprehensive scheme for establishing management priority for indigenous species. At present, formal Recovery Plans exist in draft or approved form for at least 7 species, and more are in preparation. [KEYWORDS: conservation, herpetofauna, New Zealand, species diversity].

Daugherty & Towns S24

Patterns of range contractions and extinctions in the New Zealand herpetofauna following human colonisation. CHARLES H. DAUGHERTY[1] AND DAVID R. TOWNS[2]. [1]*School of Biological Sciences, Victoria University of Wellington, P.O. Box 600, Wellington, New Zealand.* [2]*Dept of Conservation, Private Bag 68908, Newton, Auckland, New Zealand.* Data confirming range contractions and extinctions of New Zealand amphibians and reptiles are limited. However, evidence from subfossils and present distributions is consistent with that from New Zealand landbirds, in which 40% of the fauna, including the largest species, has become extinct in the 1000 years since human arrival. The largest extant species of all higher taxa — leiopelmatid frogs, tu-

atara, skinks, and geckos — are extinct on the mainland; 31% of the extant fauna (19 of 62 species) survive largely or entirely on rat-free offshore islands; and many species now occur in only a few isolated locations, remnants of once wider distributions, a pattern called "secondary endemism". Habitat alterations and occasional human predation may have contributed to range contractions, but the primary factor in extinctions is almost certainly introduced mammals, especially rats. At least three lines of evidence support this view: (1) Species diversities and population densities are both far higher on rat-free islands than on mainland sites and rat-inhabited islands. (2) Nocturnal species have suffered far more than diurnal ones; all populations of tuatara, 2 of 4 species of frogs, the largest species of *Cyclodina* skinks, and the largest species of *Hoplodactylus* geckos are now restricted to islands, most rat-free; and the largest mainland species are *Leiolopisma* skinks, which are exclusively diurnal and occur at high elevations where rats are uncommon. (3) Lizard populations on islands where rats have been exterminated have shown rapid increases in habitats occupied, densities, and reproductive success. [KEYWORDS: extinction, herpetofauna, New Zealand, rats].

Davies

S05

Heterochrony in the Myobatrachinae and Limnodynastinae. MARGARET DAVIES. *Dept of Zoology, The University of Adelaide, South Australia 5005, Australia.* Examination of ontogenetic trajectories of cranial bones and of the hyoid in pre-metamorphic and post-metamorphic *Limnodynastes* from the three recognised species groups and from pre-metamorphic *Megistolotis*, *Adelotus*, *Lechriodus fletcheri*, *Neobatrachus centralis* and *Notaden melanoscaphus* identified six osteological and one hyoid features that are influenced by heterochrony. Comparisons of the data derived from a similar study of myobatrachine taxa show major differences in timing of onset of ossification between taxa in the two subfamilies. Although the features influenced by heterochrony in the limnodynastine taxa are similarly influenced in the myobatrachines, the ontogenetic trajectories of all features are not identical. [KEYWORDS: Limnodynastinae, Myobatrachinae, heterochrony, *Limnodynastes*, osteology, ontogeny].

Day & Thorpe

S08

Population differentiation in the Lesser Antillean iguana, *Iguana delicatissima*. MARK L. DAY AND ROGER S. THORPE. *Dept of Zoology, University of Aberdeen, Aberdeen AB9 2TN, Scotland, United Kingdom.* The Lesser Antillean Iguana (*Iguana delicatissima*) is endemic to thirteen islands in the Lesser Antilles. Populations from each island, and from a range of ecologically diverse areas within Dominica have been studied. Body proportions, colour-pattern and scalation were recorded from each population. The geographic variation in these features have been described by multivariate analysis and causal hypotheses tested by partial Mantel tests. Ecogenetic adaptation to current ecological conditions is implied by these tests. Direct sequencing of a mtDNA gene, cytochrome b, was carried out in an attempt to deduce the influence of historical processes on the biogeography and geographic variation of this species. [KEYWORDS: *Iguana*, Lesser Antilles, morphometrics, hypothesis testing, mitochondrial DNA.].

De Avila-Pires

C07

Brazilian Amazonian lizards — species composition and zoogeographical notes (Reptilia: Squamata). TERESA C. S. DE AVILA-PIRES. *Museu Paraense Emilio Goeldi/DZO. C.P. 399. 66017-970 Belém, Par´, Brazil.* At present 87 species

of lizards (at least two of which are indeed species complexes) are known from Brazilian Amazonia. One, *Hemidactylus mabouia*, is a relatively recent introduction. Among the others, 14 are from open vegetation, 68 are forest species, and three occur in both environments (habitat of the one remaining species is unknown). The latter three are widespread in a large part of South America. Most forms from open vegetation either occur south of Amazonia and reach only some southern Amazonian enclaves (6 species), or occur in open areas to the north, and along the Amazon basin (2 species and 2 species complexes). *Tropidurus hispidus* occurs both north and south of the Amazon, and three other *Tropidurus* species are restricted to southern Amazonian enclaves. Among forest species,17 are widespread; 3 are restricted to the basins of the large rivers; 5 occur in most of the region, except the westernmost zone; at least 10 are restricted to the western part, and other 8 species to a southwestern area. Other types of distribution are less well defined. Only three species occupy (and are restricted to) all the area north of the Amazon and east of Rio Negro (the 'Guianan region'), while three others occur only in the western part of this area. Of these three, two inhabit dry forest, the third may be restricted to higher altitudes. Another three species occur in (different) restricted areas north of the Amazon. South of the Amazon, one species occurs from MaranhMo to Rondônia, four other species are known only from restricted areas. Some attempts to correlate these distributional patterns with those of other organisms, and to explain them, will be made during the presentation. [KEYWORDS: lizards, Amazonia, Brazil, taxonomy, zoogeography].

de Buffrénil

S17

Economic use and some biologic parameters of heavily exploited populations of the Nile monitor (*Varanus niloticus niloticus*). VIVIAN DE BUFFRÉNIL. *Museum National d'Histoire naturelle, Paris, France.* The economic exploitation of the Nile monitor, *Varanus niloticus*, in very active in the Soudano-tropical region of Africa. Four countries are mainly involved in the international trade of monitor skins: Mali, Cameroon, Chad, Soudan. Between 1985 and 1990, 465,871 skins in the average were traded each year, with a maximum of 702,314 skins for the year 1988. The techniques used to catch the lizards mainly involve hooks baited with fish, frogs or monitor meat. To a lesser extent, hunters my also use spears, snares or trained dogs. The destructive power of these techniques is discussed. Monitors taken by the hunters were studied biometrically in Chad, Mali and Cameroon. The monitors of lake Chad are the biggest and heaviest. They are also older on the average than the lizards from the other regions (age evaluations made by using the so-called skeletochronological technique). Growth rates of the monitors (body length as a function of age) was quantified. Though substantial differences exist between the lizards of Lake Chad and those of other regions, the growth rate of *Varanus niloticus* seems very rapid, as compared, for example, to the few data available for the Komodo monitor (*V. komodoensis*). Precise comparative data dealing with growth rates of wild monitors are extremely poor. Hence, growth curves presented herein could be a useful reference for future studies on other species or populations. The number of eggs found in the oviducts of females is expressed as a function of body length, and the diet of the lizards, as assessed by stomach contents, is described.

de Lapparent de Broin

S02

Examples of parallel evolution in Pleurodira from the Cretaceous to the

Present. FRANCE DE LAPPARENT DE BROIN. *Laboratoire de Paléontologie — URA 12 du CNRS, Muséum national d'Histoire naturelle, 8 rue Buffon 75005 — Paris, France.* Known since Triassic times in Germany, at a Pangean period of the Earth, Pleurodira developed in two areas, from Cretaceous, with a North-Gondwanian fauna of Pelomedusoides in Northern South America, Africa, India, South Western Europe and a South-Gondwanian fauna of Chelidae in Patagonia (South Eastern Argentina) and Australia (in relation by Antarctica, as hypothesised). Many homoplasies between the two groups are at the origin of confusions of determinations of fossil Pleurodira. As previously shown by others, the only detected autapomorphy of the group is the link by a suture between pelvis and shell. The lateral flexion of the neck, which gives its name to the infraorder, is parallelled in the two main groups as indicated by the different positions of flexion joints in the cervical column. The study of Recent skeletons and of new fossil material of Pelomedusoides, from the Cretaceous of Africa and Northern South America and of Chelidae from Patagonia, shows that many more characters than thought are developed by homoplasy in the two groups, including characters attributed earlier to the first or to second group. Examples of homoplasies are given, such as: full emargination of the skull (meeting of the lateral and of the posterior emarginations); fusion of the postzygapophysis and elongation of the cervical vertebrae; shell with strong polygonal ornamentation, shell elongation and plastral expansion, cervical shield loss, neural series reduction in front of the supra-pygal plate, lateral mesoplastra loss etc. A review of the principal detected homoplasies and of the apomorphies of each group is given, and the phylogeny and paleobiogeography of the two main groups is recalled. [KEYWORDS: turtles, Pleurodira, evolution, fossil, recent].

Delheusy & Bels

C06-046

Prey effects on feeding behaviour in *Phelsuma madagascariensis*. VÉRONIQUE DELHEUSY[1] AND VINCENT L. BELS[2]. [1]*Laboratory of Functional Morphology, quai Van Beneden 22, B-4020 Liege, Belgium.* [2]*Agronomic Centre of Applied Researches of Hainaut, rue Paul Pastur 11, B- 7800 ATH, Belgium.* Kinematics of prey reduction, transport through the buccal cavity and deglutition by the gekkonid lizard *Phelsuma madagascariensis* were investigated using high-speed cinematography. Quantified profiles of the head, jaws, throat-tongue and movements of the prey during both phases are compared. Additional kinematic variables depicting maximal displacements and the timing of events were calculated from the profiles. Kinematic variables documenting gape cycles were used in a first principal component analysis for studying the kinematic relationships between the phases. Two prey types (mealworm and cricket) were used. A three-way analysis of variance was performed on variables to measure the effects of physical features (form and size) on the reduction and transport cycles. This analysis was a mixed-model design that crossed the fixed behaviour effect with the fixed prey effect and the random individual effect. Kinematic profiles of each phase in *P. madagascariensis* with previously described data for both sister-groups of lizards. All the data are used to see whether gape and tongue cycles follow the Bramble and Wake (1985) general model for primitive tetrapods and the evolutionary features proposed for Amniota by Reilly and Lauder (1990). (Bramble, D.M. and Wake, D.B. (1985). Functional Vertebrate Morphology, Harvard University Press. Reilly S.M. and Lauder G.V. (1990), Evolution 44: 1542-1557). [KEYWORDS: Gekkonidae, feeding kinematics, prey, tongue].

Dell & How

S09

Responses of lizards to environmental variables in the Pilbara, Western Australia. J. DELL AND R.A. HOW. *Western Australian Museum, Francis St., Perth, W.A. 6000, Australia.* A rich and diverse lizard assemblage of 52 species occurs at Woodstock Station in the arid Pilbara region of Western Australia. A three year pitfall trapping program examined the annual and seasonal changes in condition of four species as measured by a body mass index. Species that occupied the *Triodia* dominated sandplain vegetation types had their greatest condition index following the cyclonic rains of late summer, while a gecko associated with the homestead showed little seasonal or annual variation in condition. A wildfire that burnt through several sites during the study showed that the number of species and their abundance were adversely affected by fire. Fossorial and burrow inhabiting species survived the immediate impact of fire, but most *Triodia* and shrub dwelling species became extinct on burnt sites [KEYWORDS: lizards, seasonality, condition, variation, fire, habitat].

Dempsey & Limpus

C06-047

The effect of temperature on emergence and locomotion in hatchling loggerhead (*Caretta caretta*) and flatback (*Natator depressus*) turtles. PAULA J. DEMPSEY[1] AND COLIN J. LIMPUS[2]. [1]*Dept of Dentistry, The University of Adelaide, South Australia 5005, Australia.* [2]*Queensland National Parks and Wildlife Service, P.O. Box 155, Albert St, Brisbane, Queensland 4002, Australia.* During the time between emergence from a nest and reaching the sea, the core temperature of hatchling sea turtles tended to drop from about 34°C to about 27°C (air temperature). During this time, the speed of loggerhead hatchlings increased two to four times, whereas flatback hatchlings did not increase speed. The average body weight of the loggerhead hatchlings was 20.4 g, while the average weight of the larger flatback hatchlings was 36.4 g. To test the hypothesis that temperature alone, in the absence of other confounding variables, affects speed, hatchlings were acclimated in waterbaths set at 26, 28, 30 and 32°C. The time taken to run two metres over sand was recorded. Speed decreased with increasing temperature in loggerheads, but remained constant at all temperatures in flatbacks. The loggerhead hatchlings in the two cooler waterbaths were also observed to be much more actively swimming in their buckets than the hatchlings in the warmer water. This response to temperature may be one factor regulating emergence of turtles from nests, as emergence during the hottest part of the day can be fatal. [KEYWORDS: sea turtles, temperature, emergence, locomotion, *Caretta caretta*, *Natator depressus*].

Devaux

S18

The conservation programme for Hermann's tortoise. BERNARD DEVAUX. *SOPTOM c/o Le Village des Tortues, BP 24, 83590 Gonfaron, France.* The few remaining wild populations of Hermann's tortoise, one of Europe's most threatened reptiles, continue to decline in their natural habitats in France, Spain and Italy. Since the beginning of the century the principal causes have been a combination of habitat destruction and modification through urbanization, forest fires and changing agricultural practices, as well as collecting from the wild. Recent field studies, including population censuses and radio-tracking programmes, have elucidated many of the factors threatening this species. In 1986 the Station d'Observation et de Protection des Tortues des Maures (SOPTOM), based in southern France, launched a species recovery programme, which was subsequently included within the IUCN Tortoise and Freshwater Turtle Action Plan (1989). The key aims are to protect natural habitats and

to reinforce remaining populations through restocking and reintroduction, at a rate of approximately 500 animals per annum. In parallel an intensive information campaign has been carried out to generate greater public and official awareness. The project is coordinated by SOPTOM from its unique and highly successful conservation and visitor centre at Gonfaron, the "Village des Tortues". Further studies on the impact of releasing captive reared animals, the movement patterns and dispersion of sub-adults and the effectiveness of different rearing techniques in relation to egg-laying, incubation and thermoregulation, are in progress. Hermann's tortoise is one of the most studied of terrestrial chelonians, yet it still remains very much at risk.

Díaz

S20

Prey selection in lacertid lizards: variation in the effects of prey size, prey profitability, and nutrient constraints. JOSÉ A. DÍAZ. *Depto. de Biología Animal I (Vertebrados), Fac. de Biología, Univ. Complutense, 28040 Madrid, Spain.* The vast majority of papers on optimal diets have dealt with endothermic birds and mammals. Lacertid lizards are insectivorous ectotherms whose energy requirements with small, terrestrial and food consumption rates are relatively much lower. Thus, maximising profitability may be just an optional strategy for these small ectotherms. Nevertheless, lacertids exhibit precisely defined patterns of prey selection. They are selective in the sizes of the prey they capture, and mean prey size (but not profitability, counterbalanced by longer handling times) has been shown to be a good predictor of prey types selection in several species. In at least some instances, nutrient optimisation has also been suggested. I will argue that, taking into account prey availability, the foraging choices of lacertid lizards represent complex behavioural response in which at least three additional factors are involved: 1) predation risk; 2) time constraints, related to reproductive cycles, that favour time minimisation in the breeding season (within-prey types size selection strongly correlated with profitability), and movement minimisation in the postbreeding season (selection of larger but fewer prey no matter their mean profitability); and 3) body temperature, whose effects on handling time, and hence profitability, show a significant interaction with prey size (handling times increase faster with prey size at low temperatures), causing temperature dependant shifts in prey choice and feeding behaviour. [KEYWORDS: ectothermy, foraging currencies, Lacertidae, predation risk, prey selection, thermal dependence, time constraints].

Díaz *et al.*

C23

Variation of reproductive characteristics in lacertid lizards: a comparative study. RAMÓN DÍAZ[1], DIRK BAUWENS[2] AND L. JAVIER BARBADILLO[3]. [1]*Dept Zoology, University of Wisconsin, Madison WI 53706, United States of America.* [2]*Inst. Nature Conservation, Kiewitdreef 5, B-3500 Hasselt, Belgium.* [3]*Unid. Paleontología, Univ. Autónoma Madrid, E-28049 Madrid, Spain.* We analysed quantitative, interspecific differences in reproductive traits in a group of lacertid lizards for which detailed information on a set of reproductive characteristics was available in the literature. The variables examined were: estimates of the body size of reproductive females, size and mass of the clutch, size of eggs and hatchlings, and clutch frequency. To correct for statistical problems induced by the phylogenetic relationships among the species studied, we used Felsenstein's method of phylogenetically independent contrasts to analyse covariation among the reproductive characteristics. All traits exhibit strong relations with female body size. We examined differences among traits in their scaling relations

to female body size. The larger sized species produce relatively smaller hatchlings, and exhibit a larger size increment between hatching and the attainment of sexual maturity. Growth of the adult females is proportional to their body size. The relation of total clutch mass to female size is isometric; the number of eggs scales positively, whereas egg mass scales negatively to female size. Thus, the partitioning of energy allocated to a clutch changes with female size: large species produce more and smaller young than would be expected from the null model of geometric similarity. Hence, body size is an important component of a species' life history phenotype, mediating the expression of reproductive characteristics. We also examined covariation among reproductive characteristics, after statistically removing the effect of body size. Few clear-cut patterns were evident. We conclude that female size is the single most important variable explaining a major portion of the interspecific variation in reproductive traits in this clade of lizards. [KEYWORDS: life-history, reproduction, covariation, allometry].

Dilmukhamedov & Duysebayeva (Matveyeva)

C06-048

The skin sense organs of squamate reptiles (Reptilia: Squamata): comparison with lateral line system. MARAT E. DILMUKHAMEDOV AND TATJANA N. DUYSEBAYEVA (MATVEYEVA). *Dept of Biology, Kazakh State University, Timirjaseva Street, 46 Alma-Ata, 480121, Kazakhstan.* The attempt to establish a vague relationship between the skin sense organs (SSO) of primitive squamate reptiles (Agamidae, Iguanidae, Gekkonidae), scales (bony and horny) and neuromasts of poikilothermal vertebrates is undertaken. SSO are located in the epidermis. There are two types of neuromast arrangement in the integument : peripheral in the epidermis (free neuromasts, FN) and deep in the dermis (lateral line neuromasts, LLN). LLN, in contrast to FN, are consolidated in the lateral line system and presumably contribute to skin bone development. It is shown that the pattern of SSO topography on the head of squamate reptiles resembles the pattern of LLN topography on the head of ancestral sarcopterygians and poikilothermal vertebrates. This similarity can be determined not only functionally, but it can also have a certain genetic reminiscence. Possible correlation between a superficial location of SSO of primitive squamate reptiles and loss of an ability of its integument to skin bone development (no without exception) is discussed. [KEYWORDS: squamate reptiles, integument, skin sense organs, lateral line system].

Dodd & Franz

C10

Island distribution of amphibians and reptiles in the Exuma Cays Land and Sea Park, Bahamas. C. KENNETH DODD, JR.[1] AND RICHARD FRANZ[2]. [1]*National Ecology Research Center, National Biological Survey, Gainesville, FL 32601, United States of America.* [2]*Florida Museum of Natural History, University of Florida, Gainesville, FL 32611, United States of America.* The herpetofauna of islands in the Exuma Cays Land and Sea Park, Bahama Islands, is influenced by both island size and anthropogenic factors. Of the 16 native amphibians and reptiles in the Exuma Island Archipelago, 15 are now recorded from within the park. Intensive surveys conducted between 1990 and 1993 indicate that individual islands (N=24) contain from 1–12 species. *Anolis sagrei* was recorded from every island, including the smallest vegetated rocks; the frogs *Osteopilus septentrionalis* and *Eleutherodactylus planirostris*, the lizard *Anolis smaragdinus*, and all snakes were found on fewer than six islands. *Cyclura cychlura* and *C. rileyi* are introduced in the park. The lizards *Leiocephalus carinatus* and *Ameiva auberi* are probably important indicators of human-related impacts, through

the effects of exotic predators, on Exuma Island faunas. At the same time, preliminary fossil data suggest several species disappeared as island size decreased. [KEYWORDS: islands, biogeography, amphibians, reptiles, Bahamas].

Dolmen *et al.*

C06–049

Habitat and threats to the red list species *Ranodon sibiricus* (Hynobiidae). D. DOLMEN[1], J.V. ARNEKLEIV[1], R. ALEKSANDROVICH KUBYKIN[2] AND D. MIKUTAVICHUS[3]. [1]*University of Trondheim, The Museum, N-7004 Trondheim, Norway.* [2]*Inst. of Zoology, National Academy of Rep. Kazakhstan, Almaty 480099, Kazakhstan.* [3]*T. Ivanausko Zoological Museum, 3000 Kaunas, Lithuania.* *Ranodon sibiricus* Kessler inhabits a very small area, in the SE Kazakh mountains. Studies have been carried out in June 1993 on habitat, different life aspects, and on possible threats to the species. Its habitat is clear-water mountain brooks, at an elevation of 1700–2700 m, fed by melt-water or originating from small hill-side springs, and the immediate terrestrial surroundings. Brooks 0.1–0.2 m deep and 0.5–1 m wide, with small waterfalls and a current velocity of 0.7–0.8 m/sec., seemed favourable, but the salamander could also be found in larger streams, or in very small brooklets, some places with overhanging turfs. The substrate was usually gravel, stones, and blocks. On land the species was found under stoneblocks by day and walking around on the banks during the night. Water temperature of the springs kept 4–5°C, but could in the brooks vary from ca. 3 to more than 20°C during a day and night. Water quality parameters showed pH: 6.8–7.6, conductivity K25: 60–154 μS/cm, and water colour 5–15 mg Pt/l. The bulk of the diet of *R. sibiricus* consisted of Lumbricidae, Trichoptera and Plecoptera larvae. The distribution of *R. sibiricus* coincides with the former spruce tree zone, which now steadily, and during the past, has been greatly reduced and most of it changed to grazing pastures for large flocks of cattle, sheep, and horses. The main threat to *R. sibiricus*, in addition to possible delayed effects from this habitat change, seems to be the impact of cattle, wading in the brooks and thereby destroying the egg sacs of the salamander, and probably also dirt and cattle excrements polluting the water. The impact of predation from fish and from fishing activities may also be potential threats in the larger streams. Fishing is done with nets, or by building of dams, redirecting the stream, and thereby drying out stretches of salamander habitat. Poachers should likewise be considered. [KEYWORDS: *Ranodon sibiricus*, habitat, threats].

Donnellan & Birrell

C01

Evolutionary relationships of Australian lizards inferred from DNA sequences of mitochondrial genes. STEPHEN DONNELLAN AND JAN BIRRELL. *Evolutionary Biology Unit, South Australian Museum, Adelaide 5000, Australia.* Partial sequences of the mitochondrial 12S ribosomal RNA and cytochrome b genes were used to estimate the phylogenetic relationships of Australian squamate families. Firstly, partial 12S rRNA sequences from members of 15 squamate families, including seven families represented in Australia, and *Sphenodon* as an outgroup provide little resolution of interfamilial relationships. Alignment of sequences in this data set proved to be difficult. Secondly, partial 12S rRNA sequences were used to estimate relationships among Australian members of the lacertilian groups Gekkonoidea and Scincidae. These data provided corroboration of relationships among tribal level groupings (Greer 1979, *Rec. Aust. Mus.* 32: 339) within the Australian Scincidae. Among the gekkonoid taxa, apart from corroborating pygopods as a member of the Diplodactylinae, these

data resolved little. Partial sequences of the cytochrome b gene were used to estimate the phylogenetic relationships of the endemic Australian family Pygopodidae. Results of these analyses are compared with phylogenies of pygopod genera constructed from morphological and allozyme data. [KEYWORDS: lizard, squamate, mitochondrial DNA, ribosomal RNA, cytochrome b, phylogeny].

Multiple paternity in the frog *Agalychnis callidryas*. CHRISTIAN A. D'ORGEIX AND BRUCE J. TURNER. *Dept of Biology, Virginia Polytechnic and State University, Blacksburg, Virginia 24061, United States of America.* In contrast to the internal fertilization found in insects, some fishes, and amniotic vertebrates, male anurans fertilise eggs externally by releasing sperm over them during, or shortly after their extrusion from the female. The potential for direct access to the eggs may make males particularly vulnerable to sperm competition. In the Red-eyed treefrog *Agalychnis callidryas* multiple-male assemblages of 2–6 unamplexed males may join a male-female pair during oviposition and attempt to fertilize her eggs. DNA fingerprinting was used to determine paternity of tadpoles from "one female-multiple male" matings in a naturally occurring population in Panama. Variation in fertilization success of primary (amplexed) and secondary (unamplexed) males in multiple-male matings ranged between 0–100%. Variation in fertilization success is attributed to temporal investment and spatial position of males during female oviposition. These results suggest an absence of physiological barriers for multiple-male fertilisation of a single female's egg clutch by external fertilisation. [KEYWORDS: multiple-paternity, sperm competition, sexual selection, frogs, amphibians].

d'Orgeix & Turner

C24

Sex-biased natal dispersal in *Uta stansburiana*. PAUL DOUGHTY[1], BARRY SINERVO[2], AND GORDON M. BURGHARDT[3]. [1]*School of Biological Sciences, University of Sydney, NSW 2006, Australia.* [2]*Dept of Biology, Indiana University, Bloomington, IN 47405, United States of America.* [3]*Dept of Psychology, University of Tennessee, Knoxville, TN 37996, United States of America.* Neonate dispersal was measured from 1989–1991 in two populations of the side-blotched lizard, *Uta stansburiana*, in central California, USA. Eggs were size-manipulated to produce miniaturised, normal, and giganticized hatchlings to investigate the effects of body size on dispersal. Hatchlings were released in the field following hatching and were captured throughout summer and the following spring. There was no effect of body size on dispersal at either site. Median dispersal was approximately four times greater at Del Puerto Canyon than at Los Baños where adults and juveniles do not occur together. Overall, there was a tendency for males and late season hatchlings to disperse further. However, there were large overlaps in dispersal distributions for all traits studied, indicating a large stochastic component to lizard dispersal. [KEYWORDS: dispersal, neonatal behaviour, habitat differences].

Doughty *et al.*

C26

Natural history of the southern leaf-tailed gecko, *Phyllurus platurus*. PAUL DOUGHTY AND RICHARD SHINE. *School of Biological Sciences, University of Sydney, NSW 2006, Australia.* We dissected 177 specimens of *Phyllurus platurus* deposited in the Australian Museum in Sydney, Australia. Although males mature at smaller body lengths than do females (SVLs of 70 vs. 77 mm), *P. platurus* displays no significant

Doughty & Shine

C06–050

sexual dimorphism in average values of adult SVL, head length, head width, inter-limb length, or height at the shoulder. However, females have much thicker (i.e. higher) abdomens than do male conspecifics, and females carrying oviducal eggs had significantly thicker abdomens than did same-sized nongravid females. This bodily dimension may constrain the range of available crevice sizes that can be occupied by gravid females, and hence increase the animals' vulnerability to predation. *Phyllurus platurus* feed primarily on large, nocturnally active prey such as spiders, cockroaches, and centipedes. We also present data on seasonal cycles of reproductive activity. [KEYWORDS: sexual dimorphism, foraging strategy, reproductive cycles].

Driscoll

C33

Speciation potential of an endangered West Australian frog. DON DRISCOLL. *Dept of Zoology, University of Western Australia, Nedlands, Perth, Western Australia 6009, Australia.* An important aim of conservation biology is to maintain the evolutionary potential of a species. To do that, an understanding of the distribution of genetic diversity and potential speciation mechanisms is required. *Geocrinia alba* (Anura: Myobatrachidae) is threatened with extinction. As part of the conservation plan for this species, an allozyme electrophoresis study was undertaken to investigate its evolutionary potential, specifically, the potential for speciation. *G. alba* was found to be highly genetically subdivided, with a Fst value of 0.366 for 13 populations collected from an area of 110 km^2. This indicates that small or isolated subpopulations may be important in speciation. The absence of allelic variation in two subpopulations suggests population bottlenecks may have a role in speciation. Other subpopulations exhibit a continuum of variation at some loci, suggesting gradual divergence in allopatry is also potentially important. It is concluded that isolated populations are likely to be important in the future evolution of *G. alba* and therefore the goal of conservation managers should be to maintain all of the subpopulations of this species. [KEYWORDS: speciation, endangered frog, subpopulations].

Dunham & Niewiarowski

S15

Individual based models and the evolution of life histories. ARTHUR E. DUNHAM[1] AND PETER H. NIEWIAROWSKI[2]. [1]*Dept of Biology, Leidy Labs, University of Pennsylvania, Philadelphia, PA 19104, United States of America.* [2]*Savannah River Ecology Laboratory, Drawer E Aiken, SC 29802, United States of America.* We consider a life history to be a heritable set of rules which, given an individual's environmental context and physiological status, determines a time ordered sequence of energy and time allocations made over its lifetime. These allocations produce a life history phenotype, and most theoretical and empirical work has focused on observed variation in life history phenotypes. We use an individual-based, physiologically structured model to alternatively study the evolution of allocation rules (life histories) in *Sceloporus merriami* the canyon lizard. Our model is particularly well suited to the study of the evolution of life histories because it can reveal the population consequences of variation in allocation rules among individuals over a wide spectrum of time frames. By iterating the model over long periods of time, we examine the relative fitness of different allocation patterns resulting in various life history phenotypes (i.e. body size, growth rate, fecundity, offspring size, longevity, etc.) in specific environments. Finally, we evaluate the potential role such models may play in the general study of the evolution of life histories.

Durbin *et al.*

C30

Local people and Project Angonoka; conservation of the ploughshare tortoise, *Geochelone yniphora*, north-western Madagascar. JOANNA C. DURBIN[1], VELOSON RAJAFETRA[2], DON REID[3] AND DAURETTE Y. RAZAN DRIZANAKANIRINA[4]. [1]*Durrell Institute of Conservation and Ecology, University of Kent, Canterbury, Kent, CT2 7NX, United Kingdom.* [2]*WWF-Education, WorldWide Fund for Nature, BP 738, Antananarivo 101, Madagascar.* [3]*Jersey Wildlife Preservation Trust, BP 738, Antananarivo 101, Madagascar.* [4]*Dept of Anthropology, Ecole Normale Niveau Trois, Antananarivo 101, Madagascar.* Project Angonoka, in its aim to protect the endangered Angonoka or Ploughshare tortoise *Geochelone yniphora* in rural north-western Madagascar, has found it is indispensable to work with local people. We have discovered that many of the environmental changes threatening the Angonoka, in large part derived from uncontrolled and repeated bush fires, also cause difficulties for local people. As the original vegetation diminishes, fewer important forest products are available, and erosion causes silting of rice fields and fishing lakes. Jersey Wildlife Preservation Trust with the WorldWide Fund for Nature Education team in Madagascar have started an environmental education and awareness campaign in the main town, Soalala, and in villages close to tortoise areas. Over several days groups of men, women and children participate in discussions, handicrafts, singing and dancing and a traditional feast. The Angonoka is used as a main theme, as an animal unique to their region, whose near extinction symbolises the drastic impact of environmental degradation. As a result Associations for the Protection of the Environment have been created in the town and in villages. These associations provide a forum for discussion and a focus for environmental activities, such as tree planting, setting up measures to control bush fires, cleaning up communal areas and rehabilitating wells. They show real promise as village- based and village-run organisations which demonstrate a local willingness to improve their management of the environment and will be the key to success in efforts to save the Angonoka. [KEYWORDS: local people, ploughshare tortoise, environmental education, village associations, conservation, Madagascar].

Dutta

C33

Sensitive, indeterminate, vulnerable and threatened or endangered species of amphibians of India with proposal for their protection. S.K. DUTTA. *P.G. Dept of Zoology, Utkal University, Bhubaneswar 751004, Orissa, India.* The amphibian fauna of India is represented by 201 species and only three species (two bufonids and one microhylid) have been treated as "Indeterminate" by the IUCN. However, there are about 13 species which are exploited for food by some of the local inhabitants of their concerned geographic ranges. Of these, two species (Indian, bull frog: *Limnonectes tigerinus* and Indian green frog: *Occidozyga hexadactyla*) are exposed to heavy exploitation due to their larger size than others. Hence, they are proposed under "Sensitive and Vulnerable" status. Similarly, eleven species (three bufonids, three rhacophorids and five ranids) are proposed in "Indeterminate" status due to their scarcity in natural habitat. The proposed inclusion of the species under "Indeterminate" status is based on recent studies by researchers in southern India. Further, the population census and field studies on the two common edible frogs (*L. tigerinus* and *O. hexadactyla*) provide evidence of gradual decrease in number of natural population due to commercial exploitation and the use of chemicals and fertilisers in agricultural fields. Specific recommendations (captive breeding, large scale rearing of tadpoles until meta-

morphosis, release program and public awareness) are also proposed to increase the natural population of some sensitive and vulnerable species.

Duysebayeva (Matveyeva) & Duysebayev

C06–051

Captive maintenance of desert monitor *Varanus griseus* Daudin, 1803. TATJANA N. DUYSEBAYEVA (MATVEYEVA) AND GAPAR J. DUYSEBAYEV. *Dept of Biology, Kazakh State University, Timirjaseva Street, 46, Alma-Ata, 480121, Kazakhstan.* Juvenile desert monitor (TL=25.5 cm; SVL=11 cm) from Eastern Kyzylkum desert was kept for three years in a 5×4×3 m terrarium partially covered by sand. The light used were natural and artificial by bulb at the voltage 150 w. Temperature fluctuation was 25–40°C. During the first year of keeping the diet included: orthopterans, small lizards, bits of hard-boiled eggs grounded up with shells, liver, fish, meat and flowers of *Tarazacum officinalis* and *Cichorium intybus*. Later the small vertebrates (laboratory mice and rats, cavies and cricetids) became the major components of the diet. Periodically the diet was supplemented with multi-vitamins. Shedding occured regularly every 2–3 months by large skin parts. At the maturity (*Varanus griseus* of three years) the total length was 100 cm and snout-vent length was in agreement with growth rate of the desert monitor in the wild. Mature desert monitor was given to the varanid nursery for breeding. [KEYWORDS: Varanidae, *Varanus griseus*, captive maintenance, feeding].

Dyson *et al.*

C29

Conditional mate choice in Gray treefrogs. MIRANDA L. DYSON[1], STEVEN TANNER[2] AND H. CARL GERHARDT[2]. [1]*Behavioural Ecology Research Group, Psychology Dept, University of Natal, King George V Ave, Durban, 4001, South Africa.* [2]*Division of Biological Sciences, University of Missouri, Columbia, Missouri 65211, United States of America.* Female gray treefrogs *Hyla versicolor* select among conspecific calls on the basis of differences in duration. Preferences for long calls over short calls cannot be explained solely by differences in the acoustic energy of the signals. Variation in call duration among males correlates with energetic investment in courtship, and differences in the ability of males to produce energetically expensive calls could reflect differences in physical condition, genetic fitness or fertility. If females gain such benefits from mating with males that produce long calls, then they should be willing to incur some cost in order mate with these males. We used two-stimulus phonotaxis experiments to determine the extent to which females will incur costs in order to mate with preferred males. To do this, we presented females with two calls that differed in duration and allowed them to move halfway to the preferred long call. The playback of the long call was then stopped. When the female reached a point midway between the release point and the short call, playback of the long call was resumed. With a 100% difference in call duration (12 pulses vs 24 pulses), females always turned back and responded to the longer alternative. A similar, although non-significant result was found when females were presented with alternatives of 18 pulses and 12 pulses (50% difference). However, females failed to turn back to the longer call when offered a choice between calls with 30 pulses and 18 pulses (67% difference) and between calls with 18 pulses and 24 pulses (33% difference). We also presented females with a 24 pulse call and a 12 pulse call but increased the distance required to travel to reach the longer call. Under these conditions, females failed to turn back to the 24 pulse alternative. These results suggest that females are willing to incur some, albeit limited, cost in order to mate with males that produce the long calls and, to a lesser extent, to avoid mating with individuals that produce very short calls. [KEYWORDS: mate choice, sexual selection, phonotaxis].

Dziubinschi

C06-052

Conservation of reptile fauna in Romania. J. DZIUBINSCHI. *Str. Viitorului Nr 6 Bl. H-H Sc.B Ap4, Suceava, Romania.* Geographical location of Romania and the diversity of ground morphology can be the reason for the large enough number of species representing herpetological fauna of this country. The reptile fauna consist of ten species of snakes belonging to *Eryx* (Boidae); *Coluber*, *Elaphe*, *Natrix*, *Coronella* (Colubridae), *Vipera* (Viperidae); nine species of lizards representing *Ablepharus* (Scincidae); *Eremias*, *Lacerta* (Lacertidae) and *Anguis* (Anguidae) together with two species of tortoise (*Testudo* and a species of fresh water turtle (*Emis orbicularis*). A few isolated individuals of marine turtle — *Caretta caretta* and *Chelonia mydas* were captured by fishers near the Romanian coast of the Black Sea. The number of species is significant and is not made clear; more investigations are required. As general trend in the world, the deterioration of nature, the destruction of specific habits cause in Romania too the decline of amphibians and reptiles. Since 1986 a long term investigation both on the ecology and the distribution of the very threatened species such as *Vipera ursini*, *Eryx jaculus turcicus*, *Elaphe quatuorlineata sauromates*, *Coluber jugularis caspius*, *Testudo graeca ibera* and *T. hermanni* has been carried out. In this paper the preliminary results of this study are reported, together with analysis of key factors that disturb specific habitats (even in protected areas) and conservation measures required.

Echeverría & Montanelli

C06–053

Microanatomy of the buccal apparatus and oral cavity of *Hyla minuta* Peters, 1872 (Anura, Hylidae). DINORAH D. ECHEVERRÍA AND SILVANA B. MONTANELLI. *Fac. Cs. Exactas y Naturales (UBA). Depto. Cs. Biológicas, Lab. Vertebrados. (1428) Buenos Aires, Argentina.* Specimens of *H. minuta* larvae have been observed on light and SEM microscopies. Histological and surface observations of the buccal apparatus is characterised by the following features: the number of each column of cells, that give arise to the labial teeth (LT), is very low in A-1 and P-2 rows. Each column has few number of epithelial cells that could developed into preconic cells, and then into labial teeth. LT are very short; without neck; with short and sharp denticles. Beak column of cells are well developed and show variable number of conic cells in different stages of keratinisation process; well keratinised cells at its edge are present. Beak teeth with a main cuspid. Upper beak has thin and sharp edge; lower beak edge is sharp, with proclive position. Teeth development seems to be abbreviated and their distribution over A-1 and P-2 labial ridges could be not completed. A-1 teeth density is lower than P-2, and lower than P-1. Internal oral features: BFA and BRA papillae few and tall; VV marginal projections reduced; secretory pits on the DV and posterior buccal roof. [KEYWORDS: larvae, buccal apparatus, Hylidae, *Hyla minuta*].

Edenhamn & Carlson

C18

Are all patches equal? — Patch dynamics in European tree frogs (*Hyla arborea* L.). PER EDENHAMN AND ALLAN CARLSON. *Dept of Wildlife Ecology, The Swedish University of Agricultural Sciences, Box 7002, S–750 07 Uppsala, Sweden.* The European tree frog (*Hyla arborea* L.) distribution is fragmented on its northern fringe,

in southern Sweden. In this northern part of its distribution, it is specialised to natural pastures with breeding ponds, free from fish and crayfish. Breeding animals are closely linked to breeding ponds during the chorus period, in May and June. Number of calling males and reproductive success were monitored for the whole Swedish distribution during four successive breeding seasons, 1989–1992, and during 1982. Each year reproducing populations were found in less than half of the ponds where calling males have been recorded. Only 20% of the ponds were used during all five years. These were more probable to have successful reproduction than localities without regularly calling males. This is an example of a source-sink system. Since stability is a good predictor of reproduction regularly used localities are of higher conservation value. Although in a longer perspective there is a turnover even in so called source localities, implicating the importance of a continuous support of new suitable breeding localities. [KEYWORDS: *Hyla arborea*, metapopulation, source-sink, turnover, habitat specialisation].

Ehmann

S25

Amateur herpetology in Australasia: its history, roles, status and future. HARALD EHMANN. *P.O. Box 9, Blackwood, South Australia, 5051, Australia.* Like most natural sciences, herpetology in Australasia has amateur origins. A large number of amateur herpetologists have contributed very substantially to the existing data base of Australasian herpetology. This has been possible because 1) amateur herpetological pursuits can flourish in the relative economic affluence of Australasia, 2) the Region's herpeto faunal abundance/diversity, and 3) relatively relaxed legislative restrictions until about 20 years ago. These restrictions (fauna and animal welfare laws) pose a serious long- term risk to herpetology. Examples of these restrictions and their counterproductive impacts will be discussed. Australasian amateur herpetology plays important roles in public education, environmental awareness, conservation, nurturing enthusiasts who become professional herpetologists, providing specimens, new data and observations, regional surveys, herpetoculture and animal welfare. If status is the collective/averaged opinion of professional herpetologists and legislative decision makers then amateur herpetology's status in Australasia is generally not commensurate with its input to the science. There are widely diverse views on its status, many negative opinions and misleading/false inforrnation abounds. The future of Australasian amateur herpetology and its ongoing contribution is presently at risk of sinking under a stifling and counterproductive bureaucratic overload. [KEYWORDS: amateur herpetology, conservation, fauna legislation, animal welfare].

Ehmann

C06–054

An assessment of the impact of fauna and animal welfare and ethics legislation/enforcement on Australian herpetology and herpetofaunal conservation. HARALD EHMANN. *P.O. Box 9, Blackwood South Australia, 5051, Australia.* There have been some noteworthy positive impacts of fauna protective legislation especially when the measures taken involved predominantly habitat conservation (mostly islands). Other protective measures (particularly those based on individual specimen protection) and enforcement procedures have (in some cases) been a strong success in public relations terms while having negative or no impact in broader ecological population terms. In almost 10 years since the last review of this nature little has changed. Fauna authorities continue to escalate the bureaucratic load placed onto field researchers. The more recent advent of inappropriate (to field study of Australian wild

native fauna) animal welfare legislation is now an additional restriction that diverts important resources from the research efforts so vital to the conservation database for many species. "At risk" species are a more difficult case in some Australian states where it is now necessary to complete an Environmental Impact Study of the research into that species before any field work can commence. Much of this bureaucracy-gone-too-far is the result of well-meant but misguided biased intent, and in some cases even appears to contravene the United Nations Conventions on Biological Diversity, not to mention the collective wisdom of many experienced wildlife researchers. It is time to take stock. Legislative Impact Studies need to be carried out on these legislations and the counter productive impact of nine different governments' views and interpretations of biodiversity conservation practice. A single national policy and executive for biodiversity, conservation and animal welfare/ethics is urgently needed. [KEYWORDS: legislative impacts, biodiversity, endangered, animal welfare].

Ehmann

C06–055

The spotted tree frog (*Litoria spenceri*): has it declined or have breeding conditions been unsuitable? HARALD EHMANN. *PO Box 9, Blackwood South Australia, 5051, Australia.* Extensive surveys in recent years in the highlands of Victoria have demonstrated that Spotted Tree Frogs are absent or in very low numbers at former collection localities. These localities are also potential breeding sites, i.e. places where frogs concentrate. In eastern and south eastern Australia most frog species are difficult to detect when not concentrated. Below the Burkes Gorge Intake (Snowy Mountains Hydroelectricity Scheme) the Bogong Creek (New South Wales) is in a permanent drought-like condition due to upstream water diversion. Drought affected highland streams are (relatively) slow flowing with still shallow side pools which can become 3° to 6°C warmer (by insolation) than the mainstream flow. In late 1992 and early 1993 an opportunistic population study at the site by staff and students involved in the Herpetological Techniques Course (Sydney Institute of Technology) found 90+ frogs and 800+ tadpoles: numbers that greatly exceed those found at any sites in Victoria. The tadpole of *L. spenceri* is not well-adapted to fast waters, and prefers the micro-habitat described above. The south-eastern Australian highlands had higher-than-average rainfall in 1992 and also in at least four previous years. It seems that *L. spenceri* breeds best during drought or near-drought years. In 1993 south-eastern highlands have received lower than average rainfall and the 1993–4 survey season may provide supporting evidence for the drought breeding hypothesis. [KEYWORDS: *Litoria spenceri*, endangered, reproduction, population declines].

Elepfandt

S19

Hearing and acoustic communication underwater in *Xenopus laevis*. ANDREAS ELEPFANDT. *Fak. Biol., Univ. Konstanz, POB 5560, D-78434 Konstanz, Germany.* The clawed frog, *Xenopus*, communicates acoustically like other frogs but completely underwater. For this, the mechanisms for sound production and for hearing had to be adapted to the conditions of underwater acoustics. There is no vocal sac and no externally visible ear. The tympanum is a cartilaginous disc underneath the skin, and the Eustachian tubes are elongated and fuse forming one common air-filled tube with one joint opening to the mouth. The advertisement call consists of a continuous trill of clicks repeated alternatingly at slower and faster rate. Its dominant frequency is between 1600–2000 Hz and very constant for a given individual. Hearing abilities

have been examined by conditioning. Hearing range is 200–4000 Hz. Frequency discrimination is found at low and high frequencies. It is best (2%) at 1800–2000 Hz, so that females can acoustically distinguish conspecific males. Sound is localised from all anterior directions. Calling males occupy territories which they delineate by calling while swimming along the border. Thus, males move more than females. If another male enters the territory, the males start to fight, producing agonistic calls until the weaker emits a release call. If a receptive female enters, mating procedure starts, followed after about an hour by egg laying. [KEYWORDS: frog, acoustic communication, underwater sound].

Elmberg

C12

Life history strategy of female common frogs *Rana temporaria* in a subarctic climate. JOHAN ELMBERG. *Dept of Animal Ecology, Swedish University of Agricultural Sciences, S-901 83 Umå, Sweden.* A population of adult female Common Frogs *Rana temporaria* L. was studied on an alpine heath in northern Sweden. Hibernation lasted more than nine months, spawning a week, and the foraging period two months. Compared with populations in more favourable situations in the foothills and on the north Swedish coast, alpine heath females were older, but there was no consistent altitudinal trend in body length or weight. Fecundity varied significantly between years as well as between study sites. However, there was no consistent trend in either absolute or size-relative fecundity. In the pooled material, fecundity per gram body mass increased with age. Relative ovary weight increased faster in alpine heath females than in foothill females during the foraging period. There was no indication of an ovarian resting period. Rather, with increased altitude the oocytes for next year's reproduction tended to have entered the vitellogenic growth phase even before oviposition of the present year's batch. [KEYWORDS: Hibernation, age, body size, fecundity, oocyte growth].

Er-Mi

S07

Amphibian distribution patterns in temperate eastern Asia. ER-MI ZHAO. *Chengdu Institute of Biology, Academia Sinica, Chengdu, Sichuan, 610041, P.R. China.* This paper deals with an area that includes China including Taiwan (TW) and Hainan (HN), Japan proper (JP), the Ryukyus (RK), the Korean Peninsula, and Mongolia. This vast area crosses the Palearctic and Oriental Realms and can be roughly divided into 11 regions. Three orders, 11 families, 43 genera, and 306 amphibian species are known, of which nine genera and 221 species are endemic. In the Gymnophiona there is one endemic species found in the South China Region (SC) only. In the Caudata there are three families, 14 (7 endemic) genera and 54 (49 endemic) species. Hynobiidae has the most species, mainly in the Palearctic, but with a few species found at high elevation in Central China (CC) and TW regions. The Salamandridae occur mainly in the Oriental Realm with one *Cynops* species on JP. In the Cryptobranchiidae there are two species, on on JP and one widely ranging over mainland China. In the Anura there are seven families, 28 (2 endemic) genera and 251 (171 endemic) species. Ranidae is the largest family with 106 species (74 in the genus *Rana*). In this area both Rhacophoridae and Pelobatidae have more than 50 species. Ranidae, Hylidae (with the exception of Qinghai-Xigang (Tibet) Region-QX), and Bufonidae occur over all 11 regions. Racophoridae is found mainly in the Oriental Realm. Pelobatidae is most abundant in the Southwest China Region (SW). Among the 11 families, all but

Ichthyophidae can be found in SW and CC. These two regions also have the most species and many endemics. Japan Proper has the highest endemism (24 out of 33 species). [KEYWORDS: Amphibia, eastern Asia, biogeography, distribution].

Physico-chemical characteristics of breeding sites of *Bufo marinus*. MURRAY EVANS[1], CLAUDIA AZEVEDO-RAMOS[2], CAROLINA YÁBER[1] WENDY SEABROOK[3] JEAN-MARC HERO[4]. [1]*Centro de Ecología, Instituto Venezolano de Investigaciones Cientificas, Aptdo. 21827, Caracas 1020-A, Venezuela.* [2]*Depto. de Zoología, Museu P.E. Goeldi, C.P. 399, Belém, PA, Brazil.* [3]*Queensland National Parks and Wildlife Service, P.O. Box 155, Albert St, Brisbane 4002, Australia.* [4]*Zoology Dept, James Cook University, Townsville, Qld 4811, Australia.* *Bufo marinus* have been found to utilise only a subset of the microhabitats (waterbodies) available to them for breeding in their natural habitat in South America and their introduced range in Australia. Factors that may be influencing the choice of breeding sites were investigated by examining the physical and chemical characteristics of a wide range of known and potential breeding sites in Venezuela, Brazil and Australia. The importance of these factors in breeding site selection and the implications for the control of *Bufo marinus* in Australia will be discussed. [KEYWORDS: *Bufo marinus*, habitat, reproduction, South America, Australia, biological control].

Evans *et al.*

S16

Jurassic lizard assemblages: new material and new interpretations. SUSAN E. EVANS. *Dept of Anatomy and Developmental Biology, University College London, Gower St, London, WC1E 6BT, United Kingdom.* Crown-group lizards are known from Britain (middle Jurassic, Bathonian), Kirgizia (Callovian), Portugal (Oxfordian/Kimmeridgian), France and Kazakhstan (Kimmeridgian), North America (Kimmeridgian/Tithonian) and Germany (basal Tithonian). The Purbeck Limestone Formation of England is now considered to be of early Cretaceous age. New middle Jurassic assemblages from Britain resemble those of the late Jurassic and early Cretaceous in being dominated by scincomorphs (at least three genera of which one may be functionally limbless), with a new anguimorph (apparently varanoid) and possible gekkotans. The anguimorph, distinct from *Dorsetisaurus*, has subsequently been recorded from both Portugal and Purbeck. In general, the lizard assemblages of Britain, Portugal, Kazakhstan and North America show strong similarities, despite the differences in age. According to previous work, however, the assemblages of Solnhofen, Germany, and Cerin, France, differ in being dominated by either gekkotans (Solnhofen) or iguanians (Cerin). This is not the case. New skull material of *Bavarisaurus* casts serious doubt on its gekkotan affinities, while a reexamination of *Eichstaettisaurus* and *Ardeosaurus* shows no basis for their inclusion within a single family. *Eichstaettisaurus* may be gekkotan; *Ardeosaurus* is a scincomorph, probably a paramacellodid. At Cerin, the supposedly agamid genus *Euposaurus* is a fauna. The generotype (holotype of *Euposaurus thiollieri*) is a very young pleurodont lepidosaur which is probably, but not certainly, a lizard. The remaining two specimens are young rhynchocephalians, each pertaining to a different genus. There is thus no record of iguanians in the Jurassic of Laurasia and the group may have had a primarily Gondwanan distribution at this time. [KEYWORDS: lizards, Jurassic, Scincomorpha, Anguimorpha, Gekkota].

Evans

S02

Evans & Milner

S02

Mesozoic salamander assemblages in Europe. SUSAN E. EVANS[1] AND ANDREW R. MILNER[2]. [1]*Dept of Anatomy and Developmental Biology, University College London, Gower St, London WC1E 6BT, United Kingdom.* [2]*Dept of Biology, Birbeck College, Malet St, London WC1E 7HX, United Kingdom.* Until recently, the Mesozoic salamander record of Europe was limited to two specimens - the partial articulated skeleton of *Hylaeobatrachus*, a neotenic form from the Wealden of, Bernissart, Belgium; and a single vertebra forming the basis of the genus *Galverpeton* from the Barremian/Aptian of Galve, Spain. The enigmatic family Albanerpetontidae are excluded from this review. Three new salamander-bearing assemblages are being studied by the authors. The earliest is a microvertebrate assemblage from the middle Jurassic (Bathonian) of Kirtlington, England and has yielded four species of salamander. Two species form the basis of the genus *Marmorerpeton*, a large form resembling members of the North American Cretaceous-Eocene family Scapherpetontidae. There is also a small salamander with some resemblance to the type material of *Prosiren*, and a very primitive form represented by fragments of several hundred individuals. A similar but undescribed assemblage has been collected from the late Jurassic (Kimmeridgian) of Guimarota, Portugal. A second microvertebrate assemblage is from the early Cretaceous (Berriasian) Purbeck Limestone Formation of Dorset, England. This includes isolated elements of two genera of small salamanders, one of which may be attributable to the Batrachosauroididae, previously known from the mid-Cretaceous to Pliocene of North America and Eurasia. The third assemblage is the Lagerstatte from the early Cretaceous (late Hauterivian/early Barremian) locality of Las Hoyas, Spain. This has now produced more than 20 articulated salamander skeletons representing three genera. One neotenic genus with four pairs of branchial arches is the commonest form while a single specimen represents a second neotenic form. A third genus is represented by postmetamorpbic individuals. None of the three taxa is obviously immediately related to previously described genera. [KEYWORDS: salamanders, amphibians, Europe, Jurassic, Cretaceous].

Fanti

C34

Re-introduction of reptiles born in captivity to their natural environment. E. FANTI. *Herpetarium of Guadalajara Zoo. AP 1-837 CP 44100 Guadalajara, Jal., Mexico.* The Herpetarium of Guadalajara Zoo reproduce 21 species of reptiles and amphibians of Mexico, which more of 90% of the broods gotten are liberated in their natural environment. The liberations are realise with an official permission of Mexico government, escorted for inspectors and who liberate the organisms are countryman indigenous of bounding communities to the place of the liberation. This herpetarium, besides, realise another labours of maintenance like; shifting expositions, didactical exhibitions, maintenance course in captivity of reptiles and amphibians, conferences in hospitals and universities, thus like to public in general, TV presentations. The tactics and experiences gotten to the work with indigenous communities of the region, they can to serve of model to programs similar of maintenance associations that work in countries in development with maintenance problems.

Fanti & Burchfield

S30

A basic guide for the medical treatment of envenomations by the potentially dangerous terrestrial animals of North America. E. FANTI[1] AND PATRICK BURCHFIELD[2]. [1]*Herpetarium of Guadalajara Zoo. AP 1-837, CP 44100 Guad; Jal., Mexico.* [2]*Gladys Porter Zoo, 500 Ringgold St., Brownsville, TX 78520, United States of America.* A large variety of venomous animals exist in North America. In the case of an envenomation, however, there is not a widely accepted key or guide for the emergency room practitioner to use to identify venomous animals or to outline symptomatology and acceptable treatment procedures. Although the incidence of envenomations is higher in the southern and southwestern US and Mexico, it remains a comparatively rare occurrence. It is even rarer for an experienced practitioner familiar with envenomation treatment to be on duty protocols in an emergency room when an envenomation victim is admitted. This work attempts to provide a practical key to the venomous terrestrial animals of the near arctic region with a synopsis of the symptoms manifested by their bites or stings, and a guide to basic clinical management protocols.

Decline of anurans in national parks in western United States. GARY M. FELLERS[1] AND CHARLES A. DROST[2]. [1]*Point Reyes National Seashore, Point Reyes, CA, United States of America.* [2]*Cooperative Parks Studies Unit, University of California, Davis, CA, United States of America.* Amphibians in many parts of the world are suffering serious population declines. We have conducted surveys of nine U.S. National Parks and have documented precipitous declines for *Rana cascadae*, *R. muscosa*, *R. boylei*, *Bufo canorus*, *B. boreas*, and *Pseudacris* (=*Hyla regilla*. In 1992, we surveyed 38 sites along a 140 km transect through Yosemite National Park. Habitats ranged from oak woodland at 65 m elevation to alpine fell-fields at 3700 m. Comparisons with surveys conducted 75 years ago demonstrate that 42% of the historic populations have disappeared. In the remaining populations, significant declines have occurred in five of six species. Much more extensive surveys in 1993 strongly support this same trend in other parks. Documentation of a decline for an entire anuran fauna throughout a broad region is unprecedented. The decline seems to have been caused by a combination of local and regional factors, including 1) the presence of non-native, predatory fish; 2) the gradual loss of open meadows and associated aquatic habitats from routine forest fire suppression; and 3) the loss of breeding habitat due to an extended drought. The decline suggests that common management practices in parks and wilderness areas may be endangering some of the species these areas are intended to protect. Similar factors may account for amphibian declines reported elsewhere and should be carefully evaluated along with regional or global factors such as pesticides and acid precipitation. [KEYWORDS: population decline, amphibians, conservation, park management].

Fellers & Drost

C32

Pineal melatonin as a transducer of the photothermal environment in lizards. BRUCE T. FIRTH[1], INGRID BELAN[2] AND DAVID J. KENNAWAY[3]. [1]*Dept of Anatomy & Histology, The University of Adelaide, SA 5005, Australia.* [2]*Dept of Zoology, The University of Adelaide, SA 5005, Australia.* [3]*Dept of Obstetrics and Gynaecology, The University of Adelaide, SA 5005, Australia.* The pineal hormone melatonin has been traditionally considered as a neurochemical transducer of the environmental photoperiod. There is increasing evidence, however, that in ectothermic vertebrates such as reptiles, melatonin is also able to convey thermoperiodic information. The present paper reviews the evidence for such thermoperiodism and presents new data on the interaction between thermocycles, photocycles, and circadian mechanisms in influenc-

Firth *et al.*

S29

ing blood melatonin rhythms in the scincid lizard *Tiliqua rugosa*. The phase of the plasma melatonin rhythm in *T. rugosa* can be dramatically altered by the imposition of a thermocycle (hot or cold pulse) at different times relative to the photocycle. Further, the duration of the thermocycle affects the shape of the melatonin curve in a 12L:12D photoperiod. The amplitude and phase of the melatonin peak are also influenced by the amplitude of the thermocycle in this photic environment. In constant light and constant dark, an imposed thermocycle can entrain the melatonin rhythm. Combined, these results indicate that several features of the thermoperiod contribute to the phase, duration and amplitude of melatonin rhythms in *T. rugosa* lizards, most likely via a circadian mechanism. Ectotherms, therefore, probably rely upon both thermoperiodic and photoperiodic environmental cues in their seasonal physiological adaptations. Some preliminary evidence is presented suggesting that acclimation to the photothermal environment can influence thermoregulatory behaviour. The phase relationship between light and temperature cycles is a major determinant in this acclimatory process. The possible involvement of pineal melatonin as an encoder of such photothermal information is discussed. [KEYWORDS: melatonin, pineal, thermocycle, photocycle, lizard, rhythm].

Fisher

S08

Population genetics and speciation of island lizards, with reference to the genus *Gehyra* (Gekkonidae). ROBERT N. FISHER. *Center for Population Biology, University of California, Davis, California, 95616, United States of America and Dept of Biology 0116, University of California San Diego, La Jolla, California, 92093, United States of America.* The relationships of the four species of *Gehyra* that occur on non-landbridge Pacific islands were studied to determine the minimum number of dispersal events necessary for their colonisation. Two species have a wide range (*oceanica* and *mutilata*) within the region studied. *G. mutilata* is found outside the study area as well. The other two species (*brevipalmata*, and *vorax*) are endemic to this region and are geographically restricted. Protein variation using starch gel electrophoresis and mtDNA sequence for the cytochrome B gene were compared for samples of all four species, and other species of the genus. These data indicate that each species represents a different invasion from Papua New Guinea or Southeast Asia. *G. mutilata* and *G. oceanica* were sampled together on several archipelagos and were found to have very different patterns of genetic variation between populations. *G. oceanica* represents a widespread species with local subpopulations, while *G. mutilata* is an anthropophilic species that is widespread with no protein variation indicating possible human aided transport across the Pacific. *Gehyra oceanica* was studied in more detail to determine whether its current distribution was entirely natural or human modified (commensal or stowaway). Protein variation was analysed for 13 island groups from across its range in the Pacific. Based on fixed allelic differences, the species consists of two natural groups in the Pacific, a northern (Micronesian) and a southern (Melanesian and Polynesian) form. The northern form has very similar gene frequencies across its range in Micronesia. The southern form has the greatest allelic diversity in the south central Pacific. The F statistics for *G. oceanica* in the south fall within the range of values for mainland Australian species of *Gehyra* that are not human commensals. The results found for the molecular data in the genus *Gehyra* were consistent with that for other island lizards. [KEYWORDS: dispersal, evolution, biogeography, lizards, geneflow,

South Pacific].

Effects of environmental stochasticity and autocorrelation on population dynamics of squamates. LEE A. FITZGERALD. *Biology Dept, University of New Mexico, Albuquerque, NM 87131, United States of America.* Population growth and structure in species with life histories characteristic of squamates is very sensitive to the effects of good and bad years for reproduction. Clutch size and the proportion of females reproducing are variable for all species, but variability in both parameters increases with body size and life span. I modelled populations of lizards and snakes with distinct life histories via numerical projections of a life history table to explore the consequences of life history on population dynamics in an uncertain world. Fluctuations in population growth due to environmental stochasticity cause great variation around the long-run or "real" growth rate of the population. Differences in clutch size and life span result in very different convergence times to the long-run population growth rate. Autocorrelation in stochastic parameters amplifies the pattern because autocorrelation keeps the population trajectory away from the long-run growth rate for longer periods. Waves of successful cohorts in the life table result in dramatic fluctuations in population structure which vary in their magnitude and duration according to life history characteristics. These findings have important ramifications for ecology and conservation biology. The potential for species to endure population declines and recover from them depends on the interplay between life history and environmental stochasticity. Because of long convergence times to long-run growth rates and the nonexistence of a stable age distribution, very long-term studies are required to learn about the ramifications of variability on population dynamics. Investigation of the community level consequences of fluctuating population structure of squamates and would be a fruitful line of research. [KEYWORDS: population dynamics, life history, environmental stochasticity, autocorrelation, squamates].

Fitzgerald

S14

Steps toward sustainable use of *Tupinambis* lizards in Argentina and Paraguay. LEE A. FITZGERALD. *Biology Dept, University of New Mexico, Albuquerque, NM 87131, United States of America.* Lizards of the genus *Tupinambis* have always been used by people, but today an average of 1.9 million *Tupinambis teguixin* and *T. rufescens* are killed each year in Argentina and Paraguay to supply an international market for their skins. *Tupinambis* are difficult and costly to study in the wild, and population estimates based on field data have low confidence. Size and sex can be determined from harvested skins, however, and pilot studies showed analyses of the annual harvest can provide valuable information for evaluating population trends. *Tupinambis* populations are sensitive to yearling survival, which is in turn influenced by environmental variation. Stochastic models demonstrate that naturally occurring good and bad years for reproduction result in dramatic fluctuations in population growth, which tend to mask changes in population trajectory caused by different harvest regimes. These patterns help explain how *Tupinambis*populations have persisted in spite of high and variable harvest levels, but conversely, stochastic effects make it difficult to evaluate clearly the effects of conservation measures. To learn quickly what levels of *Tupinambis* harvests are sustainable, we should deliberately experiment with alternative management policies. Positive steps are being taken towards implementing sustainable use

Fitzgerald

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programs for *Tupinambis*. In Argentina, the Comisión Nacional de *Tupinambis* and the National Wildlife Service are organising the trade and establishing a permanently funded harvest monitoring system among the provinces. Paraguay legalised its trade and initiated field studies and harvest monitoring. In both countries, laws now exist prohibiting the commercialisation of small skins, 95% of which correspond to subadults. Education programs are teaching hunters that small skins have no commercial value. [KEYWORDS: *Tupinambis*, Argentina, Paraguay, sustainable use, population monitoring, reptile trade].

FitzSimmons *et al.*

S18

Microsatellites in marine turtles: what they can tell us about species, populations and mating systems. NANCY N. FITZSIMMONS[1], CRAIG MORITZ[1] AND STEVE S. MOORE[2]. [1]*Dept of Zoology, University of Queensland, Brisbane Qld 4072, Australia.* [2]*CSIRO, Molecular Animal Genetics Centre, Ritchie Research Complex, University of Queensland, Brisbane Qld 4072, Australia.* Microsatellite analysis is a proven technique for studies of disease linkage, paternity and forensic fingerprinting in humans and is gaining application in studies of mating systems and population structure of native species. We developed polymerase chain reaction (PCR) primers to amplify microsatellite regions in three species of marine turtles, *Chelonia mydas*, *Caretta caretta*, and *Eretmochelys imbricata* and tested these primers across several species of turtles to determine the degree of flanking sequence conservation, the extent of allelic variability within and across species, and the applicability of microsatellite alleles in population studies. Some of our primers have amplified variable microsatellite loci across both marine turtle lineages (Chelonidae and Dermochelyidae), confirming a conservation of microsatellites and their primer flanking sequences an order of magnitude greater than that found in other vertebrates. Across species, some microsatellite loci display over 50 alleles, while within species variability ranges from 1 to 15 alleles. Results from testing primers in other turtles will be discussed along with preliminary data on multiple paternity and microgeographic variability in marine turtles. Several problems arise in the use of microsatellites for population genetics, particularly the ambiguous genealogy of 'shared' alleles and the statistical and theoretical problems associated with large numbers of rare alleles. We will contrast our data on microsatellite variability within and among populations to previous results using mtDNA analyses. [KEYWORDS: marine turtles, DNA microsatellites, population genetics, multiple paternity].

Foa *et al.*

S11

Seasonal changes of locomotor activity patterns in *Podarcis sicula*: role of the pineal gland. AUGUSTO FOA, AUGUSTO INNOCENTI AND LUCIA MINUTINI. *Dipartimento di Scienze del Comportamento Animale e dell'Uomo, Università di Pisa, via Volta 6, 56100, Italy.* The pattern of daily activity in ruin lizards (*Podarcis sicula*) is unimodal during spring and autumn, while it becomes bimodal in summer (Foa, Tosini & Avery, 1992). Part of the seasonal changes must be endogenously controlled, as, lizards tested at different times of the year under constant temperature (29°C) and darkness (DD) display the same pattern of activity they showed in the field during the same season. Furthermore, in the bimodal lizards the period of the freerunning rhythm (τ) significantly shorter and the activity time (α) longer than in the unimodal ones. This suggests the existence of seasonal variations in the phase-relationship between mutually coupled circadian oscillators that drive locomotor rhythms (Pittendrigh & Daan, 1976). In order to test whether melatonin and the pineal whole play a role in the control of these seasonal changes, bimodal lizards were subjected to either pinealectomy or chronic implants of exogenous melatonin (in silastic capsules) while freerunning in DD. Both treatments induced the abolishment of the bimodal activity pattern, a lengthening in τ and a shortening in α. Such behavioural effects may be due to the abolishment of circadian rhythms of plasma melatonin, as a result of other pinealectomy or melatonin implants (Foa, Janik, Minutini, 1992). The following conclusions can be drawn: 1. The pineal participates in the control of seasonal changes in the pattern of daily activity; 2. The specific function of the pineal is that of a "coupling device" between extrapineal circadian oscillators that drive locomotor rhythms; 3. Since the state of coupling between circadian oscillators apparently varies depending on presence or absence of plasma melatonin rhythms, future investigations should test whether seasonal changes in activity patterns are related to seasonal changes in the circadian profiles of melatonin secreted by the pineal into the blood. [KEYWORDS: lizards, circadian rhythms, pineal, seasonal changes].

Ford

S22

Perceptual cues involved in mating behaviour of snakes. NEIL B. FORD. *Dept of Biology, University of Texas at Tyler, Tyler TX 75799, United States of America.* The perceptual capabilities of snakes are fairly well known but because two of their most important sensory modalities (smell and touch) are secondary senses for humans, our ability to design experiments examining the roles of sensory cues in courtship of snakes has been limited. In addition, most of the details known on mating behavior in snakes are from a limited number of temperate colubrids. In those species (primarily *Thamnophis*), pheromones from the skin of the female are involved in attracting males and carry information concerning species specificity and sexual receptivity. Vision is often involved during the chase sequence. Male semen may contain inhibitory pheromones that turn off both female attractivity and receptivity. Tactile cues from the male, including body movements, tail searches, and biting, may contain signals of species identity and male fitness. The variation in tactile cues within genera is as variable as between families although some particular signals are restricted to certain groups, i.e. pelvic spurring. [KEYWORDS: courtship, behaviour, perception, snakes].

Forsman

C21

Annual variation in growth rate and survival selects for plastic life-history traits. ANDERS FORSMAN. *Dept of Zoology, Uppsala University, Villavägen 9, S-752 36 Uppsala, Sweden. Current address: Zoology A08, School of Biological Sciences, University of Sydney, NSW 2006, Australia.* Life history theory suggests that it may pay an individual to trade present reproductive investment for growth, if this increases future reproductive capacity and/or longevity. Whether or not growth will increase longevity depends on the relation between body size and survivorship. I examined annual variation in growth rate and survivorship in a natural population of adders, *Vipera berus*, using recapture data. Individual growth rate varied significantly among years. The relation between body size and survivorship was similar in the two sexes but varied significantly among years. In 1987 survivorship decreased significantly with increasing snout-vent length. The pattern was significantly reversed the following year when survivorship increased with increasing size. In 1990 individuals intermediate in size survived better than small or large individuals. No significant relation between

survivorship and size was detected in 1986 and 1989. In temporally heterogeneous environments, allocating resources to growth will influence future reproductive success differently in different years. This may select for plasticity in life history traits. [KEYWORDS: fluctuating selection, life history, growth rate, size-dependent survival].

Forsman

C05

Opposing fitness consequences of colour pattern in male and female *Vipera berus*. ANDERS FORSMAN. *Dept of Zoology, Uppsala University, Villavägen 9, S-752 36 Uppsala, Sweden. Current address: Zoology A08, School of Biological Sciences, Univ. of Sydney, NSW 2006, Australia.* Local populations of the adder, *Vipera berus*, are polymorphic for dorsal colour pattern, containing both melanistic (black) and zig-zag patterned individuals. To find an explanation for the maintenance of this polymorphism I examined temporal and spatial variation in morph frequency, and tested for differential selection among morphs using data from a mark-recapture study. Morph frequency did not change through time within a population but varied among populations. Adders frequently moved between islands within a group, but the tendency to disperse was independent of morph. Scar frequency was twice as high among melanistic as among zig-zag snakes, and melanistic individuals were easier to capture, indicating that predation may be higher on the melanistic morph. Colour morphs did not differ in growth rate or body size. Analysis of recapture data shows evidence for differential survival among morphs but the relative survival rates of morphs were opposite in males and females. This difference was consistent through time and may be due to sexual differences in behaviour, with melanism increasing predation intensity when associated with male but not with female behaviour. Opposing fitness consequences of colour pattern in the two sexes may help maintain colour polymorphism within natural populations of *Vipera berus*. [KEYWORDS: polymorphism, melanism, crypsis, differential survival, selection].

Foster & Griffiths

C19

Asymmetric competition between two species of larval anuran, *Bufo calamita* and *Rana temporaria*. J.P. FOSTER AND R.A. GRIFFITHS. *The Durrell Institute of Conservation and Ecology, University of Kent, Canterbury, Kent CT2 7NX, United Kingdom.* Competition between natterjack toad, *Bufo calamita*, and common frog, *Rana temporaria*, tadpoles was investigated by manipulating their densities in a series of artificial ponds. The two species were observed to compete asymmetrically. As in previous studies, the species with the stronger intraspecific effect was found to be the superior competitor under mixed species conditions. Natterjacks were affected more by frogs than by the addition of an equal number of conspecifics. *R. temporaria* tadpoles, however, showed little sign of reduced growth when raised with natterjacks compared to that observed with increased intraspecific competition. Similar results were obtained in a simultaneous laboratory experiment employing the same basic design. These more closely- controlled conditions permitted a further treatment which suggested that the number rather than biomass of superior competitors is important in regulating the intensity of interspecific competition. The results have implications for the conservation of *B. calamita*, which is Britain's rarest amphibian. Historically the two species have been separated by differences in habitat preference and breeding phenology, but opportunities for interspecific competition are now being increased by changes in land management practices and development pressure. [KEYWORDS:

tadpoles, asymmetric competition, breeding ecology].

Frye

Application of ultrasonic doppler flow detection and echocardiography in clinical herpetological medicine. F.L. FRYE. *Fund for Clinical Research, 741 Plum Lane, Davis, California, 95616-3237 United States of America.* Evaluation of the cardiovascular system of herpetofaunal patients by conventional auscultation, even with the smallest conventional paediatric stethoscope, is often impossible or limited severely by the modest size of the animals and the relatively miniscule volume of blood which is being circulated. Compact solid-state portable Doppler ultrasonic flow detectors*, designed around very small crystal transducers#, offer the clinician a new and non-invasive diagnostic modality which is capable of yielding much useful information; their cost is relatively modest and can be amortised over a brief period of time. Because the Doppler ultrasonic flow motion detectors can be very small and still yield accurate sound amplification, even tiny reptiles and amphibians can be examined more thoroughly than ever before. Adventitious heart and muscular vessel sounds such as brits and murmurs arising from lesions involving the atrioventricular and aortic heart valves can be discerned easily. To this date, several significant cardiac conditions have been diagnosed in reptiles who were far too small for conventional stethoscopy. Several low blood viscosity (anaemic) murmurs, two cases of vegetative endocarditis, and one case of aortic stenosis were revealed. The use of this device has/can become a part of the routine physical examination of most reptile patients because it is a valuable screening technique and adjunct to conventional electrocardiography, physiological chemistry, microbiology, plain and contrast radiological imaging, and histopathology. *For example, Ultrascope Obstetrical Doppler, Model 2, 2.25MHz; and Ultrascope Doppler Blood Flow Detector, Model 8, 8 MHz; EMS Products, Inc., 1130 8th St., Kirkland, WA 98033 United States of America.; Telephone 1-206-827-5996; 1-800-926-9622. # The Model 2 has an external diameter of approximately 1.0 cm; Model 8 has an external diameter of approximately 0.5 cm and was designed specifically for detecting blood flow in small vessels. Mention of any product is not necessarily an endorsement by the author.

Frye *et al.*

S26

Histological, histochemical, and immunohistochemical characterisation of disseminated malignant mesothelioma in a corn snake, *Elaphe g. guttata*. F.L. FRYE, S.L. BARTEN, D.W. PEPIN, E.E. MCNEELY AND J.R. VASSER. *Fund for Clinical Research, 741 Plum Lane, Davis. California, 95616-3237 United States of America.* The histological, histochemical, and immunohistochemical characteristics of a widely disseminated malignant mesothelioma in a colubrid snake, *Elaphe g. guttata* were investigated by employing a battery of highly specific staining techniques, two of which were based upon monoclonal antibodies to cellular constituents or products of metabolism. These characteristics were compared with mesotheliomata observed in humans and were found to be identical thus indicating that these reagents are directly applicable in lower vertebrates and that this unusual tumor type can be distinguished readily from adenocarcinoma with which it is often confused.

Frye *et al.*

S26

Hypertrophic osteoarthropathy in an iguana, *Iguana iguana*. F.L. FRYE, R.F. CLAXTON, J.F. BAILEY, J.R. VASSER AND H.E. MCNEELY. *Fund for Clinical Research, 741 Plum Lane, Davis, California 95616-3237 United States of America.*

The clinicopathologic, radiological, pathophysiological, histological, and probable epidemiological characteristics of hypertrophic (pulmonary) osteoarthropathy (HPOA) in a common green iguana, *Iguana i. iguana* were investigated over a period of almost two years. This lizard developed massive and extremely sclerotic neo-osseous tissue which eventually involved the diaphyses of most of its limb longbones. This highly unusual case was compared with the pathophysiological and epidemiological features characteristic of of HPOA in higher vertebrates, especially humans.

Frye *et al.*

Functional pancreatic glucogonoma in a rhinoceros iguana, (*Cyclura c. figgensi*), characterised by immunohistochemistry. F.L. FRYE, H.E. MCNEELY, D.W. PEPIN, L.B. HADFY, J.H. CORCORAN AND J.R. VASSER. *Fund for Clinical Research, 741 Plum Lane, Davis, CA 95616-3237, United States of America.* The clinicopathologic, histological, and immunohistochemical characteristics of a glucogonoma, a hormonally functional endocrine tumor of pancreatic alpha cells, were investigated in an adult female Great Exuma Island rhinoceros land iguana, *Cyclura c. figgensi*. The monoclonal antibody-linked immunohistochemical reagents and test procedures employed for diagnosis in humans were found to be equally suitable when applied to suspected formalin-fixed neoplastic pancreatic tissue from a lower vertebrate.

Frye *et al.*

Adenoviral hepatitis in a clutch of captive-bred Rankin's dragon lizards (*Pogona henrylawsoni*). F.L. FRYE, R. MUNN, M.F. GARDNER, S.L. BARTEN AND L.B. HADFY. *Fund for Clinical Research, 741 Plum Lane, Davis, California, 95616-3237, United States of America.* A clutch of juvenile captive bred and genetically related Rankin's dragon lizards, *Pogona (Amphibolurus?) henrylawsoni*, began dying at approximately four months of age with antemortem signs of lethargy, inappetence, and central nervous system derangement expressed particularly as seizures, forelimb weakness and paralysis. Death usually occurred within a few days after these signs were first observed. Gross pathologic findings, other than hepatic mottling, were lacking. Histopathology revealed massive hepatitis and hepatocellular necrosis; the most significant finding was the presence of one or more large intranuclear viral-type inclusion bodies measuring 14–40 micro-meters in diameter within most of the hepatocytes. Electron microscopy disclosed numerous regularly spaced paracrystalline arrays of hexagonal to spherical virus particles with electron-dense cores and electron-lucent capsids. These particles measured 65–70 nm in diameter and their morphological characteristics are consistent with adenovirus. They appear identical or very similar to another adenovirus previously reported from the New Zealand lizard, *Amphibolurus barbatus*, by Julian and Durham (1990). The source of this virus and how it was introduced into the nearly closed breeding colony of lizards has not been established with certainty, but it possibly came into this group when a newly acquired lizard recruited from another genetically related breeding colony was inserted into this collection. Close inbreeding could have induced a genetic predisposition for infection or immuno-incompetency in this small, genetically non-diverse clutch of sibling lizards.

Fukuyama *et al.*

C06–058

Spermatozoa and breeding systems in Japanese anuran species with special reference to the spiral shape of sperm in foam-nesting rhacophorid species. KINJI FUKUYAMA[1], KATSUMI MIYAZAKI[1] AND TAMOTSU KUSANO[2]. [1]*Dept of Biology,*

Keio University, Yokohama 223, Japan. [2]*Dept of Biology, Faculty of Science, Tokyo Metropolitan University, Hachioji 192-03, Japan.* The characteristics of spermatozoa were compared among 18 Japanese anuran species (six genera in four families) in relation to their breeding systems. The structure of sperm was observed by SEM. The locomotivity was observed by phase contrast microscope and recorded by video tape recorder. Bufonid, hylid, and ranid species had the common shape of spermatozoon; it had a long elliptical head, a small middle-piece, and a long tail. On the other hand, rhacophorids had curious sperm. For example, the sperm of foam-nesting rhacophoris had a head which liked a corkscrew and a tail which liked a coil spring. When the sperm swam, it extended and beaten its tail. The sperm of *Buergeria buergeri*, rhacophorids which did not build a foam-nest but laid eggs in the stream, had a long head and a thin tail. The head and tail of it were not spiral. Multi-male breeding, where a female is grasped by two or more males during spawning, occurs frequently in the foam-nest building rhacophorids. Therefore, the spiral shape of spermatozoa seemed to be associated with foam-nesting or multi-male breeding. The relationship between the characters of spermatozoa and sperm competition or the condition of oviposition will be discussed. [KEYWORDS: sperm morphology, sperm competition, foam-nesting, breeding system].

Fusari *et al.*

C06–059

Surface locomotion of three fossorial species of *Lerista* (Scincidae) from Western Australia. M.H. FUSARI[1], C. GANS[2] AND F.H. POUGH[3]. [1]*Environmental Studies, U.C. Santa Cruz, CA 95064, United States of America.* [2]*U. Michigan, 2127 Kraus Nat. Sci., Ann Arbor, MI 48109, United States of America.* [3]*Ecology and Systematics, Corson Hall, Cornell U., Ithaca, NY 14853, United States of America.* The relatively large, but superficially similar *L. macropisthopus*, *connivens* and *lineopunctulata* differ in bodily elongation and limb reduction. All inhabit sandy areas and move under sand. Computer generated excursion and curvature graphs show that their locomotor patterns differ on smooth and rough surfaces, with and without pegs, and in channels. *L. macropisthopus* walks frequently, using its four, clawed limbs whenever traction is available. Its undulating body curves uniformly. The biped *L. connivens* walks with its hind limbs, although less frequently, and oscillates its tail in propelling its relatively stiff, short body. The biped, *L. lineopunctulata* rarely uses its hind limbs, but undulates body and tail strongly. In channel travel, *L. macropisthopus* and *L. connivens* walk well on rough surfaces, but *L. lineopunctulata* wedges and slides better in smooth channels. The species differ in the way each enters shallow sand. *L. macropisthopus* walks across sand surfaces rather than diving immediately and uses its hindlimbs. *L. lineopunctulata* uses body undulations exclusively while *L. connivens* uses both. Apparently distinct motor coordination patterns are associated with differences in morphology, habit and habitat. [KEYWORDS: limb reduction, surface locomotion].

Galatti *et al.*

S16

Coexistence of *Bufo marinus* with other frogs in Amazonia. ULISSES GALATTI, PETER BAYLISS AND WILLIAM E. MAGNUSSON. *Depto. de Ecologia, Instituto Nacional de Pesquisas da Amazonia, CP 478, 69011-970 Manaus AM, Brazil.* Habitat use and feeding of *Bufo marinus* were compared with the two other most abundant species at Alter do Chao in Brazil, *B. granulosus* and *Leptodactylus ocellatus*. The

three species all occur at estimated adult biomass of about 7 kg/km^2. They overlap in using the edges of a river and lakes to hydrate and reproduce, although most spawning of *B. marinus* and *L. ocellatus* are in lakes whereas most spawning of *B. granulosus* is in the river. Foraging habitats observed by radio and carretel tracking and by systematic surveys were usually distinct for the three species. *B. marinus* used forested patches, *B. granulosus* was in the savanna and *L. ocellatus* appeared to feed in bushes associated with the edges of the lakes and the river. Stomach content sampling showed high similarities in the proportions of prey types and sizes consumed by the three species. Such an overlap in the use of prey indicates a potential for competition, but the separation of feeding habitats means that this potential is not currently realised. Further studies are being undertaken to consider larval and metamorph co-existence. [KEYWORDS: Amphibia, *Bufo marinus*, co-existence, habitat, feeding].

Gans *et al.*

C02

The Asian forest frog *Megophrys montana*: specialisation for elongate prey. C. GANS[1], K. NISHIKAWA[2] AND D. CANNATELLA[3]. [1]*U. Michigan, 2127 Kraus Nat. Sci., Ann Arbor, MI 48109, United States of America.* [2]*Biol., U. No. Arizona, Flagstaff, AR 86011, United States of America.* [3]*Biol., U. Texas, Austin, TX 78712, United States of America.* The large and curiously formed tongue of this south-east Asian pelobatoid resembles a ping-pong paddle as it has a large pad connected to the mandibular symphysis by an elongate and muscular handle, the complex pars medialis of the *M. genioglossus*. Unlike the pattern in many other frogs, the pad lies at a site far back of the symphysis, posterior in the buccal cavity. The fascicles of the *M. hyoglossus* weave among those of the genioglossus all terminating deep to the surface of the lingual pad. Videotapes (120 frames per second) of experimental and feeding sequences were analysed frame by frame. Nerves were stained. Muscle actions were elicited by stimulation and nerve transection. Lateral films show the basal stalk of the lingual paddle facilitating the longitudinal flip, lifting and protracting the flexible pad over the symphysis. *Megophrys* has modified its prey catching behaviour by striking at the middle of prey rather than the most motile aspect (tip of a worm). The pad deforms markedly around large prey rather than relying on contact adhesion alone. In retraction, the tongue lifts the mid-portion of the prey object and pulls it far back into the buccal cavity. [KEYWORDS: video analysis, frog tongues, feeding.].

Gardner

C26

A test of the damage limitation hypothesis for the function of mite pockets. ANDREW S. GARDNER. *Dept of Biology, College of Science, Sultan Qaboos University, P.O.Box 36, Al Khod 123, Muscat, Sultanate of Oman.* According to the damage limitation hypothesis, mite pockets in lizards have evolved to concentrate mite infestations in restricted areas of the skin, thus minimising the damage caused. Two predictions from this hypothesis were tested using geckos of the genus *Pristurus* in Oman. *P. carteri* has well developed axillary pockets, which often contain trombiculid mite larvae. *P. rupestris* and *P. minimus*, which can be found sympatrically with *P. carteri*, do not have mite pockets. The infestation rates and distribution of mites over the body were compared in a series of populations of these species. The hypothesis predicts a higher infestation rate in *P. carteri* than in the pocket-less species, and a relative concentration of the mites in the pockets of *P. carteri*. The results give mixed support to this hypothesis. The mites on *P. carteri* were almost exclusively restricted to the pockets, while *P. rupestris* often had severe infestations on the sides of the neck and in the axillae. Skin damage was also much more severe in *P. rupestris* than in *P. carteri*. Hence the pockets do appear to concentrate the mites and minimise their damage. However, *P. carteri* was found to have a lower infestation rate than *P. rupestris* in most populations. *P. minimus* was rarely infested with trombiculid mites. [KEYWORDS: mite pockets, *Pristurus*, Gekkonidae, Oman.].

Garland

S11

Phylogenetic analyses of ecophysiological data. THEODORE GARLAND, JR. *Dept of Zoology, University of Wisconsin, Madison, WI 53706, United States of America.* Recent conceptual and statistical advances have revolutionised the way evolutionary biologists treat comparative (cross-species) data. New analytical methods can correct for the problem of statistical non-independence of species values caused by the hierarchical nature of phylogenetic relationships. This talk will provide an introduction to several comparative analytical methods that explicitly use information on phylogenetic relationships (topology, branch lengths). These methods also allow new questions to be addressed, such as how much of the variation in a trait is explained by phylogeny or whether rates of phenotypic evolution have differed between classes. Physiological ecologists and comparative physiologists have been responsible for generating some of the largest comparative data sets (e.g. standard metabolic rate in relation to body size and ecology), and many of these data sets warrant reanalysis with the new methods as suitable phylogenetic information becomes available. Some of the methods will be illustrated with data sets relating (1) treadmill endurance capacity to body size and body temperature and (2) standard to maximal rates of oxygen consumption.

Gasso & Bulakhov

C06-060

Lizards reproductive adaptation under strong industrial pollution. VICTOR Y. GASSO AND VALENTIN L. BULAKHOV. *Dept of Zoology & Ecology, State University, 72 Gagarin Ave., 320010 Dnepropetrovsk, Ukraine.* We studied population of the sand lizard *Lacerta agilis* L. subjected to a great deal of organic and inorganic pollutants from chemical and metallurgical works. The lizard population from the Dnieprovsko-Orelsky Nature Reserve (Ukraine) was as a control. The both populations occupy the biotypes of the same type. Our researches showed that in the population from the polluted biotypes lizards took part in reproduction running the length (without a tail) as high as 5.5 cm. In the Reserve this index was 6.3 cm. Females dominated the males in both populations. But in the polluted area the females amounted to an average of 61.3% (in the Reserve, 55.9%). Relative weight of fat bodies and gonads (both for the females) in the third week of June is more than in the Reserve by a factor of 3.9 and 4.7 respectively. The same tendency was observed for the males. But the differences were less than for the females. It was found the increasing of the total protein and lipids levels in the gonads of the both sexes. These indices were more for the lizards from polluted biotypes by a factor of 1.4 and 2.4 respectively. Apparently, such modifications have to compensate teratogenic impact of industrial pollution as well as its influence on spermato- and ovogenesis. [KEYWORDS: lizard, pollution, reproductive adaptation, fat bodies, gonads, total protein and lipids.].

Gaulke

S17

Observations on the habitat selection of water monitors (*Varanus salvator*). MAREN GAULKE. *Muhliusstrasse 84, 24103 Kiel, Germany.* During long termed

field surveys on several islands of the Philippines it was observed that water monitor populations are highest in mangrove swamps, and lowest in savannah areas, depending first on the availability of food and shelter. Their concentration in the mangrove areas is extreme during the dry season, while populations scatter over a wider range during the rainy season, making use of food sources at periodical water pools. Since very few regions in the Philippines are left untouched by man, the further existence of the water monitor depends on its ability to adapt to cultivated areas. In areas with high human population, water monitors were usually found to be rare. However, significant differences in their density were observed between regions with a Christian and those with an Islamic majority. This indicates that *V. salvator* does not generally avoid cultivated areas, provided that they are tolerated by man. In this case, coconut groves are oftenly frequented by water monitors in their search for food and as resting places; especially if there is some undercover, and rivers or ponds nearby. Rice fields provide a rich source of animal food and are used as hunting grounds. Due to its opportunistic behaviour, *V. salvator* is able to adapt to human made environments; their population development is less dependent on a special type of habitat, than on man itself. [KEYWORDS: Philippines, *Varanus salvator*, habitat selection, human impact].

Gendron *et al.*

C15

Multilevel detection of toxic stress in the mudpuppy: an ecotoxicological approach. A. GENDRON[1], A. HONTELA[1], C.A. BISHOP[2] AND R. FORTIN[1]. [1]*Dept of Biological Sciences, Universté du Québec a Montréal, CP 8888, Succ A, Montréal, Québec H3C 3P8, Canada.* [2]*Canadian Wildlife Service, Environment Canada, Canada Center for Inland Waters, 867 Lakeshore Road, P.O. Box 5050, Ontario L7R 4A6, Canada.* The phenomenon of generalised amphibian decline highlights the need for ecotoxicological research addressing the issue of environmental contaminants: how do amphibians respond to toxic stress in their environment? Long life expectancy, high trophic level, benthic behaviour, and an entirely aquatic life make the Mudpuppy *(Necturus maculosus)* susceptible to the chronic effects of contaminants accumulated through diet or through contact with the sediment. We have investigated the overall response of this salamander to toxic stress in specimens collected with baited minnow traps during the winter 1992 and 1993, along a pollution gradient in the St. Lawrence/Ottawa River system (Quebec, Canada). The covariation of physiological indicator (plasma corticosterone: a general stress indicator), organismic and demographic health indices (condition and hepatosomatic indices, prevalence of deformities, growth rate and fecundity) and the contaminants load in sediments and in target tissues of the salamanders, was examined. Plasma concentration of corticosterone in mudpuppies acutely stressed by a standardised capture and confinement protocol decreased with increasing contaminants load of the sites. Females from the cleaner area increased their plasma corticosterone to higher levels than females from the most polluted habitat (ANOVA, $P < 0.01$) These results suggest that chronic toxic stress might impair the normal function of the hypothalamo-pituitary-interrenal axis (HPI), the endocrine system which mediates the physiological general stress response. Considering the important role of the HPI axis in the regulation of metabolism and of the immune response, an impairment of the HPI axis could affect growth of somatic and sexual tissues. In that perspective, the between sites variation in growth and fecundity was assessed. Among health indicators examined, an important finding is the extremely high prevalence of squelettal deformities

in adult populations originating from the most polluted environment (25.7%). These salamanders were 3.95 times more at risk (χ^2, $P < 0.0001$) to present a limb deformity than salamanders from the cleaner site (6.5% and our results indicate a dose response relationship along the contamination gradient. Detailed analysis of several chemicals in mudpuppies of the two extreme sites of the gradient revealed higher level of several organochlorines and PCBs congeners and of mercury in female whole bodies. Gonads appeared as an important accumulative compartment for organic contaminants. Environmental influences other than toxic stress that could explain the biological changes will be discussed. [KEYWORDS: toxic stress, biomarkers, mudpuppy, endocrinology, population dynamics].

Ghira

C06- 061

Morphological features, ecological aspects and phylogenetic implications of a natural hybrid population of vipers (*Vipera ammodytes ammodytes* × *V. berus berus*) in Romania. IOAN GHIRA. *County Museum, Str.l Decembrie Nr.39, 2700 Deva, Romania.* Natural hybridisation between two viper species (*V. ammodytes*, *V. berus*) is very rare. Eight specimens (males and females, adults and young) were collected in spring 1992, at the northern limit of the area, in a small, isolated population of *Vipera ammodytes ammodytes*, in which it was also found a melanic *Vipera berus* male. Morphological features and some ecological aspects are given. Based on the similarity of these natural hybrids to *Vipera aspis* species and on the areas of *V. ammodytes*, *V. berus* and *V. aspis*, new hypothesis of the origin of *Vipera aspis* is given. [KEYWORDS: hybrid, viper, phylogeny].

Giacoma *et al.*

C26

Sexual selection in *Rana temporaria*: seasonal variation in male mating success. CRISTINA GIACOMA, SERGIO CASTELLANO, ELANA MARZONA AND LUIGIA COLOMBO. *Dipartimento di Biologia Animale, Università di Torino, V.A. Albertina 17, 10123 Torino, Italy.* The common frog *Rana temporaria* breeding season may last only one month. Male mating behaviour includes calling and searching for mates, as well as attacking amplexed pairs to take possession of females. We studied male mating success in relation to body size during two breeding seasons. The climate of the second breeding season was characterised by a large amount of snow, a lower minimum daily temperature and a larger interval between daily minimum temperature values. These climatic differences also caused an increase in surface water area in the second year. In the first year, male mating behaviour showed a higher incidence of scramble competition (45% of male deaths) while in the second year it was mainly due to cold weather (74% of male deaths). A male size advantage was found only in the first year. The effect of sexual selection in *Rana temporaria* should favour an increase in male size but this character is affected by a large random component which is largely due to climatic fluctuations from one season to the next. [KEYWORDS: sexual selection, fluctuating pressures, *Rana*, climate].

Gillespie & Hollis

C06– 216

Distribution, habitat and conservation status of the spotted tree frog (*Litoria spenceri*). G.R. GILLESPIE AND J.G. HOLLIS. *Dept of Conservation and Natural Resources, 171-173 Nicholson St, Orbost, Victoria 3888, Australia.* *Litoria spenceri* is listed as one of Australia's most endangered amphibians. During the past 15 years, local extinctions or declines have occurred in 10 of the 12 river systems where pop-

ulations were historically known. Extensive surveys during the past two years have uncovered *L. spenceri* along six streams in which it had not been previously recorded, and relocated the species along six streams from which it was believed to have disappeared. Further research is being conducted to monitor these populations and collect data on this species' ecology and habitat requirements. Results of the most recent research are presented and current knowledge of the biology of *L. spenceri* is reviewed.

Goetz & Thomas

S23

Use of annual growth and activity patterns to assess management procedures for captive raised tuatara (*Sphenodon punctatus*). BERNARD G.R. GOETZ[1] AND BRUCE W. THOMAS[2]. [1]*Reptile Research Centre, 104 Quebec Road, Nelson, New Zealand.* [2]*Landcare Research New Zealand Ltd, Private Bag 6, Nelson, New Zealand.* Daily and seasonal surface activity of 2 captive female, 4 year old tuatara, were monitored for 1.5 minutes every 10 minutes (i.e. 11.5 minute cycle) for 24 hours, 1 day per week for 13 months (October 1991–October 1992), using a closed circuit, low light, video surveillance system. Humidity and ambient maximum/minimum temperatures were taken each recording session, with weights and measurements monthly. Following the dormant winter period from mid-June to the end of August, there was an initial burst of early spring activity in September. A remarkable increase occurred in October and activity remained high, but fluctuating, throughout the summer months until mid-March when a dramatic decrease occurred. Surface activity remained at reduced levels throughout autumn until all activity suddenly ceased at the onset of winter in June. Growth and weight increases closely matched seasonal patterns of activity in both animals. Social interactions and environmental factors are known to affect biological functions. In a captive situation involving highly specialised organisms such as reptiles, it is easy to inadvertently introduce elements that frequently generate stress factors leading to adverse physical development. It is argued that surface activity and corresponding growth and weight increases in tuatara are significant, and characteristic to the species, and can be used to gauge the effectiveness of captive management procedures. [KEYWORDS. Tuatara, *Sphenodon punctatus*, activity, captivity].

Goldberg et al.

S26

Gastrointestinal helminths of *Sceloporus* lizards from Arizona, USA (Sauria: Phrynosomatidae). STEPHEN R. GOLDBERG[1], CHARLES R. BURSEY[2] AND RANA TAWIL[1]. [1]*Dept of Biology, Whittier College, Whittier, California 90608, United States of America.* [2]*Dept of Biology, Pennsylvania State University, Shenango Valley Campus, Sharon, Pennsylvania 16146, United States of America.* Arizona spiny lizards, *Sceloporus* spp. were examined for gastrointestinal helminths. *Sceloporus clarki* harboured the cestodes *Mesocestoides* sp.*, *Oochoristica scelopori** and the nematodes *Atractis penneri*, *Physaloptera retusa**, *Piratuba prolifica**, *Skrjabinoptera phrynosoma**, *Spauligodon giganticus*. *Sceloporus magister* harboured *A. penneri*, *P. retusa* and *P. phrynosoma*. *Sceloporus undulatus consobrinus* harboured *O. scelopori** and *P. retusa*. *Sceloporus undulatus tristichus* harboured *Mesocestoides* sp.*, *P. retusa* and *S. giganticus*. *Sceloporus virgatus* harboured *A. penneri** and *P. retusa**. Data on prevalence and infection intensity are presented. It appears larger sceloporine species have more diverse helminth faunas than smaller species. Pathology caused by helminths in lizards is discussed. * = new host record. [KEYWORDS: Helminths, Cestoda, Nematoda, Phrynosomatidae, *Sceloporus*, prevalence, intensity, survey, pathology].

Structure and dynamics of a hybrid zone in *Bombina*. GÜNTER GOLLMANN. *Institut für Zoologie, Univ. Wien, Althanstr. 14, A-1090 Wien, Austria.* Population structure in the hybrid zone between the fire-bellied toads *Bombina bombina* and *B. variegata* in the Waldviertel (Lower Austria) was studied using variation of belly patterns and allozyme markers. Attention was also given to the persistence of breeding habitats over a decade. Suitable habitats are rare in this region, causing a fragmented population structure. In some populations alleles of one species are fixed at several diagnostic loci, while other marker loci show high frequencies (up to 30%) of foreign alleles. These data are compared with the results of other investigations of hybridisation in *Bombina*. Their bearing on conflicting theories of hybrid zone dynamics is discussed. [KEYWORDS: hybrid zone, allozyme markers, *Bombina*].

Gollmann

S03

Morphometric analysis of a hybrid zone in *Geocrinia*: larval versus adult character suites. GÜNTER GOLLMANN AND BIRGIT GOLLMANN. *Institut für Zoologie, Univ. Wien, Althanstr. 14, A-1090, Wien, Austria.* The two south-east Australian species of *Geocrinia* (Anura, Myobatrachinae), *G. laevis* and *G. victoriana*, have strikingly different advertisement calls, yet form narrow hybrid zones. Studies of allozyme variation indicated random mating in these hybrid populations and revealed a peculiar pattern of steep, staggered clines in the frequency of some marker proteins. Frogs of the two species are similar in external morphology. To get morphological data suitable for comparisons with genetic and acoustic results, we took measurements of two character suites: skeletons of adult males collected in the field, and external morphology of tadpoles raised from field collected egg masses. The contrast between larval and adult variation patterns may provide an indication at which life stage selection operates. We applied univariate and multivariate statistical tests to examine congruence of results obtained for these diverse character sets. Both larval and adult morphological traits show fairly smooth transitions across the hybrid zone. [KEYWORDS: hybrid zone, morphometry, larval morphology, osteology, *Geocrinia*].

Gollmann & Gollmann

S03

Life history variation across a hybrid zone in *Geocrinia*. BIRGIT GOLLMANN AND GÜNTER GOLLMANN. *Institut für Zoologie, Univ. Wien, Althanstr. 14, A-1090 Wien, Austria.* Natural hybridisation between *Geocrinia laevis* and *G. victoriana* has previously been described using calls and enzyme markers. To investigate ecological aspects of this hybrid zone, we studied embryonic and larval development of clutches collected at twelve field sites. Larvae of *G. victoriana* were bigger than those of *G. laevis* at hatching. Offspring size of hybrids was intermediate, but did not show a smooth cline across the hybrid zone. Embryonic and larval mortality were low in all samples and not significantly elevated in the hybrid zone. Larval growth rates were similar in both species, the highest values were obtained for populations from the centre of the hybrid zone. [KEYWORDS: hybrid zone, offspring size, embryonic mortality, larval growth rates, *Geocrinia*].

Gollmann & Gollmann

C06-062

A panoramic view of sea turtle research and conservation in Mexico. ANA M. GONZÁLEZ-DE-LA-VEGA[1], JORGE A. JUÁREZ[1] AND ALEJANDRO PELÁEZ[2]. [1]*Depto de Biologia, Fac. de Ciencias, UNAM. Ciudad Universitaria, Coyoacan, DF CP 04510,*

González-de-la-Vega et al.

C06–063

Mexico. [2]*Com. Nal. para el Conocimiento y Uso de la Biodiversidad AP149-113. Mexico DF, CP 14201, Mexico.* We present preliminary data about sea turtle camps of Mexico, their localisation, actions and results. This work is part of an effort aimed to obtain elements to evaluate the work of the camps in order to be able to propose actions to improve their activities. Six of seven sea turtle species nest in the seashores of Mexico, other can be seen in juvenile stages. Research institutions, universities and environmentalist organisations had joined efforts to protect and research this group of chelonids. Research and protection of sea turtles has been oriented to three areas: 1) biologic research, 2) operation of sea turtle camps, and 3) to avoid accidental trapping of sea turtles by fisheries activities in the high seas, by evaluation of technical-economic issues of turtle excluders disposals (TED). Since 1960 research and protection programs for sea turtles were established. Now there are in operation around 10 sea turtle camps in the Gulf of Mexico and Caribbean littoral and another 25 in the Pacific littoral. Migratory characteristics of the sea turtles, their broad distribution in the seas of the world and the long periods of time that they stay in the oceans make observation difficult. Therefore, only during the reproductive periods it is possible to study these organisms and this is possible in the camps. Thanks to the research work realised in the sea turtle camps it can be reported the following issues about the biology of the sea turtles: general distribution areas, main sea turtles arrival zones in the Mexican beaches, species and subspecies existing in national seas, estimation and evaluation of the population sizes, reproductive behavior and fecundity data and, effect of the fishery activities and the modifications of their habitats. Regarding all the previous discussion we strengthen the importance of the sea turtle camps for the conservation of this resource and for the obtention of basic information in order to improve and broaden the biological knowledge of the sea turtle species, mainly about reproduction, fecundity, longevity, mortality, migration, behavior and growth patters. It is clear that the results of the activities of the camps could be notably improved if a coordinator plan encompassing personal training, standardisation of methodologies, canalisation of resources and establishing of agile communications channels between the organisations involved is formulated and implemented [KEYWORDS: sea turtle camps, conservation, sea turtle protection].

Graham

C27

Seasonal habitats of the spotted turtle, *Clemmys guttata*, in the northeastern USA. TERRY E. GRAHAM. *Dept of Biology, Worcester State College, Worcester, MA 01602-2597, United States of America.* Adult spotted turtles, *Clemmys guttata*, were radio-tracked to determine their seasonal patterns of habitat utilisation at the Cedar Swamp in Westboro, Worcester County, Massachusetts. All turtles were initially hand-captured in vernal pools (ephemeral wetlands) in May 1989. Following transmitter attachment, their movements were recorded for up to one year. Spotted turtle habitats varied seasonally with the general pattern including: (1) overwintering in red-maple/sphagnum swamps, (2) overland migration (ca. 120 m) to upland vernal pools in late March, (3) feeding in and fidelity to these ephemeral waters for up to 4 months, (4) overland return to the original red maple swamp in early August, (5) localised movement within the swamp until onset of very cold weather in December, (6) wintering in underwater passageways among the roots of sphagnum/maple islands. Spring migration to temporary wetlands is timed to take advantage of seasonally abundant foods in them. Eventual return to permanent swamps is apparently in response to declining availability of these ephemeral foods. [KEYWORDS: spotted turtle movements, seasonal resource utilisation].

Grant & Licht

C14

Effects of ultraviolet radiation on life history parameters of frogs from Ontario, Canada. KAREN P. GRANT AND LAWRENCE E. LICHT. *Dept of Biology, York University, 4700 Keele St., North York, Ontario, M3J 1P3, Canada.* The effects of ultraviolet radiation (UVA and UVB) were determined for the embryonic and larval stages of two species of Ontario ranid frogs. Eggs of *Rana sylvatica* were irradiated with UVA or UVB using doses simulating exposures on sunny summer days in Ontario, Canada. No effect of UVA on embryonic development or survival was found; UVB, at high doses, caused developmental abnormalities and/or increased mortality compared to control and UVA treated embryos. Similar doses of UVA and UVB were administered to larvae of *Rana clamitans* and *R. sylvatica*. UVA did not affect larval development or survivorship compared to nonirradiated control groups. UVB, however, had detrimental effects on larval growth and survivorship. Whereas surviving UVB larvae of *R. clamitans* attained similar body mass as UVA and control larvae, their stage of development was retarded. Similar doses of UVB resulted in higher mortality of larval *R. sylvatica* than *R. clamitans*. Findings are discussed in light of the ecology of the species tested. [KEYWORDS: ultraviolet radiation, frogs, embryos, larvae].

Graveson & Hall

C05

Pigment cell formation by cranial neural crest in *Ambystoma mexicanum*. ANN C. GRAVESON AND BRIAN K. HALL. *Dept of Biology, Dalhousie University, Halifax, N.S., Canada.* The neural crest is the source of all pigment cells, except those of the pigmented layer of the retina. It has been generally believed that the pigmentation of both the head and trunk is derived almost exclusively from trunk neural crest. Although neural crest cells from cranial levels have been shown to possess the potential to form pigment cells under experimental conditions, their contribution to normal pigmentation was deemed to be minimal and belated, at best. We have performed reciprocal, homotopic transplants of neural crest cells between albino and wild-type *Ambystoma mexicanum* embryos in order to determine the contribution and distribution of pigment cells derived from various axial levels. The results clearly demonstrate that cranial neural crest is a significant source of pigment cells. Trunk neural crest provided pigmentation to only the branchial portion of the head. Pigment cells rostral to this level were derived from cranial neural crest. Pigment production is therefore not an example of the apparent developmental and evolutionary dichotomy of the cranial and trunk neural crest. [KEYWORDS: axolotl, neural crest, pigment cells].

Grechko *et al.*

C06–209

Taxonoprint DNA analysis of some species of the Family Lacertidae. VERNATA V. GRECHKO[1], DIMITRY M. RYABININ[1], LARISSA V. FEDOROVA[1] AND ILYA S. DAREVSKY[2]. [1]*V.A. Engelhardt Institute of Molecular Biology, Moscow 117984, Vaviliv str. 32., Russia.* [2]*Zoological Institute, St Petersburg 199034, University nab. 1, Russia.* It was earlier shown that electrophoretic patterns of the highly repetitive segments of DNA's of some animal species studied seem to have species specificity ("DNA taxonoprint method"). In this paper the results of investigation of more than 20 lizard species of the *Lacerta* genus in comparison with representatives of some other genera

and families are presented. It was shown that in taxonoprints there is one band, at least, but usually more bands common for all *Lacerta* species. Among *Lacerta* species there are 10, which form the separate group being very similar by most of the taxonoprints. This fact goes in line with hypothesis that five parthenogenetic species of this group evolve due to interspecies hybridisation of another five bisexual species of this group. The other species studied have specifc peculiarities in various taxonoprints permitting to draw some conclusions on the phylogenetic relations. [KEYWORDS: lizards, DNA, taxonoprint, parthenogenesis, Caucasus].

Grechko *et al.*

C03

The DNA relationships of the parthenogenetic forms of the *Lacerta* lizards species and supposed parental bisexual species as it may be revealed by polymerase chain reaction with arbitrary single primer (AP-RAPD). VERNATA V. GRECHKO[1], MICHAIL V. KATAYEV[1], MARINA N. MELNIKOVA[1] AND ILYA S. DAREVSKY[2]. [1]*V.A. Engelhardt Institute of Molecular Biology, Moscow 117984, Vavilov str. 32., Russia.* [2]*Zoological Institute, St Petersburg 199034, University nab. 1, Russia.* Due to some suggestion the parthenogenesis in vertebrates is the result of interspecies hybridisation, and some species seem to be the main candidates participating in this process. DNA parts, which may be revealed using polymerase chain reaction in AP-RAPD modification, were compared in parthenogenetic lizard forms and in supposed parental species for them. As it was shown by other authors and confirmed by us, arbitrary primed randomly amplified DNA products are species specific and may be used as a molecular taxonomic criterion. It was shown that each parthenogenetic species studied has the patterns containing only the bands of one or another supposed parents and no more. This is in favour of the hypothesis mentioned above. [KEYWORDS: lizards, AP-RAPD, DNA, parthenogenesis].

Green *et al.*

C22

Diet, food consumption rates and field energetics of *Bufo marinus*. BRIAN GREEN[1], PETER BAYLISS[2] AND VICTORIA MEDIALDEA[3]. [1]*CSIRO Division of Wildlife and Ecology, P.O. Box 84, Lyneham, A.C.T. 2602, Australia.* [2]*Depto. de Ecologia, Instituto Nacional de Pesquisas da Amazonia, CP 478, 69011-970 Manaus AM, Brazil.* [3]*Centro de Ecologia, Instituto Venezolano de Investigaciones Cientificas, Caracas, Venezuela.* The field energetics of amphibians cannot be investigated by using the doubly-labelled water technique since water flux rates are extremely high relative to metabolic rates. As an alternative, ^{22}sodium turnover is being used to assess food consumption rates in *B. marinus* and other anurans. Seasonal influences on the composition of the diet (species and nutritional status), feeding rates and energy budgets are being assessed. [KEYWORDS: *Bufo marinus*, diet, sodium turnover, body fat].

Green *et al.*

S17

The breeding biology of *Varanus rosenbergi*. BRIAN GREEN[1], MIKE MCKELVEY[2] AND PEGGY RISSMILLER[2,3]. [1]*CSIRO Division of Wildlife and Ecology, P.O. Box 84, Lyneham, A.C.T. 2602, Australia.* [2]*Pelican Lagoon Research Centre, Penneshaw, S.A. 5222, Australia.* [3]*Dept of Anatomy and Histology, The University of Adelaide, S.A. 5005, Australia.* *Varanus rosenbergi* is a medium sized monitor lizard (about 1.25 kg) that occupies temperate habitats in southern regions of Australia. The females deposit their eggs in termite mounds in late summer and hatchlings emerge in mid-spring. The behaviour of adults and young and their attendant energy costs are described, along with the ecological implications of this breeding pattern. [KEYWORDS: *Varanus rosenbergi*, breeding behaviour, breeding energetics].

Green

S23

Genetic partitioning in Hochstetter's frog, *Leiopelma hochstetteri*: identifying the significant units of conservation. DAVID M. GREEN. [Redpath Museum, McGill University, Montréal, Québec H3A 2K6, Canada.]. Hochstetter's frog exists in numerous, isolated populations of variable size and extent. Although the species, as whole, is not considered endangered, some of these isolates may be threatened or vulnerable. In a genetically and geographically discontinuous species like *L. hochstetteri*, every population may be an important component in biogeographic diversity since each isolate may represent an emergent historical entity. In *L. hochstetteri*, cytogenetic diversity is extreme even though morphological divergence, biochemical divergence estimated using isozymes, and DNA sequence divergence are all small or trivial. Supernumerary chromosomes are variable within and between populations. The population on Great Barrier Island is cytologically unique within *L. hochstetteri* since the females do not possess the univalent, sex-specific chromosome found in all females from the North Island. This may not yet represent species-level divergence since no difference is discernible among males. Nevertheless, identification of cytogenetically distinct races indicates that conservation measures regarding Hochstetter's frog might best be framed population by population rather than at the species level.

Green

S03

The bounds of species: hybridisation in the *Bufo americanus* group of North American toads. DAVID M. GREEN. [Redpath Museum, McGill University, Montréal, Québec H3A 2K6, Canada.]. Interspecific hybridisation is widespread and frequent among frogs and toads. The evolutionary significance of hybrids depends upon their capacities to contribute genetically to succeeding generations, which in turn depends upon the genetic compatibility of the hybridising taxa. Hybrids are not discountable abnormalities resulting from faulty isolating mechanisms but are the normal results of particular kinds of genetic interactions. Classic hybrid zones result from historical contact of distinctive but not reproductively isolated populations along ecotone gradients, resulting in clines. Hybrids also occur as rare accidental mismatings among otherwise genetically hermetic syntopic populations. The range of hybrid interactions is best viewed as a continuum of differentiation. This is at odds with systematics since hybrids transgress the boundaries of taxa set both by the biological criterion of interbreeding capability and the phylogenetic criterion of common descent. Fourteen years of study of a sympatric hybrid zone among toads, *Bufo*, illustrates the temporal dynamicism of hybrid interactions since interspecific F1 hybrids have reappeared after a ten year hiatus. The appearance of hybrids in such sympatric hybrid zones is largely unpredictable since it is based upon the vagaries of local weather conditions. On the other hand, clinal hybrid zone between other related species of *Bufo* shows quasi-stability and geographic shifts over 20 years of study.

Greer

S06

An introduction to the reptiles of Australia. ALLEN E. GREER. *The Australian Museum, 6-8 College St, Sydney, NSW 2000, Australia.* The major lineages of Australian reptile will be discussed to highlight the unusual and significant aspects of their evolution, behaviour, ecology, morphology, and physiology will be emphasised. The dis-

cussion will be of particular interest to those not familiar with Australian reptiles and to those requiring an initial introduction to this distinctive and important component of the continent's fauna. [KEYWORDS: crocodilians, turtles, lizards, snakes, Australia].

Grenot

C06-215

The natural supercooling of the European common lizard, *Lacerta vivipara*. CLAUDE J. GRENOT *Laboratoire d'Ecologie, CNRS-URA 258, Ecole Normale Supérieure, 46 rue d'Ulm, 75230 Paris Cedex 05, France.* *Lacerta vivipara* has a distribution extending from the mountains of north west Spain north to above the Arctic Circle and east to Sakalin on the Pacific coast. ^{22}Na, a gamma emitter was used to locate winter dormancy sites. Body radioactivity was measured directly and plasma levels of ^{22}Na were also measured in some individuals. The site was in the lowlands of Brittany and measurements were made between September and February. Lizards were usually found 2–4 cm beneath litter of moss or flattened grass; others were in the middle of large graminiferous tuffs or in old micromammal galleries. All were rolled up in the nest with closed eyes, snout against vent and with a wet skin surface. They could be rapidly aroused from dormancy with moderate increases in temperature. From November–February, the radioactivity remained stable indicating a non-feeding condition. Body mass also remained stable. The soil may freeze at burrow depth (26 days in January) indicating a supercooling ability in *L. vivipera* to survive temperatures below 0°C. Water exchange between the animal and its microenvironment was indicated by tritiated water injection. The apparent water flux was less between June and September. Further preliminary results on cold tolerance in this species are presented. [KEYWORDS: hibernation, isotopes, *Lacerta vivipara*, metabolism, plasticity, radiotracers, supercooling].

Grenot *et al.*

S11

Behavioural thermoregulation and metabolism of lizards from lower altitude regions of southern California. CLAUDE J. GRENOT[1], SERGIO ALVAREZ[2], PATRICIA GALINA AND ALFREDO ORTEGA. [1]*Laboratoire d'Ecologie, C.N.R.S. - URA 258, Ecole Normale Supérieure, 75005 Paris, France.* [2]*Centro de Investigaciones Biológicas, Baja California Sur, La Paz, 23000 B.C.S. Mexico.* Where do the main sympatric species of desert lizards of Baja California Sur (Cape Region) spend their nocturnal lives? *Urosaurus nigricaudus* is a true tree dweller (*Prosopis*), *Cnemidophorus hyperythrus* and *Uta stansburiana* are loam- sandy soil dwellers and *Callisaurus draconoides* is a sand dweller. Sodium 22 (^{22}Na, τ emittor), was used for radiotracking in combination with a scintillation counter. They are significant differences between the substrata used during the night by diurnal species. They apparently depend strongly on this substratum, not only to escape predators but also to thermoregulate efficiently. Surprisingly, all the recaptured lizards spend the night in the ground. Even the tree dweller (*U. nigricaudus*) do not sleep in holes in logs and trees but descends to the ground. This tracing method permits not only the location of lizards at night, but also to determine accurately the time of the beginning of morning activity and the microclimatic conditions. We also compared the water flux rate (WFR) and energy expenditure (using double labelled water) with the climatic characteristics of the area and some ecological parameters of each species (like activity, habitat use and diet). During the rainy season, the lizards exhibit high WFR, which does not differ from those of nondesert species. This is because they consume more water compared to the intake energy due to the consumption of abundant prey which contain more water (caterpillars). During the

dry season the low WFR are basically due to low energetic rates. [KEYWORDS : Baja California, lizards, metabolism, radiotracer, sleeping localisation, thermoregulation].

The effects of fire on the population ecology of the frilled lizard, *Chlamydosaurus kingii*. A.D. GRIFFITHS. *Faculty of Science Northern Territory University, P.O. Box 40146, Casuarina NT 0811, Australia.* Savannas of Northern Australia experience a high frequency of fire. Populations of *C. kingii* in three fire regimes; annual high intensity, annual low intensity and fire exclusion were examined using radio telemetry and mark recapture techniques. Population structure, density, fire mortality, diet, home ranges and habitat requirements were compared between the three regimes. *C. kingii* exhibits a preference for recently burnt areas, which is reflected in much higher densities and other distinct differences between populations. [KEYWORDS: fire, ecology, population dynamics, diet, home range, *Chlamydosaurus kingii*].

Griffiths

C11

Diversionary tactics in tadpole competition. R.A. GRIFFITHS[1], T.J.C. BEEBEE[2] AND A.L-C. WONG[2]. [1]*The Durrell Institute of Conservation and Ecology, University of Kent, Canterbury, Kent, CT1 7NX, United Kingdom.* [2]*School of Biology, University of Sussex, Falmer, Brighton, BN1 9QG, United Kingdom.* In Britain certain populations of the endangered natterjack toad, *Bufo calamita*, are threatened by incursions of superior competitors (i.e. *Bufo bufo*, *Rana temporaria*) into their breeding areas. When this occurs natterjack tadpoles suffer from reduced growth and survival. Experiments conducted in both replicated ponds and the laboratory have shown that growth inhibition is mediated by a cellular growth inhibitor released in the faeces of superior competitors. Nucleic acid, morphological and immunological studies determined that this cell was a new species of unpigmented alga, *Prototheca richardsi*. *Prototheca*-laden faeces are highly attractive to small tadpoles, and thereby divert them from alternative, higher-quality food. In natural ponds *Prototheca* increase in pond sediment when tadpoles are present and decline in number after metamorphosis. Diversionary tactics may therefore complement conventional exploitative and interference competition mechanisms in amphibian assemblages. [KEYWORDS: tadpoles, competition mechanisms, growth inhibition].

Griffiths *et al.*

C19

***Caiman latirostris* as a model for the evolution of marine capability in crocodiles.** GORDON C. GRIGG. *Dept of Zoology, The University of Queensland, Qld 4072, Australia.* Among crocodilians so far examined, all Crocodylidae have lingual salt glands and all Alligatoridae lack them, which implies distinct differences between the evolutionary histories of the two groups (Taplin and Grigg, 1989). Among species of Crocodylidae there is quite a diversity in salt gland excretory performance, correlating perhaps with life in a diversity of habitats with different exposure to salt water. Salt glands are present even in Crocodylidae which are not known ever to be exposed to saline waters, raising questions about whether or not there is a current functional significance or whether the glands are nothing more than an evolutionary hangover. It is interesting to speculate about the circumstances which may have led to the evolution of salt glands in crocodilians in the first place, and *Caiman latirostris*, an Alligatorid which, though found mainly in freshwater habitats, occurs also in estuarine habitats in southern Brazil and offers a possible model. Analyses of plasma samples from in-

Grigg

S12

dividuals captured in the field (Grigg, Beard, Moulton and Queirol Melo) show the maintenance ionic and osmotic homeostasis even in estuarine water at twice the concentration of the plasma. Like other Alligatoridae, salt glands are lacking and the drinking of fresh water is implicated as a mechanism to explain the observed pattern. In all respects except one *C. latirostris* seems to have Alligatorid not Crocodylid physiology: preliminary data suggest that evaporative water loss is close to Crocodylid rather than to Alligatorid values, so the skin may be less permeable to water than is typical for Alligatorids. Perhaps the lifestyle of *C. latirostris* in estuaries is similar to that which may have generated the selection pressures which led to the evolution of salt excretory function for the lingual mucous glands in the ancestors of today's Crocodylidae.

Grimmond *et al.*

C16

Energetic costs of feeding on different prey types for the skink *Chalcides ocellatus*. NICOLA M. GRIMMOND[1], MARION R. PREEST[2] AND F. HARVEY POUGH[3]. [1]*Dept of Zoology, University of Otago, P.O. Box 56, Dunedin, New Zealand.* [2]*Dept of Biology, San Diego State University, San Diego, CA 92182, United States of America.* [3]*Laboratory of Functional Ecology, Section of Ecology & Systematics, Corson Hall, Cornell University, Ithaca, NY 14853-2701, United States of America.* Skinks (*Chalcides ocellatus)* were found to use 50% more energy to seize, crush and swallow hard-bodied insect prey (*Tenebrio molitor* beetles) than medium- and soft bodied prey (*Tenebrio molitor* larvae and *Manduca sexta* larvae respectively). However, even for the beetles, the energy cost of prey handling was no more than 1% of the energy gained from feeding. Differences in handling times are probably more important than differences in energetic cost in determining the desirability of different types of prey. [KEYWORDS: prey handling, energetics, diet selection, optimal foraging].

Grismer

S08

The need for phylogeny in calculating species index values for reptiles on islands in the Gulf of California, Mexico. L. LEE GRISMER. *Dept of Biology, San Diego State University, San Diego, CA 92182-0057, United States of America.* The Gulf of California is a relatively narrow body of water approximately 1100 km in length and averaging approximately 170 km in width. It is bordered by the Baja California Peninsula on the west and mainland Mexico on the east. There are 65 islands within the Gulf of California for which herpetological records exist. The herpetofauna of these islands is unique in that it has two potential sources of colonisation; a western source from Baja California and an eastern source from mainland Mexico. Herpetological studies in the Gulf of California utilising the equilibrium theory of island biogeography in an attempt to explain patterns of insular diversity have made the *a priori* assumption that the herpetofauna of any particular island is a subset of that of the nearest continental source. This has resulted in inacurately calculated species index values (the number of species on an island divided by the number of species of the presumed continental source) for several islands. By inferring the phylogeny of each insular species in the Gulf of California using a cladistic analysis, the source of origin of each species can be hypothesized rather than assumed. For example, if an insular species is most closely related to a species or a lineage of species from Baja California, then it is most parsimonious to hypothesise that the ancestor of the insular species was/is also from Baja California and colonisation was from the west. It is clear now that on many islands that are geographically closer to the Baja California Peninsula than to mainland Mexico, species occur that are descended from lineages occurring in mainland Mexico. In fact, 56% of the 25 major islands examined consist of a herpetofauna with origins from both sides of the Gulf of California. Being that these islands are continental in origin and geologically associated with Baja California, the colonising species from mainland Mexico must have undergone transgulf overwater disperals. Therefore, the importance of the Baja California Peninsula as a colonisation source for reptiles on islands in the Gulf of California has been overestimated and species index values for reptiles on these islands, have been inflated by as much as 21%. [KEYWORDS: Baja California, Gulf of California, phylogeny, equilibrium theory].

Guillette *et al.*

S10

Reproductive cyclicity and fall vitellogenesis in the american alligator (*Alligator mississippiensis*). L.J. GUILLETTE, JR[1,4], A. WOODWARD[2], G. MASSON[1,3], T.S. GROSS[4] AND H.F. PERCIVAL[3]. [1]*Dept of Zoology, University of Florida, Gainesville, FL 32611, United States of America.* [2]*Wildlife Research Laboratory, FL Game and Freshwater Fish Commission, Gainesville, FL, United States of America.* [3]*USFWS Cooperative Research Unit, University of Florida, Gainesville, FL, United States of America.* [4]*Reproductive Analysis Lab, BEECS Program - ICBR, University of Florida, Gainesville, FL, United States of America.* Previous studies have suggested that reproductive activity (vitellogenesis, gravidity and nesting) of the female alligator was restricted to the spring and summer months. We collected blood samples from wild females that were analysed for (1) estradiol-17β (E_2), testosterone (T), and insulin-like growth factor I (IGF-I) by RIA, (2) vitellogenin by 1D-SDS-PAGE, and (3) total protein, albumin, phosphorus and calcium by spectrophotometric assays. Reproductively active females show elevated levels of E_2 throughout the year with peaks (150 pg/ml) in September and March–May whereas nonreproductive females exhibit baseline levels (15 pg/ml) with no apparent peaks. Testosterone is elevated during late vitellogenesis. IGF-I plasma concentrations show a similar pattern to that described for plasma E_2. Electrophoretically detectable plasma vitellogenin is observed in autumn and spring months. Elevated vitellogenin and estradiol are poorly correlated with elevated plasma total protein and calcium. Our data suggest that female reproductive activity begins in the fall with an increase in plasma E_2 in September and vitellogenesis in October. Ovarian activity slows during winter and reactivates with the onset of warmer spring temperatures. IGF-I, a growth factor known to be synthesised in the liver and oviduct, was elevated during vitellogenesis. [KEYWORDS: reproductive cycle, alligator, hormones.].

Guillette *et al.*

S11

Estrogenic environmental contaminants and their effect on the development and reproductive biology of reptiles. L. J. GUILLETTE, JR [1,2], T.S. GROSS[2], G. MASSON[1,3], H.F. PERCIVAL[3] AND J.M. MATTER[1]. [1]*Dept of Zoology, University of Florida, Gainesville, FL 32611, United States of America.* [2]*Reproductive Analysis Lab, BEECS Program - ICBR, University of Florida, Gainesville, FL, United States of America.* [3]*USFWS Cooperative Research Unit, University of Florida, Gainesville, FL, United States of America.* During a five year study examining viability of alligator eggs, we observed significantly depressed viability from one lake, Lake Apopka, that is severely contaminated. Xenobiotic factors can contribute to abnormal eggs and neonatal death. We used turtle and alligator eggs collected in the same nests from Lake Apopka (contaminated) and Lake Woodruff (control) to test whether various ab-

normalities existed in neonates produced. Viability of alligator eggs (28.27% ± 7%), but not turtle eggs, was significantly depressed on Lake Apopka. For neonatal alligators and turtles from Lake Apopka that survived, no significant difference was seen in body weight or total length after 6 months of growth when compared to Lake Woodruff neonates. After 6 months of growth, blood samples were collected from all young alligators and analysed for the steroids estradiol (E_2) and testosterone (T). Male (0.58) and female (6.6) juvenile alligators from Lake Woodruff have normal E/T ratios whereas the females (10.6) and males (4.1) from Lake Apopka have elevated E/T ratios. These abnormal ratio correlate with abnormal gonadal histology. Our data suggest partial sex reversal and feminisation of the gonad is occurring in both turtles and alligators from Lake Apopka during embryonic development. Estrogenic environmental contaminants are known to be present in alligator eggs from this lake system. Environmental contamination may be a major herpetological conservation concern in the near future. [KEYWORDS: ecophysiology, alligator, turtle, hormones, sex determination].

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Guinea

C06–064

A phylogenetic analysis of the thick sea snakes (Hydrophiidae: Ephalophiinae). MICHAEL GUINEA. *Faculty of Science, Northern Territory University, P.O. Box 40146, Casuarina, NT 0811, Australia.* The sea snake genera in the subfamily Ephalophiinae include *Ephalophis*, *Parahydrophis*, *Hydrelaps*, *Emydocephalus*, and *Aipysurus*. Their phylogenetic position relative to the sea kraits (Laticaudidae) and other sea snakes (Hydrophiinae) has been obscured by homoplasy. A phylogeny based on scale meristics, morphology and microdermatoglyphics is presented which supports *Aipysurus* and *Emydocephalus* as a monophyletic group with *Hydrelaps* and *Ephalophis* with *Parahydrophis* forming a sister group.

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Gullberg *et al.*

C06- 065

Genetic analysis of a species with fragmented distribution - the sand lizard (*Lacerta agilis*). ANNICA GULLBERG[1], HÅKAN TEGELSTRÖM[1] AND MATS OLSSON[2]. [1]*Dept of Genetics, Uppsala University, Box 7003, S-750 07 Uppsala, Sweden.* [2]*Dept of Zoology, Univ. of Göteborg, Medicinareg.18. S-41390 Göteborg, Sweden.* The Swedish sand lizard (*Lacerta agilis*) populations are relicts from the post glacial period when the climate was warmer. There are both completely isolated populations and populations connected by gene flow, which makes them an excellent model system for studies of genetic processes in small and endangered populations. The primary threat for many Swedish populations is the deterioration of their habitats. However, in some of the smaller populations inbreeding effects may be a problem. On the other hand, some populations may be genetically different to such an extent that artificial gene flow (by moving individuals) could cause out-breeding effects or introduce foreign lethal alleles that might endanger the genetic future of the population. Due to low allozyme variation in Swedish sand lizards we have chosen to study genetic variation using DNA fingerprinting. Both the level of variation within and divergence between populations have been assessed to trace the history of individual populations. We have used genetic variation in mitochondrial DNA (mtDNA) to trace immigration history and possible population bottlenecks. Preliminary results show that the level of variability both in mtDNA and fingerprinting loci is very low compared to other species. Probe 33.15 gives an average bandsharing between individuals from the same population of 0.48–0.69. However, there is a much lower degree of similarity between individuals from

different populations. The variability of the Swedish populations will be compared to that of large central Europeans populations with a wider geographic distribution. [KEYWORDS: sand lizard, conservation biology, DNA fingerprinting, mtDNA].

Conservation and commercial utilisation of endangered monitor lizards. BRIJ K. GUPTA. *Dept of Zoology, Science Faculty, University of Dayalbagh, D.E.I., Dayalbagh, Agra 282 005 India.* Monitor lizard *Varanus* sp. are highly endangered species. Their distribution is now restricted to only a few parts of India with the major concentration in the semi-arid habitats of the central zone. The lizards are used in aphrodisiac potions and their skin employed for leather. The genus is totally protected under The Wildlife Protection Act (1972), but is still hunted all over the country. The impact of this on the status of the species is not known and the level of threat from habitat destruction is also undocumented. The University of Dayalbagh with collaboration of the Captive Breeding Specialist Group, are studying the conservation and establishment of viable population of the threatened species through captive propagation programs and through intensive protection and management of the small and fragmented populations in the wild. Both *ex situ* and *in situ* methods are applied to improve strains and varieties. [KEYWORDS: monitor lizard, conservation, hunting, captive breeding, management].

Gupta

C06-066

Aspects of captive breeding of endangered *Phelsuma guentheri* at the Jersey Wildlife Preservation Trust. BRIJ K. GUPTA[1] AND JOHN E. FA[2]. [1]*Dept of Zoology, Faculty of Science, D.E.I., Dayalbagh University, Dayalbagh Agra 282/005, India.* [2]*Jersey Wildlife Preservation Trust, Les Augres Manor, Trinity, Jersey JE3 5BF, Channel Island, United Kingdom.* The large day gecko *Phelsuma guentheri* is restricted to Round Island, Mauritius. It is highly dependent on the palm savannah of Western slopes. Its numbers cannot therefore be expected to increase to a sustainable level as long as the serious soil erosion on Round Island continues reducing the amount of land suitable for growth of *Lantana* palms and leaving mature palms more susceptible to periodic cyclone damage. *Phelsuma guentheri* lays its eggs in the wild at communal sites, the largest numbers of which were found on the N.W. slopes of the island. In 1975 the total populations on Round Island was estimated approximately at 880. In 1978, the Jersey Wildlife Preservation Trust started a captive breeding programme to have a viable number of individuals. The present study is based on *Phelsuma guentheri* records kept at the Jersey Wildlife Preservation Trust. The aim is to understand aspects of the species' reproductive performance in captivity by looking at fecundity and mortality rates in captive and wild born females, seasonality of reproduction, egg production in relation to life span and viability and hatchability success of eggs since the start of the colony. The study shows captive and wild born *Phelsuma guentheri*, the percentage female starts laying eggs at the maturity time i.e. 7200 days. There was no significant difference among captive and wild born females. At the age of 3300 days to 5000 days both captive and wild born females lays eggs in the constant manner. The survivorship goes down to 35% at the age of 1100 days among males. But the females at the same age the survivorship percentage was 65–88%. The seasonality of egg production among the females was found higher in May, then June and July. The life span in relation to egg production depicts at the life span of 600 to 1600 days, the production of eggs were

Gupta & Fa

C06- 067

highest. The hatched eggs percentage was highest during 1979 (90%). The life span of female individuals at the J.W.P.T. was 4000–4600 days during 1978. In the 1988–1989 the life span was recorded only 600–1600 days.

Hall & Graveson S05

Amphibian skeletogenic and odontogenic neural crest. BRIAN K. HALL AND ANN C. GRAVESON. *Dept of Biology, Dalhousie University, Halifax, NS B3H4J1 Canada.* Neural crest is a vertebrate synapomorphy. The vertebrate head contains extensive neural crest derivatives such as cartilage, bone, connective tissue and dentine. Traditionally, cranial neural crest produces bone, cartilage and dentine but trunk neural crest does not. This dichotomy, largely derived from experiments on chick embryos and extrapolated to other vertebrates, has greatly influenced our thinking on developmental and evolutionary origins of the neural crest, skeletal and dental tissues. Three relevant data sets will be discussed. (1) Evidence for a cranial-trunk regionalization of skeletogenic and odontogenic neural crest in all vertebrates will be reviewed. (2) Data on regionalisation of amphibian neural crest will be discussed. (3) Experiments on regionalisation of the neural crest in the axolotl (*Ambystoma mexicanum*) will be discussed. Neural crest from various axial regions has been recombined with oral ectoderm and/or endoderm and maintained in explant culture. Teeth, identified in sections using light and polarising light microscopy, developed along with cartilage from cranial neural crest caudal to the region producing teeth *in vivo*, i.e. odontogenic capability of cranial neural crest is more extensive than expressed in *vivo*. Teeth, but not cartilage developed from trunk neural crest, i.e. trunk neural crest is odontogenic but not skeletogenic. A strict dichotomy between odontogenic/skeletogenic cranial neural crest and non odontogenic/skeletogenic trunk neural crest therefore cannot be maintained. [KEYWORDS: cranial/trunk, neural crest, patterning, evolution, cartilage, teeth].

Halliday et al. C29

Physiological contraints on the outcome of mating interactions in smooth newts. TIM HALLIDAY, LOTTIE HOSIE AND VERINA WAIGHTS. *The Open University, Walton Hall, Milton Keynes, MK7 6AA, United Kingdom.* The outcome of a courtship encounter between a pair of newts, that is, whether sperm transfer occurs, depends on the receptivities of the male and of the female. The receptivity of an individual fluctuates over time and depends, *inter alia*, on time of day, stage of the breeding season, and the individual's recent mating history. Our current hypothesis is that a female's receptivity is strongly influenced by her sperm supply and is thus affected by the time since she last mated. Females also appear to require multiple matings to initiate egg-laying. A male's receptivity is strongly influenced by his immediate ability to produce spermatophores, and is thus also affected by the time since he last mated. An important male 'mating decision' concerns how much sperm should be allocated to each spermatophore. This decision is complex because (i) receptive females are available over an extended breeding season, (ii) males cannot produce new sperm during the season, (iii) the reproductive value of matings changes over the season as females lay their eggs, and (iv) there is sperm competition. The female's extended period of receptivity means that males must maintain their reproductive effort over an extended period, during which they have to conserve their supply of sperm.

Hanken S05

Cranial pattern formation in direct developing anurans: integrating life-history evolution and developmental biology. JAMES HANKEN. *Dept of Environmental, Population, and Organismic Biology, University of Colorado, Boulder, Colorado 80309-0334, United States of America.* The neotropical frog genus *Eleutherodactylus* is a paradigmatic example of direct development, a common, evolutionarily derived life-history mode characterised by absence of the free-living, aquatic larval stage typical of metamorphosing species. Evolution of direct development in *Eleutherodactylus* has involved a comprehensive alteration in cranial pattern formation, which likely was mediated by the embryonic neural crest; many larval-specific features have been lost, other components initially assume a mid-metamorphic configuration that is subsequently remodeled by the time of hatching. These large-scale changes in embryonic development, however, are not associated with any significant change in adult morphology. Evolutionary dissociation between characters of early and late ontogeny may be facilitated by the developmental mechanisms underlying the ancestral, complex life history retained by many living species. [KEYWORDS: direct development, *Eleutherodactylus*, evolution, skull, musculature, nerves, neural crest].

Harlow C14

Life history attributes of an agamid lizard with temperature dependent sex determination. PETER HARLOW. *School of Biological Sciences, Zoology A08, University of Sydney, NSW 2006, Australia.* The Australian Water Dragon, *Physignathus lesueurii*, has temperature dependent sex determination: eggs incubated at constant temperatures of 25°C and below, and at 30°C and above, produce only females. Males are produced at intermediate temperatures. Adult sex ratios are male biased in a field population, and hatchling sex ratios are dependent on both female nest site selection and weather conditions during the temperature sensitive period of embryonic development. This common species is phylogenetically and ecologically remote from other Australian agamids, and shares a combination of life history attributes more similar to crocodilians than most agamids. Adult males show extreme sexual dimorphism, are about twice the mass of adult females and engage in territorial fights during the breeding season. Females mature in their third year and lay one or two clutches of eggs per season. Longevity is > 14 years in the field and > 26 years in captivity. Laboratory studies suggest that incubation temperatures influence the behaviour and performance of hatchlings, and these influences may translate into fitness effects under field conditions. [KEYWORDS: temperature dependent sex determination, Agamidae, *Physignathus lesueurii*].

Harris *et al.* C24

The effect of population density on joint nesting in four toed salamanders (Caudata: Plethodontidae). REID HARRIS, IVOR KNIGHT AND WHITNEY HAMES. *Dept of Biology, James Madison University, Harrisonburg, VA 22807, United States of America.* Female four-toed salamanders, *Hemidactylium scutatum* lay eggs in either solitary or joint nests. A replicated experiment was conducted in large outdoor terrariums to test the alternative hypothesis that female population density affects the frequency of joint nests. Despite a three-fold difference in female population density, the proportion of joint nests did not vary. However, the proportion of females that laid eggs in joint nests tended to be higher in high density populations. Generally, only one female brooded joint nests, brooding of eggs increased embryonic survival, and there was a cost of brooding in terms of weight loss. Solitary and joint nests were charac-

terised by nearly equal mean hatchling success, but the variance of hatchling success was higher for solitary nests. An interaction between population density and nest type might maintain the nesting dimorphism. The hypothesis that kin selection is the basis of a single female brooding a joint nest is currently under investigation. [KEYWORDS: brooding behaviour; density dependence, *Hemidactylium*, joint nesting].

Harry *et al.*

S05

The search for a conserved sex determining gene. JENNY L. HARRY[1], ANNE-MARIE CORIAT[2], MARK W.J. FERGUSON[2] AND PAUL T. SHARPE[2]. [1]*Dept of Zoology, University of Melbourne, Parkville, Victoria 3052, Australia.* [2]*Dept of Cell & Structural Biology, Stopford Building, University of Manchester, Manchester M13 9PT, United Kingdom.* Although the primary switch directing sex determination in vertebrate species may be either genetic (e.g. mammals) or environmental (e.g. alligators, turtles), gonadal differentiation ultimately depends on genetically determined pathways. Both chromosomal and temperature-dependent sex determination (TSD) occur among closely related species of reptiles, suggesting that similar genes may be required for both modes of sex determination. The recent discovery of a mammalian master testis-determining gene, *SRY* (Sex determining **R**egion of the **Y** chromosome), has provided an opportunity to test this hypothesis. We have cloned and sequenced a large number of DNA sequences from the American alligator, using primer pairs directed against the conserved region of the mammalian *SRY* gene and the polymerase chain reaction (PCR) to amplify these sequences. Three major classes of A-SRY have been identified which show varying degrees of sequence homology (45–87%) to mammalian SRY and related gene products. We have used the PCR amplified alligator sequences to isolate the transcribed genes from an alligator cDNA library and preliminary results from Northern blot analysis show that these genes are expressed with some tissue-specificity in alligator embryos. The temporal and spatial expression of all alligator *SRY*-cDNA sequences is now being assessed. These findings will be discussed in relation to our current understanding of the role of *SRY* in mammalian sex determination. [KEYWORDS: gonad differentiation, TSD, *SRY*, gene expression].

Hass

S08

Relationships of the west Indian curly-tailed lizards (*Leiocephalus*): evidence from mitochondrial DNA sequences and albumin immunology. CARLA ANN HASS. *Dept of Biology, Penn State University, University Park, PA 16802, United States of America.* The iguanid lizard genus *Leiocephalus* is endemic to the West Indies. The fossil record indicates that until recently it was distributed throughout the Greater Antilles and on some islands of the Lesser Antilles. Now it is restricted mainly to the islands of Cuba and Hispaniola. In addition, five species are endemic to islands or island banks in the southern Bahamas. Fifteen of the 21 extant species were examined using estimates of protein sequence divergence in serum albumin as detected by micro-complement fixation (MC'F) and direct nucleotide scquences of portions of three mitochondrial genes (16S rRNA, cytochrome b. and NADH-1). An antiserum was produced against the serum albumin of the Hispaniolan species *schreibersi*. All Hispaniolan species examined (*barahonensis*, *lunatus*, *melanochlorus*, *personatus*, *semilineatus*) and the Bahamian *inaguae* have albumins that are almost indistinguishable from *schreibersi* (IDs 0–4) while the Cuban species (*carinatus*, *cubensis*, *macropus*, *raviceps*, *stictigaster*) and other Bahamian species (*greenwayi*, *loxogrammus*, *punctatus*) are slightly more divergent (IDs 3–14). A preliminary analysis of DNA sequence data supports the monophyly of the Hispaniolan species (including *inaguae*). The sister taxon relationship of two Bahamian species (*greenwayi* and *punctatus*) from adjacent island banks, is strongly supported by the sequence data. Outgroup compansons for both the immunological and sequence data suggest that this genus is more closely related to the crotaphytine and sceloporine iguanids rather than to the tropidurines. Both molecular data sets strongly support an origin by overwater dispersal for *Leiocephalus* and recent (Miocene and later) inter-island dispersal and speciation. [KEYWORDS: Caribbean, DNA sequence, MC'F, biogeography, systematics, *Leiocephalus*].

Hay *et al.*

C06–068

Genetic variation within tuatara (*Sphenodon*). JENNIFER M. HAY[1], LINDA R. MAXSON[1] AND CHARLES H. DAUGHERTY[2]. [1]*Dept of Biology, Pennsylvania State University, University Park, PA 16802, United States of America.* [2]*School of Biological Sciences, Victoria University of Wellington, Box 600, Wellington, New Zealand.* As the only extant genus within the order Sphenodontida, the tuatara (*Sphenodon*) has been the focus of numerous comparisons with other reptiles with respect to anatomy, physiology, reproduction, behaviour and phylogenetic relationships, However, few comparisons have been made among geographic groups within *Sphenodon*. Endemic to New Zealand and once widespread there, tuatara are now restricted to 30 offshore islands. The quantitative immunological technique of micro-complement fixation (MC'F) was used to estimate the amount of protein divergence in serum albumin among the three main geographic/taxonomic groups. Antisera were made against purified serum albumin of *S. guntheri* and *S. punctatus* from Cook Strait, south of the North Island. Reciprocal comparisons detected no differences in antigenic sites between them (immunological distance [ID] = 0). However, both showed low but consistent differences from *S. punctatus punctatus* (average ID = 9) which is located on ≈25 islands northeast of the North Island. This variation coincides with allelic variation in albumin detected in an allozyme study (Gp-6 locus). We are now sequencing mitochondrial genes to examine patterns of variation among populations of tuatara. Preliminary results indicate that cytochrome *b* shows sufficient variation to distinguish the three groups. Patterns of variation within *S. p. punctatus* are being investigated. [KEYWORDS: *Sphenodon*, genetic variation, micro-complement fixation, cytochrome *b*].

Hay & Waldman

C29

Variation in call structure of whistling frogs (*Litoria ewingi*). TIM HAY AND BRUCE WALDMAN. *Dept of Zoology, University of Canterbury, Christchurch, New Zealand.* Whistling frogs, *Litoria ewingi*, initially were introduced from Tasmania to the South Island of New Zealand over 100 years ago. Littlejohn *et al.* (1993) demonstrated that advertisement calls of South Island frogs were more variable than those of Tasmanian populations. We observed calling behaviour and examined variation of call characteristics within and among *L. ewingi* breeding sites in the vicinity of Christchurch. Males vocalise in breeding choruses around standing water throughout the year. To identify individuals, we toe-clipped males after initially recording their calls. We captured individuals repeatedly in the vicinity of their calling site, although some moved to new calling sites after several nights. Males often interact aggressively near calling sites. Females move toward and appear to evaluate calls of territorial males before initiating amplexus. Advertisement calls consist of an initial drawn-out

pulsed note followed by a variable number of similar, but shorter, rapidly repeated notes. These distinctive patterns may serve as individual signatures. Some temporal characteristics regress significantly on the caller's size, body temperature, or both. Statistically controlling for these factors, we found that breeding choruses differed in numerous call characteristics, including call duration, number of notes per call, and note repetition rate. Even calling males in adjacent ponds, separated by just 50 m, differed dramatically in these temporal call characteristics. Pulse rate did not differ among sites, however. This result is consistent with previous studies which have shown pulse rate to be highly species-specific. [KEYWORDS: mating behaviour, communication, population variation, whistling frogs].

Hayashi

C06–069

Diel activity of the japanese newt *Cynops pyrrhogaster* in the field. TERUTAKE HAYASHI. *Tochigi Prefectural Museum, 2-2 Mutsumi-cho, Utsunomiya, Tochigi 320, Japan.* Diel activity of the Japanese newt *Cynops pyrrhogaster* was studied under the natural conditions during spring (reproductive season) and summer (non-reproductive season). The overall activity of *C. pyrrhogaster* is generally nocturnal or crepuscular in both seasons. In the spring, sex ratio of appearing individuals was biased to males (males:females = 3:1 to 4:1), whereas the sex ratio obtained by capturing all newts in the study site (a ditch with ca. 40 m in length and ca. 50 cm in width) was 1.23:1. This discrepancy between sex ratios of appearing and collected newts is attributed to sexual difference in the rate of active individuals. Namely, males are more active than females in the spring reproductive season. On the other hand, in the summer, the sex ratio of appearing individuals corresponds well with that of captured ones (males:females = ca. 1:1), showing no sexual difference in the rate of active individuals. [KEYWORDS: Caudata, Salamandridae, *Cynops pyrrhogaster*, diel activity, sex ratio].

Hayes *et al.*

S10

Mechanisms of steroid action on amphibian metamorphosis. TYRONE HAYES, TZU HAO WU, RUTH CHAN AND PAUL LICHT. *Dept of Integrative Biology, University of California, Berkeley, CA 94720, United States of America.* Corticosterone (B) has several effects on larval development in the toad, *Bufo boreas*, however, these effects vary with temperature. At 22°C B inhibits metamorphosis, while at 27°C metamorphosis is induced. At 27°C, many of B's actions (tail resorption, and head restructuring) appear to be mediated by synergism with endogenous thyroid hormones. Preliminary studies have revealed that B also reduces pituitary thyrotrophes and corticotrophes as well as the number of follicles and the size of the thyroid gland. The inhibition of metamorphosis at 22°C may be related to the fact that the thyrotropic axis develops slower at lower temperatures. When tadpoles are treated at earlier developmental stages (prior to thyroid development and secretion of thyroid hormones), B may down regulate the thyroid system, reducing thyroid hormone secretion which is required for B's effects. Because of B's function as a stress hormone, this work is relevant to the induction of metamorphosis by environmental stressors. [Supported by NSF grant DCB-9020493]. [KEYWORDS: tadpole, steroid, metamorphosis, metabolism].

Hayes *et al.*

S21

Predatory versus defensive strikes by North American crotaline snakes: risk assessment and venom metering. WILLIAM K HAYES[1], MATTHEW P. ROWE[2] AND DAVID DUVALL[3]. [1]*Biology Dept, Southern College, Collegedale, TN 37315-0370, United States of America.* [2]*Biology Dept, Appalachian State University, Boone, NC 28608, United States of America.* [3]*Life Sciences Program, Arizona State University West, Phoenix, AZ 85069-7100, United States of America.* Several studies were conducted to determine whether predatory and defensive strikes of crotaline snakes differ in ways that might influence the quantity of venom injected during the bite. The first experiment compared predatory and defensive strikes of adult prairie rattlesnakes (*Crotalus v. viridis*). Slow motion videotape analyses indicated that the duration of fang contact was significantly briefer during defensive strikes at rats (*Rattus rattus*) than predatory strikes at mice (*Peromyscus maniculatus* and *Mus musculus*). Although venom measurements were not obtained, fang contact during defensive bites may be too brief for substantial delivery of venom, which may lead to the frequent "dry" bites observed in defensive strikes at humans. In a replication study, representatives from three genera (*Agkistrodon*, *Sistrurus* and *Crotalus*) confirmed that the relatively brief defensive bites were characteristic of strikes by other taxa. In the third experiment, northern Pacific rattlesnakes (*C. v. oreganus*) were videotaped as they struck defensively at membrane-covered plastic pots. Venom was released in most of the strikes (75%), but wet bites and dry bites were of similar contact duration. Thus, dry bites may result from venom metering rather than brief fang contact. Defensive strikes of brief duration and minimal envenomation may have been favoured by natural selection as strategies to avoid counterattack by would-be predators/antagonists and to conserve venom supplies. [Research funded by NSF grants BNS-8813271 and IBN-9213870]. [KEYWORDS: Serpentes, Crotalinae, predator-prey, striking, risk assessment, venom, metering].

Hedges

S07

Biogeography of West Indian amphibians. S. BLAIR HEDGES. *Dept of Biology, Penn State University, University Park, PA 16802, United States of America.* There are 156 known species of West Indian amphibians (all anurans) grouped in six genera and 3 families. The leptodactylid genus *Eleutherodactylus* (133 species) dominates the amphibian fauna. Endemism is very high, with nearly every species restricted to a single island and most species are limited to a small area within an island. No species is endemic to the Bahamas Bank, and only seven occur in the Lesser Antilles, hence species diversity is concentrated in the Greater Antilles. A variety of niches are occupied by Caribbean amphibians, including underground burrows, rock walls, crevices, caves, bromeliads, tree holes, grass, waterfalls, rocky streams, mangrove swamps, ponds, and species occur from below sea-level to the highest elevation (3175 m). Species diversity and distribution are correlated with physiography and rainfall, but historical factors such as plate tectonics and phylogeny have played a significant role. There are no known extinctions, but several species have not been seen in recent years. [KEYWORDS: amphibian, West Indies, biogeography, distribution, Caribbean, conservation].

Heger & Heger

S17

Thermoregulation, activity pattern, and home range variation in the large monitor lizard, *Varanus giganteus*. NANCY A. HEGER[1,2] AND THOMAS G. HEGER[1,2]. [1]*Dept of Zoology, University of Texas, Austin, TX 78712, United States of America.* [2]*c/o CALM, P.O. Box 201, Exmouth WA 6707, Australia.* Radiotelemetry techniques were used to study thermoregulatory behaviour, activity pattern, and home range variation in *Varanus giganteus* in Western Australia between September 1991 and June 1992. The activity pattern of *V. giganteus* in the summer months was found to be

bimodal with activity in the early morning and late afternoon. The mean activity body temperature for *V. giganteus* was 36.4°C (SE = 0.44, N = 17, range: 33.6–38.8°C) which was higher than the mean temperature at the ground's surface and 10 cm above the ground. *V. giganteus* maintains consistent home areas, although home ranges tended to overlap both within and between sexes. Home range size for males was significantly larger than that of females and may be related to the perceived increase in movement by males during the breeding season (approximately November to January). Heating and cooling experiments confirmed that larger individuals do heat and cool more slowly than smaller individuals and all experimental lizards heated more quickly than they cooled. Thermal time constants tended to increase with body mass. Large individuals may benefit from inertial homoiothermy. The implications of this aspect of their thermal biology require further investigation. [KEYWORDS: thermoregulation, thermoregulatory physiology, radiotelemetry, activity pattern, home range, inertial homoiothermy].

Hels

C06–070

Population dynamics in a small population of European tree frogs (*Hyla arborea* L.) in Denmark. TOVE HELS. *Dept of Population Biology, University of Copenhagen, DK-2100 Copenhagen Ø, Denmark.* A small population of tree frogs (*Hyla arborea* L.) breeding in an environment consisting mostly of marl pits in an intensively cultivated farmland (main crops: sugar beets and wheat) was studied. The study area covers approximately 1000 km^2, within which the frogs inhabit about 40 ponds. These ponds are patchily distributed making up 4 "metapopulations". Data on numbers of calling males and numbers of larvae are presented on the basis of 5 survey years between 1981 and 1993. A considerable decline in the number of calling males during the 1980s (from 558 calling males in 1981 to 258 in 1991, a reduction of ≈55%) seems to be followed by a continuing decline in the 1990s (1992: 323, 1993: 300). However, the breeding success has increased considerably between 1991 and 1992, most likely due to improved breeding conditions after dredgings of breeding ponds, which started in the autumn of 1991. The numbers of calling males within a locality correlated positively and significantly from year to year. This, combined with the fact that very few (re)colonisations occurred, indicates a low degree of mobility between subpopulations. Within the range of population sizes studied the number of larvae did not increase with the number of calling males, indicating that the number of calling males is not a limiting factor for population growth. A multiple regression analysis indicated that among 7 environmental variables included, the water quality, as estimated on the basis of an ecological water quality scale, was a factor that contributed significantly to the determination of the number of calling males and the number of larvae. [KEYWORDS: *Hyla arborea*, population dynamics, dredgings, multiple regression analysis.].

Henle

S25

A critical analysis of the causes of the decline of amphibians and reptiles. KLAUS HENLE. *Projektbereich Naturnahe Landschaften, Umweltforschungszentrum Leipzig-Halle GmbH, Permoserstr. 15, D(O)-7050 Leipzig, Germany.* The loss of biodiversity has accelerated within the recent past. Because of the degree of this loss, it has become a major concern not only of biologists but also of the general public and politicians. Herpetologists have also drawn attention to the decline of amphibians and reptiles and have warned against their demise. In order to develop appropriate conservation and management strategies, we need to know not only the extent of the

decline but also need to critically assess the various causes which are responsible for the observed trends. Seven factors are generally implicated as causes for the decline of herps: habitat loss or degradation and particularly landscape fragmentation, biocides and pollutants, road traffic, immigrant predators, hunting and collecting, competition with alien species, and natural causes. Many conservation oriented herpetologists are not aware of the methodological possibilities and limitations to identify causes of decline and consequently often speculations are taken as proven causes. A critical assessment of the various factors often implicated as causes for the decline of amphibians and reptiles is presented. [KEYWORDS: Amphibia, Reptilia, extinctions, causes of decline].

Henzi *et al.*

C06–071

Environmental predictors of chorus attendance in reed frogs (*Hyperolius marmoratus*). S.P. HENZI[1], M.L. DYSON[1], S.E. PIPER[1] AND N.I. PASSMORE[2]. [1] *University of Natal, Durban, South Africa.* [2] *University of the Witwatersrand, Johannesburg, South Africa.* Numbers of male and female painted reed frogs at a natural breeding site fluctuated markedly over 28 consecutive nights. The attendance patterns of both sexes were analysed to assess the hypothesis that males actively time their visits in order to maximise access to females. As this argument hinges on the establishment of a mechanism whereby males can predict female numbers, available data on environmental conditions were used to model attendance patterns. The analyses provide no support for the hypothesis. While it was shown that environmental variables are excellent predictors of numbers, male and female patterns are described by different models. These are used to argue that the patterning of attendance reflects the action of other selection pressures. For males these appear to be ties to energy conservation. The data for females suggest that they time their arrival at the breeding site to coincide with conditions that will enhance the survival and development of their offspring.

Hero & Magnusson

C22

***Bufo marinus* and amphibian community ecology in Australia and South America.** JEAN-MARC HERO[1] AND WILLIAM E. MAGNUSSON[2]. [1] *Dept of Zoology, James Cook University, Townsville, QLD 4811 Australia.* [2] *Depto. de Ecologia, INPA, CP 478, Manaus 69011 AM, Brazil.* Waterbodies in Australia, Brazil and Venezuela were sampled to examine the influence of the Cane Toad, *Bufo marinus*, on amphibian assemblages. *B. marinus* inhabits a wide range of the available waterbodies and could interact with many amphibian species during both the larval and adult stages. However, overlaps between *B. marinus* and other species were low, suggesting that *B. marinus* reproduces at times or locations when other species are absent. The influence of habitat and the presence or absence of predators on the anuran assemblages were also examined. The potential interaction of the Cane Toad on amphibian assemblages in Australia will be discussed in relation to processes observed in amphibian assemblages in South America. [KEYWORDS: *Bufo*, community ecology, tadpole assemblage].

Herrmann & Joger

C06– 072

Molecular phylogeny of African vipers. HANS-WERNER HERRMANN[1] AND ULRICH JOGER[2]. [1] *Philipps-Universität Marburg, Biologie/Zoologie, Karl-von-Frisch-Str, D-35043 Marburg, Germany.* [2] *Hessisches Landesmuseum, Zoologische Abteilung, Friedensplatz 1, D-64283 Darmstadt, Germany.* Immunological comparisons of blood serum albumin and transferrin using quantitative precipitin tests were carried out for all genera of African vipers (except *Adenorhinos*) and most recent species. In contrast to

earlier revisions of African vipers we found them to be not monophyletic. *Atheris*, excluding *A. superciliaris*, is an early sidebranch of the viperine, separated by a larger immunological distance (ID) from *Bitis* than Eurasian vipers (i.e. *Cerastes*, *Echis*, *Macrovipera* and *Daboia*) are. *Atheris superciliaris* is clearly no member of *Atheris* and should be treated as a separate genus with closer relationships to *Bitis*. However, low IDs between *Bitis* and *A. superciliaris* albumins may be due to plesiomorphic similarities. The genera *Cerastes* and *Echis* are part of the Eurasian radiation of Viperinae. *Bitis* was found to consist of three main groups: (1) *B. arietans*, (2) *B. gabonica* and *B. nasicornis*, (3) small *Bitis* species (*B. atropos*, *B. caudalis*, *B. cornuta*, *B. peringueyi*, *B. schneideri*, *B. xeropaga*). Serum albumin of *Bitis atropos* shows a considerably low relative evolutionary rate. As suggested by other authors using morphological methods, *Causus* is situated at the basis of viperine snakes. [KEYWORDS: African vipers, blood serum proteins, quantitative precipitin test].

Herrmann *et al.*

C06–072

Ecological observations on some amphibians from a mountainous area near Xichang (Sichuan, P.R. China). H.J. HERRMANN, K-D., KÜHNEL AND K. KABISCH. *TetraWerke, Dr. rer. nat. Ulrich Baensch GmbH, Postfach 1580, 49304 Melle, Germany.* During an excursion to the province of Sichuan in southwest China in June 1992 we investigated the ecology of *Bombina maxima* in an area close to Xichang. On a plateau at a level of 3000 m we found nine species of amphibians. Focussing on *Bufo andrewi*, *Rana chaochiaoensis*, *Rana yunnanensis* and *Calluella yunnanensis* we present ecological, morphometrical, micromorphological, and bioacoustical data. Spawn, larvae, and adults of *Bombina maxima*, adults of *Batrachuperus karlschmidti* and larvae of *Rana yunnanensis* were predominantly observed in creeks. Adults of *Tylototriton taliangensis* and larvae of *Bufo andrewsi*, *Bufo gargarizans* and *Calluella yunnanensis* were found in ponds, which had a size of 700 and 800 m^2. The adults of *Megophrys gigantica*, *Bufo andrewsi*, *Bufo gargarizans*, *Rana chaochiaoensis* and *Rana yunnanensis* mainly lived in swampy areas near small mountain streams or ponds. The results of the morphometrical and micromorphological investigations especially on epithelial structure of nuptial pads and dorsal warts of adult animals and of the epithelial structure of denticles, papillas and jaws of larval mouths as well as the bioacoustic data (sonagrams of mating calls) reveal important details of taxonomic value.

Hetherington

S19

Comparative studies of different peripheral auditory pathways in amphibians. THOMAS E. HETHERINGTON. *Dept of Zoology, Ohio State University, 1735 Neil Ave., Columbus, Ohio, 43210-1293, United States of America.* Terrestrial amphibians may use a variety of pathways for transmission of sound energy to the inner ear. Only anurans possess a tympanic middle ear (TME), although some species lack one. Almost all anurans and salamanders have another middle ear system, the operecularis system (OS), and they also may employ a lung-inner ear pathway. Laser vibrometric studies were done on a variety of species of anurans and salamanders with different middle ear configurations to characterise and compare the peripheral response properties of these different pathways. The frequency responses of all pathways were dependent on body size, but in all species the suprascapula (origin of the operecularis muscle of the OS) displayed the most motion at very low frequencies (< about 200 Hz). The lateral body wall over the lungs was very responsive to intermediate frequencies, but was more

sensitive in anurans than salamanders. In anurans lacking a TME, the body wall was much more responsive to sound than the lateral head surface. The TME of anurans generally was tuned to relatively high frequencies (> about 1000 Hz). In anurans with a reduced tympanic ear (such as lacking a tympanum) the TME remained tuned to high frequencies and its sensitivity was only slightly reduced. These studies suggest that the OS may function in reception of very low frequency sound, and that the lungs may be an important pathway for low and intermediate frequencies in salamanders and especially in "earless" anurans lacking a TME. Such a lung pathway may reflect a retention of the original mechanism of terrestrial hearing in vertebrates. Evolutionary loss of a tympanum appears to have a minimal effect on frequency response and sensitivity of the TME. [KEYWORDS: ear, middle ear, hearing, Anurans, Salamanders].

Hillyard & Hoff

S13

Chemosensory role of anuran skin. STANLEY D. HILLYARD AND KARIN VS. HOFF. *Dept Biology, University of Nevada, Las Vegas, NV 89154, United States of America.* During periods of rehydration, toads adopt a behaviour, termed the water absorption response (WR) in which the hindlimbs are splayed and body movements optimise the area of ventral skin in contact with a moist surface. In our experiments, *Bufo punctatus* were dehydrated by approximately 10% of their standard (hydrated toads with an empty urinary bladder) weight and placed on 10 × 10 cm pieces of laboratory tissue that were saturated with water or with 250 mM solutions of NaCl, KCl or urea. In a second set of experiments, 10μM amiloride, a reversible blocker of epithelial Na^+ channels, was added to these rehydration media. For both experiments, we recorded the percentage of trials in which animals showed WR behaviour and the time that a toad remained on the moist surface. WR behaviour was observed in 100% of trials when toads were placed on surfaces wetted with water in the presence and absence of amiloride. Conversely, WR behaviour was observed in none of the trials with KCl or urea solutions as the hydration source in the presence or absence of amiloride. However, the frequency of trials in which toads showed WR behaviour on NaCl solutions was significantly increased from 3% to 44% when amiloride was added to that solution. Similarly, amiloride significantly increased the time spent on the NaCl but not the KCl or urea solutions. These results demonstrate that amiloride-sensitive Na^+ channels in the toad skin serve a sensory as well as a transport function. [KEYWORDS: toads, skin, amiloride, behaviour].

Himstedt & Simon

S20

Sensory basis of foraging behaviour in caecilians (Amphibia, Gymnophiona). WERNER HIMSTEDT AND DIETMAR SIMON. *Institut für Zoologie Technical University, D-64287 Darmstadt, Germany.* Like urodele amphibians caecilians are carnivorous during larval stage as well as after metamorphosis. Nocturnal and subterranean habits impede behavioural observations in these animals. We registered activity and responses to different sensory stimuli under infrared illumination by means of video-camera and -recorder in the species *Ichthyophis kohtaoensis*. In some experiments sensory systems were put out of use. In contrast to most salamanders vision is not involved in prey selection in caecilians. Olfactory orientation is of particular importance. The sensitivity for detecting prey odour is higher than in urodele amphibians. The tentacle, a tactile and chemoreceptive organ typical for caecilians, plays a minor role in foraging behaviour. Like in urodeles caecilian larvae possess a lateral line system with neuromasts and elec-

trosensitive ampullary organs that is quite efficient in identification and localisation of aquatic prey. [KEYWORDS: Amphibia, Gymnophiona, *Ichthyophis*, prey recognition].

Hirth S18

A leatherback sea turtle nesting population at Piguwa, Papua New Guinea. HAROLD F. HIRTH. *Dept of Biology, University of Utah, Salt Lake City, UT 84112, United States of America.* Some aspects of the natural history and conservation of leatherback sea turtles (*Dermochelys coriacea*) nesting at Piguwa, Papua New Guinea, were studied. The peak of nesting here, one of the more important nesting colonies in the Pacific Ocean, is December, January and February. The average, standard, over-curve carapace length of nesters was 161 cm and the mean clutch was 88 eggs. Statistically significant positive relationships were found between carapace lengths and sizes and weights of clutches. Eggs are important sources of protein for local inhabitants. A section of the nesting beach is recommended for Wildlife Management Area status. Ecotourism is also a distinct possibility. Compared to leatherbacks in the well-known Jalova, Costa Rica, nesting colony, Piguwa nesters are larger, lay more eggs, make fewer "orientation circles" and lay fewer eggs on the foreshore. [KEYWORDS: Leatherback sea turtle; Papua New Guinea].

Hitchmough C07

Systematics of New Zealand geckos: a hierarchically structured species complex. RODNEY A. HITCHMOUGH. *School of Biological Sciences, Victoria University of Wellington, P.O. Box 600, Wellington, New Zealand.* The New Zealand gecko genus *Hoplodactylus*, as currently recognised, includes two widespread species as well as several species with restricted geographic ranges. Allozyme surveys have confirmed the existence of species complexes within both widespread species and one northern endemic, taking the number of species within *Hoplodactylus* from eight to at least 22. Examples of the variation found within the *Hoplodactylus maculatus* complex will be described. There is a hierarchy of differentiation within this complex from morphologically and genetically distinct sympatric species, through parapatric species pairs both with and without hybridisation in the contact zone, to regionally differentiated groups of populations without evidence of reproductive isolation. Because of this hierarchical structure, species-level taxonomy is subject to different interpretations dependent on the species concept used, and inevitably oversimplifies the variation seen in nature. [KEYWORDS: *Hoplodactylus*, Diplodactylinae, Gekkonidae, systematics, species complex, allozymes].

Hitchmough C01

Phylogenetic relationships of diplodactyline geckos - an alternative hypothesis. RODNEY A. HITCHMOUGH. *School of Biological Sciences, Victoria University of Wellington, P.O. Box 600, Wellington, New Zealand.* The Australasian gecko subfamily Diplodactylinae was divided by Kluge (1967) into two tribes — Diplodactylini (Australia) and Carphodactylini (Australia, New Caledonia, and New Zealand). Bauer (1990) has produced a morphology-based cladogram for the Carphodactylini. However, reanalysis of Bauer's data with inclusion of taxa from the Diplodactylini strongly suggests that the tribal split is invalid, and that some of the higher-level relationships proposed by Bauer are artifacts of morphological convergence. This reanalysis is also more consistent with King's (1987) cytogenetic data, except for the position of *Carphodactylus*. A small-scale allozyme study has suggested that the New Zealand and New

Caledonian groups are each monophyletic. This survey also shows no separation among the Australian taxa consistent with the current tribal classification. Bauer (1990) suggested that the New Zealand genus *Hoplodactylus* was paraphyletic with respect to the New Caledonian genera; all my data suggest that *Hoplodactylus* is indeed paraphyletic, but with respect to *Naultinus* (which Bauer considered more ancestral) rather than the New Caledonian group. [KEYWORDS: Gekkonidae, Diplodactylinae, phylogeny, morphology, allozymes].

Hödl S22

Mating behaviour in leptodactylid foam-nesting frogs. WALTER HÖDL. *Institut für Zoologie der Universität Wien, Althanstrasse 14 A1090, Wien, Austria.* Leptodactylid foam-nesting bouts are initiated by lordotic arching of the female. Female lordosis ("signal position") triggers the basket formation and foambeating motion in the amplectant male. In the initial phases of nest building only oviducal fluid is stirred into foam. Once a foam platform exists, eggs are extruded onto the downwardly oriented cloaca of the amplectant male. In *Pleurodema diplolistris* and *Physalaemus ephippifer* foam beating (and egg distribution within the aquatic foam) occurs during alternate leg kicks of the male involving rotational movements of the tibia and tarsus perpendicular to the body axis. Males of *Leptodactylus knudseni* beat the terrestrial foam by moving their feet and tarsi back and forth in a lateral ("wiping") motion, similar to the arboreal foam-nesting movements undertaken by treefrogs of the hylid genus *Polypedates*. Nesting individuals do not require feedback from the foam mass to make an effective nest; nesting bouts continue regularly after removal of the foam built during previous bouts. Following initial nesting bouts, females of *P. ephippifer* and *P. diplolistris* are incapable of delivering further egg jelly to be beaten into foam. The lack of continuous jelly discharge may have led to communal nesting, frequently observed in both species. Eggs extruded after experimental removal of the foam platform in *P. diplolistris* that sunk to the aquarium floor were fertile. Close contact between the amplectant pair's cloacae during egg discharge and fertilization prior to egg deposition within the foam are considered to be the main reason for the absence of unpaired ("sneaky") males interfering with nesting pairs frequently observed in hylid foam-nesting species.

Höggren & Tegelström C24

Within season multiple paternity in the adder (*Vipera berus*) - confirmed by DNA fingerprinting. MATS HÖGGREN AND HÅKAN TEGELSTRÖM. *Dept of Genetics, Uppsala University, Box 7003, S-750 07 Uppsala, Sweden.* Paternity among the offspring of European adders was determined after breeding experiments in outdoor enclosures using DNA fingerprinting. Bandsharing analyses and the presence/absence of male-specific bands of all neonates revealed within ovary cycle multiple paternity in five out of six litters, with up to three fathers per litter. Thus, multiple copulations can result in mixed paternity if mating occurs within a critical period. None of the young in the mixed litters were sired by sperm stored from previous year(s). One female was evidently inseminated prior to capture and her offspring turned out to be fathered by a single male. She was probably still receptive when introduced into the enclosure, suggesting that multiple paternity may be rarer in the wild than under unnaturally restricted enclosure conditions. Genetic similarity values within the natural populations that we sampled indicate that DNA fingerprinting is useful for inferring multiple paternity among offspring also when potential fathers are not available. [KEYWORDS:

DNA fingerprinting, multiple paternity, *Vipera berus*].

Honegger
P6

Amateurs — conservation and captive care. RENÉ E. HONEGGER. *Dept of Herpetology, Zürich Zoological Garden, CH - 8044 Zürich, Switzerland.* We witness a global irresistible decline of biodiversity and thus of our quality of life. The reasons are manyfold and basically known. Everyday we learn of an increasing apathy towards living creatures, although private and governmental organisations are engaged, together with bona-fide zoological gardens, to conserve habitats and to breed selected species. Many of them are flag-ship taxa, which are defined through their category, insular distribution, size, form and their political and economical value. The vanishing of other species is less spectacular: they just simply disappear! Sometimes when it comes to conservation talks, and especially to captive breeding philosophy, one is often left with a feeling, that much of the discussion is academic and far from reality. Active involvement of amateurs in global herpetological conservation effort is much needed. Their successful personal involvement and most valuable contribution to the breeding biology of wild species of herpetofauna, outnumbering the "favoured few", must not be prevented through impeding and unrealistic laws. Biodiversity can best be conserved by yielding financial and material rewards through sustainable utilisation, as shown for some species of crocodiles. Bureaucratic decrees do not save any species and no habitat. Habitat protection and saving the *wild* herpetofauna is the goal, and the propagation of albinos, hybrids and other freaks should be abandoned. Without the participation of the knowledgeable amateurs in captive breeding, there will be little further engagement in conservation of habitats and finally the number of engaged herpetology-students will decrease and the apathy in dedication towards lower vertebrates will increase even more. [KEYWORDS: decline of biodiversity, herpetofauna, amateurs, habitat protection, captive breeding, sustainable utilisation, research].

Hong
C31

The ampullary organ of the Chinese giant salamander *Andrias davidianus*. HONG CHENG. *Dept of Biology, Peking University, Beijing, 100871, P.R. China.* The lateral line system of larval, juvenile and adult Chinese giant salamander (*Andrias davidianus*), the specific protected aquatic urodele, were first examined by the use of light and scanning microscopical techniques. In larva stage the ampullary organs, free neuromasts and sunken neuromasts were found. But we failed to find the ampullary organs in juvenile and adult. The ampullary organs concentrated in head around the rostrum, external nares, eyes and the tip of the lower lip. Its fundamental structure consists of sensory cells, supporting cells, few mantle cells and canal lumen. The sensory cells are egg-shaped with obvious synaptic spheres on the base and arrange around the lumen which connected to the surface by opening. The differences of the free and sunken neuromasts are shown in the paper. The comparison of this animal's ampullary organs and the comparison of these organs and those of other species of urodeles described by early authors are also presented. In the discussion stress is laid on the relation between the disappearance of the ampulary organs in juvenile and adult, the animal's habits and the evolution from water to land. [KEYWORDS: Chinese giant salamander, ampullary organs, electrophoresis, neuromasts, lateral line system].

Hoogmoed & De Avila-Pires
C07

Preliminary notes on the herpetofauna of caxiuana, a protected area in the lower Amazon. MARINUS S. HOOGMOED[1] AND TERESA C.S. DE AVILA-PIRES[2]. [1]*Nationaal Natuurhistorisch Museum, Postbus 9517, 2300 RA Leiden, The Netherlands.* [2]*Museu Paraense EG/DZO, Caixa Postal 399, 66017-970 Belém, PA, Brazil.* The Museu Paraense Emilio Goeldi, Belem, at the moment, is building the permanent scientific field research station "Ferreira Penna" in the Floresta Nacional de Caxiuana. It is envisaged to conduct long-term field work in this area. Inventorying herpetological research in the area started in 1992 and will continue till 1996. Within the area primary tropical rainforest is the prevalent vegetation, but also some cultivated areas and sandy beaches occur. The forest is characterised by a high number of chablis (open areas caused by tree falls). Around the station a grid of lines with 50 m markers is present, thus enabling to pinpoint the spot where specimens were collected/observed. Through cooperation with botanists of the museum it is also possible to attribute specimens to the type of vegetation in which they have been collected/observed. The first results so far indicate that the herpetofauna answers our expectations for the area. Most species present belong to the widespread Amazon Basin element. Due to the presence of many, sunny open spots, the herpetofauna connected to such spots was rather abundant. Two small leaflitter frogs *Adenomera andreae* and *Dendrophryniscus minutus* dominate the leaflitter herpetofauna of the dry season. A single endemic frog *Dendrobates galactonotus* is common. In older settlements in the area *Hemidactylus mabouia* is well represented. In the newly opened area of the biological station it is still absent, and its niche in human habitations is (still?) occupied by *Gonatodes humeralis* and *Thecadatylus rapicuada*. Some comments on the (seasonal) abundance and on habitat preferences of species will be made. Several collecting methods are tested. The relationship with other areas in Amazonia will be discussed. [KEYWORDS: Amazon area, Caxiuana, herpetofauna].

Horne & Dunson
S24

The effects of metals on the embryonic and larval forms of three amphibian species that breed in temporary ponds in Pennsylvania: interactions with DOC, water hardness and pH. MICHAEL T. HORNE AND WILLIAM A. DUNSON. *Dept of Biology, The Pennsylvania State University, 208 Mueller Laboratory, University Park, PA 16802, United States of America.* Water chemistry greatly determines the success or failure of embryonic and larval forms of amphibians that breed in temporary ponds in Pennsylvania. Preliminary data suggest that of the three species studied, the Jefferson salamander, *Ambystoma jeffersonianum*, is the most sensitive member of its amphibian assemblage to the effects of toxic metals and pH. Wood frogs, *Rana sylvatica* are the least sensitive to these effects. Spotted salamanders, *A. maculatum*, show an intermediate response. Mesocosm, greenhouse, and coldroom studies confirm that Cu and Al in levels analogous to those found in some temporary ponds greatly reduce hatching success, and greatly increase larval mortality in all three species studied. However, higher levels of DOC and/or electrolytes such as Ca act to reduce these toxic effects either by chelation or by competitive inhibition via complexation with the gill surface. These data provide the basis for powerful predictive models that may help in the further evaluation of amphibian decline in species that breed in temporary waters. [KEYWORDS: *Ambystoma jeffersonianum*, *Ambystoma maculatum*, *Rana sylvatica*, toxicity, DOC, hardness, pH, Cu, Al, Pb, Zn, Fe].

Houck

S19

Chemical persuasion in salamanders. LYNNE D. HOUCK. *Dept of Ecology & Evolution, University of Chicago, 940 E. 57th Street, Chicago, IL 60637-1455, United States of America.* Behavioural observations and experiments have revealed the tremendous importance of chemosignals during courtship behaviour and during territorial interactions in many salamander species. Well-tested protocols for evaluating behavioural interactions are now being coupled with newly developed techniques to control pheromone delivery. This combined approach will permit tests of the behavioural effectiveness of chemically purified pheromones. The nature of chemical communication can now be examined with different questions in mind. For courtship pheromones, two levels of inquiry promise exciting results: (1) What are the physiological effects of courtship pheromones on the female? Among males, are behavioural differences in courtship pheromone delivery (e.g. the number and the timing of delivery bouts) correlated with increased insemination success? (2) How have courtship pheromones evolved in relation to behavioural and genetic divergence of populations and species? For plethodontids, preliminary results suggest that pheromones may vary among disjunct populations of conspecifics. Are chemical differences associated with behavioral effectiveness (i.e. do pheromones from males of one population also stimulate females from a disjunct population?). These questions are being addressed for several plethodontid species in which behavioral as well as allozyme differences among populations are known.

Houston

S27

Arafura filesnakes (Acrochordidae); a possible commercial resource? DARRYL HOUSTON. *School of Biological Sciences, Zoology A08, University of Sydney, NSW, 2006, Australia.* Arafura filesnakes (*Acrochordus arafurae*) are large (males to 1.5 m, females 2.0 m) piscivorous, entirely aquatic nonvenomous snakes. Field studies in the Northern Territory of Australia have revealed that filesnakes can occur in extremely high population densities (> 150 snakes/ha), in suitable billabongs. At first glance, the large body size and high population densities of these animals suggest that they represent an important commercial resource, especially in terms of harvesting for the skin trade. However, filesnakes have delayed maturation ($\geq$7.5 years for females) and individual female snakes reproduce only infrequently, in response to proximal environmental factors. Therefore, before any attempt is made to harvest wild populations of filesnakes, small-scale selective experimental harvesting is required to examine how populations respond. Research should also be directed toward establishing commercial farming operations; perhaps as an adjunct to existing crocodile or fish farming operations. [KEYWORDS: Acrochordidae, *Acrochordus arafurae*, delayed maturation, harvesting].

How & Dell

S06

The zoogeographic significance of urban bushland remnants to reptiles in the Perth region, Western Australia. R.A. HOW AND J. DELL. *Western Australian Museum, Francis St., Perth, WA 6000, Australia.* The 71 reptile species occurring in the Perth region make this area as diverse as any similar sized coastal region in Australia. Cluster analysis of the lizard and skink assemblages of 17 bushland remnants in the region indicate that three main sub-regions can be identified; Darling Plateau and Scarp, Offshore Islands and Swan Coastal Plain. Within the Swan Coastal Plain the lizard and skink faunas of bushlands on the same landform are more similar to one another than they are to those of adjacent landforms. The Swan River appears to be a distributional boundary for some species. Species-area relationships indicate a variety

of responses amongst the different taxonomic groups of reptiles, with snakes being the most sensitive to loss of habitat. The isolated remnant bushlands of inner urban areas retain a variety of reptile species, but there is no significant relationship with remnant area. The implications of zoogeographic and area relationships are discussed. [KEYWORDS: reptiles, urban, bushlands, zoogeography, remnants].

How *et al.*

C10

Geographical variation in the genus *Dendrelaphis* (Serpentes: Colubridae) within the Banda Arc Islands, Indonesia. R.A. HOW[1], L.H. SCHMITT[2] AND MAHARADATUNKAMSI[3]. [1]*Western Australian Museum, Francis St, Perth, WA 6000, Australia.* [2]*Dept Anatomy and Human Biology, University of WA, Nedlands, W.A. 6009, Australia.* [3]*Museum Zoologicum Bogoriense, Jl. Ir.H. Juanda No18, Bogor, 16122, Indonesia.* The south-eastern islands of Indonesia between Bali in the west and Ambon in the east define a region that is known to be at the interface of the Asian and Australasian biogeographic regions. Three species of the genus *Dendrelaphis* are recorded from the region — *Dendrelaphis pictus* occurs on Bali and the islands of Nusa Tenggara: *D. calligaster* is recognised from the southeastern Moluku islands; *D. punctulatus* is known from Ambon. This paper examines the geographic variation in cranial and body measurements within the genus using multivariate statistics. Our findings suggest that *D. pictus* from Bali and Lombok are specifically different from populations on the remaining islands of Nusa Tenggara and that there is no difference between the two subspecies previously recognised within this latter area. Several cranial measures are strongly correlated with longitude within the Nusa Tenggara species. The biogeographic significance of the findings is discussed in the context of work on other vertebrate groups [KEYWORDS: biogeography, morphology, variation, Indonesia, *Dendrelaphis* spp.].

Hristovski & Kalamaras

C06– 074

Helminths in anuran species from Macedonia. N.D. HRISTOVSKI[1] AND A. KALAMARAS[2]. [1]*Agricultural College, University of Bitola, Bitola, Macedonia.* [2]*Institute of Histology, Medical Faculty, University of Skopje, Skopje, Macedonia.* In Macedonia are distributed the following species of Anura: *Rana ridibunda*, *R. temporaria*, *R. graeca*, *R. dalmatina*, *Bufo viridis*, *B. bufo*, *Bombina variegata*, *Hyla arborea*, and *Pelobates fuscus*. During the examination period of 1967–1993 in them were found the following helminths: *Polystoma integerrinum*, *Diplodiscus subclavatus*, *Gorgordera cygnoides*, *G. microovata*, *G. pagenstecheri*, *Gorgoderina vitelliloba*, *G. alobata*, *Pleurogenes claviger*, *P. loosi*, *Pleurogonoides medians*, *Prosotocus confusus*, *Halipegus ovocaudatus*, *Cephalogonimus retusus*, *Haematoloechus variegatus*, *H. asper*, *Dolichoaccus rastellus*, *Opistogluphe ranae*, *Haplometra cylindracea*, *Rhabdias bufonis*, *Cosmocerca ornata*, *C. commutata*, *Aplectana acuminata*, *Oxysomatium brevicaudatum*, *Chaboudgolvania terdentatum*, *Oswaldocruzia filiformis*, *Icosiella neglecta*, *Thelandros tba*, *Acanthocephalus ranae*, *A. falcatus*.

Hudson *et al.*

S30

Antibacterial activity of venom preparations from species of Elapidae and Viperidae maintained in captivity in Australia. B.J. HUDSON[1], C.J. FERNANDES[1], P.J. MIRTSCHIN[2] AND J.H. BOWIE[3]. [1]*Microbiology Dept, Royal North Shore Hospital, St Leonards, NSW 2065, Australia.* [2]*Venom Supplies, Tanunda, SA 5352, Australia.* [3]*Dept of Chemistry, The University of Adelaide, SA 5005, Australia.* When

snake venom is extracted and stored, it apparently has a long period of integrity. This suggests the possibility of the presence of a natural preservative in the venom that helps resist breakdown by bacteria and fungi. We have investigated the antibacterial properties of venom preparations against clinical isolates of bacteria. Venom preparations from three Australian elapids (*Pseudechis australis*, *P. guttatus* and *P. porphyriacus*) and one viper (*Vipera lebetina*) were tested by a standardised agar dilution method for antibacterial activity against a wide range of human pathogens. The three elapid venoms tested had significant antibacterial activity against *Staphylococcus aureus*, including multi-resistant strains and *S. epidermidis*. Similar antibacterial activity was noted with the venom preparation from *V. lebetina*. In general Gram-negative rods were less susceptible, except for *Xanthomonas maltophilia* and *Pseudomonas aeruginosa*. Snake venoms contain many proteinaceous components which incapacitate and digest prey. It is likely that some of these compounds could be responsible for the antibacterial activity. The detailed results will be presented.

Hudson

S15

Relative growth, habit and reproductive output in southeastern Australian skinks. SIMON HUDSON. *Dept of Zoology, La Trobe University, Bundoora, Victoria 3083, Australia.* For a viviparous lizard, it would be expected that reproductive output would be limited by the space available for developing embryos. Interspecific differences in body shape associated with habit may therefore influence reproductive output in lizards, as may allometric changes in shape. To investigate this, near-term gravid females were collected from 10 scansorial and terrestrial species in the scincid genera *Niveoscincus* and *Pseudemoia* from locations in south-eastern Australia. Snout-vent length, inter-limb length, non-gravid mass and total wet clutch mass were measured. Results will be discussed. Preliminary results suggest that interspecific differences in body shape associated with habit, and allometric changes in body shape, are both accompanied by changes in total clutch mass. [KEYWORDS: growth, habit, *Niveoscincus*, reproductive effort, *Pseudemoia*].

Huey

P3

Evolutionary physiology of reptiles: integrating physiology, phylogeny and demography. RAYMOND B. HUEY. *Dept of Zoology NJ-15, University of Washington, Seattle, WA 8195, United States of America.* The field of evolutionary physiology explores how physiological processes influence and are influenced by evolutionary patterns and dynamics. The evolution of physiology is ideally studied from multiple perspectives. For example, history provides one important perspective. To elucidate the actual patterns of physiological evolution that have occurred over historical time, my colleagues and I are conducting a major comparative analysis of the thermal sensitivity of sprint speed in lizards (> 70 species) from several families. Using an explicitly phylogenetic approach, we find, for example, that evolutionary shifts in thermal sensitivity of sprinting (e.g., "optimal temperature") are generally correlated with evolutionary shifts in activity temperatures. Thus most species are active at body temperatures that are close to those that maximize their sprint capacity. Demography provides a complementary perspective on the evolutionary significance of physiology in contemporary populations. By conducting physiological studies on demography monitored populations, my colleagues and I are determining, for example, whether and how individual variation in physiological performance has an impact on fitness and whether

lizards in natural populations "age", such that their physiological performance (and survivorship) declines as they grow old. In some cases, we are able to manipulate certain traits ("phenotypic engineering") to test experimentally the patterns of causality suggested by the above descriptive studies. Quantitative genetics provides an additional perspective, one that provides guidelines as to how populations will respond evolutionarily to selection. Increased interactions of physiologists with demographers, functional biologists, geneticists, and systematists promise to enhance our understanding of the directions and dynamics of physiological evolution. [KEYWORDS: demography, lizards, phylogeny, physiology, thermal biology].

Hulse

C18

Comparative demographics of two populations of *Cryptobranchus alleganiensis* (Caudata: Cryptobranchidae) from western Pennsylvania, USA. ARTHUR C. HULSE. *Dept of Biology, Indiana University of Pennsylvania, Indiana, PA 15705, United States of America.* A mark recapture study was conducted on two populations of *Cryptobranchus alleganiensis* a giant salamander. Both populations were located in streams within the Ohio River drainage of western Pennsylvania, United States of America. Tionesta Creek is a moderate sized stream with a total length of 111 km and an average width of 30 m at the study site, while Tubmill Creek is a relatively small stream with a total length of only 23 km and an average width of 11 m at the study site. Populations were compared for population number and density, sex ratio, size distribution of males and females, home range size, and size of cover objects selected. The population at Tionesta Creek has a density of 1 animal per 1.3 linear m of stream bed while Tubmill has a density of 1 animal per 7.6 m of linear stream bed when adjusted for differences in stream width. Sex ratio is 1:1 at Tionesta Creek but males outnumber females by 1.8:1 at Tubmill Creek. In both populations females are significantly larger than males and both males and females from Tubmill Creek are significantly larger than males and females from Tionesta. Size distribution for both males and females in Tubmill Creek is skewed to the left indicating an aging population, whereas the Tionesta population has a more normal size distribution. Home range size is smaller for Tubmill animals as compared to those from Tionesta. Choice of cover objects is similar in both populations. The above findings are discussed in view of differences in anthropogenic impact history of the streams examined and their size differences. [KEYWORDS: *Cryptobranchus*, population structure, habitat choice, home range].

Hutchinson *et al.*

S06

Discovering the biology of a rare lizard, the pygmy bluetongue, *Tiliqua adelaidensis*. MARK N. HUTCHINSON[1], TIM MILNE[2] AND GRAHAM ARMSTRONG[3]. [1]*South Australian Museum, GPO Box 234, Adelaide, SA 5001, Australia.* [2]*Biological Conservation Branch, Dept of Environment and Land Management, PO Box 902, Norwood, SA 5067, Australia.* [3]*19 Landy Ave, Salisbury East, SA 5109, Australia.* The pygmy bluetongue lizard, *Tiliqua adelaidensis* (Peters, 1863) (Scincidae) had been regarded as possibly extinct prior to the discovery of a population in October, 1992, the first record of the species for 33 years and only the third this century. We present the initial results of the first ecological study of the species which show that it is a diurnal inhabitant of open tussock grassland and uses spider holes for shelter. Males had enlarged turgid testes during spring and a female examined at this time had yolked

ovarian follicles. Males were more active and trappable than females during spring, but both sexes were sedentary during late summer-autumn. Litters of 1–4 young were born in the maternal burrow during February–March. It is very likely that this species has suffered a real decline; most of the natural grassland and grassy woodland within the historical range of *T. adelaidensis* has been ploughed and cleared and only scattered, degraded remnants remain. However, it is evident that failure to locate the species had been due partly to ignorance of its preferred habitat coupled with its unusual and secretive habits. [KEYWORDS: lizard, Scincidae, *Tiliqua*, morphology, ecology, conservation].

Hutchison

S29

Critical thermal maxima: advances since Cowles and Bogert. VICTOR H. HUTCHISON. *Dept of Zoology, University of Oklahoma, Norman, OK 73019, United States of America.* The two major methods for determination of thermal tolerance to high temperatures are: (1) the lethal temperature method, which uses static test temperatures and different exposure times, and (2) the critical thermal maximum (CTMax), which uses a dynamic method with increasing temperature. The 1944 definition of CTMax by Cowles and Bogert often has not been followed in investigations of CTMax. The onset of spasms (OS) is a better endpoint than the often used loss of righting response (LRR). The phenomena of heat hardening, cellular thermotolerance and thermosensitivity and induction of heat shock proteins are more related to the thermal conditions at OS than at LRR. The OS is also more precise than the LRR and provides an accurate measure for standardized comparisons of ecologically relevant tolerances to high temperature. Tolerance to low temperature results from a very different set of physiological changes and LRR is an appropriate endpoint for the critical thermal minimum. [KEYWORDS: critical thermal maximum, heat shock, temperature, thermal tolerance].

Inger & Voris

S24

Changes in abundance of frogs over time in two pristine Old World tropical rain forest communities. ROBERT F. INGER AND HAROLD K. VORIS. *Dept of Zoology, Field Museum of Natural History, Chicago, IL, 60605, United States of America.* Streams at two pristine lowland tropical rain forest sites in Borneo have been surveyed using standardised stream sampling methods. We made observations on 4,174 frogs during 46 night stream transects made on three steams at Nanga Tekalit, Sarawak, in 1962, 1970 and 1984. Eleven species representing three families made up about 90 percent of all observations. We observed 1,276 frogs on two streams at Danum Valley, Sabah, in 1986, 1989 and 1990. Nine species representing two families constitute more than 80 percent at Danum. At both sites the total number of frogs fluctuates up and down between the sampling years. Examples of population increase, decrease and stasis are observed among the species at both sites. The magnitude and direction of change in numbers for a given species between years at streams at the same site often differ. Relative abundances of species also fluctuate. At these sites there is no evidence for a consistent decline in numbers of frogs. [KEYWORDS: anurans, abundance, Borneo].

Ingram

S06

Hot reptiles. GLEN INGRAM. *Vertebrate Section, Queensland Museum, PO Box 3300, Sth Brisbane, Qld 4101, Australia.* For an Australian herpetologist — for any herpetologist — northern Australia is the place to be. In the heat and amongst the lush vegetation, reptile life is common. But do not be misled by this vision of abundance

tied to lush vegetation. Most happenings in the reptile world go on in spite of it: the clue to the whereabouts of reptiles is usually on the ground. For reptiles, it is the substrate that is the key to their distribution — vegetation is usually a secondary, but useful, indicator of the nature of the substrate. The habits of aboreal reptiles, however, tend to obfuscate this correlation; trees can be found throughout most habitats and across different geologies. The obfuscation is further befuddled by the habit of several aboreal species of climbing on rocks. However, those that like climbing on rocks do not necessarily like climbing trees. In the north, there are several, restricted, rock-dwelling reptiles in restricted, rock habitats. Interestingly, those with limbs tend to have big eyes, many scales and long legs and toes. Even so, most tropical reptiles move mainly on the horizontal: most are ground-dwelling. They live on the ground or in it or just above it, in and on the litter discarded by vegetation. Limbed reptiles that live in leaf-litter tend to be small and stubby with pointed heads, short limbs and thick tails. The correlations with substrate goes on: there are hole-diggers, crack-dwellers, crack-crawlers, rubble-runners, sand-swimmers, sand-runners . . . [KEYWORDS: reptiles, habitats, habits, tropics, Australia].

Iordansky

C06– 075

Morphofunctional patterns and adaptations of jaw apparatus in the Lacertilia. NIKOLAI N. IORDANSKY. *Russian Acad. Sci. Institute of Animal Evol. Morphology & Ecology. 117071 Moscow, Leninsky pr. 33., Russia.* The amphikinetic skull seems to be one of the basic adaptive achievements of lizards, as compared with their probable ecological precursors (such as procolophons, eosuchians a.o.). The main adaptive role of amphikinesis is improvement of manipulative abilities of jaws and optimization of forces applied by jaws to a prey. In the lacertilian phylogeny cranial kinesis was perfected in two ways: 1) intensification of the streptostyly; 2) evolving of the flexipalatality. Morphofunctional patterns of lacertilian jaw apparatus do not reveal clear correspondence with a diet, and often species-"specialists" feeds on the same diet, as "generalists". On the other hand, similar morphofunctional features (e.g. hyperstreptostyly) may evolve in connection with different adaptations (the paraconvergence; Iordansky, 1982). Peculiar morphofunctional patterns of jaw apparatus characterize three main groups of extant lizards: Iguania, Autarchoglossa and Gekkota. The patterns of Dibamidae and Amphisbaenia seem to be derivatives of the Autarchoglossa-type; that of the Ophidia may be deduced from the Gekkota-type. [KEYWORDS: Lacertilia, evolution, adaptation, jaw apparatus].

Ishchenko

C06–076

Life-history traits variation in some Eurasian brown frogs. VLADIMIR G. ISHCHENKO. *Institute of Plant and Animal Ecology, Ural Dept of Russian Academy of Sciences, 620219, Ekaterinburg, 8 March 8 str., 202, Russia.* Body size, growth, time of maturation and life-span have been studied in six Eurasian brown frogs: *Rana arvalis* Nilss., *R. temporaria* L., *R. macrocnemis* Boul., *R. chensinensis* David, *R. amurensis* Boul. and *R. dalmatina* Bonap. A growth and lifespan are determined by skeletochronology. In all species metamorphosis take place at similar size but large species are characterised by more intensive growth after first and second winterings, while relatively small species, *Rana arvalis* and *R. amurensis*, grows rapidly after first wintering mainly. A maturation usually occur before third and fourth winterings in all species, rarely before second or fifth winterings. The life-span is usually equal to 6–8 years.

The increase of life-span occurs within species in north and mountain populations of *R. arvalis*, *R. temporaria*, and *R. macrocnemis*. The maximum longevity is registered in population of *Rana temporaria* at Subarctic Urals where the specimen of 16–17 years old is found. At the same time north and mountain populations are characterised by relatively slow growth. There are two main types of growth. Rapid growth before maturation is common in males and more even is usual in females. The even growth is more common for the elder animals. In subarctic populations of *R. temporaria* another type of growth is registered, where in some specimens growth is very slow before maturation and rapid after maturation. On the basis of longterm studies of population of *Rana arvalis* and of study of geographical differences it has been established that geographical diversity of life-history traits and diversity within single population and differences between species are the same.

Ishii

S10

A new neuroendocrine reflex: amplexus induces luteinising hormone surge in male toads, *Bufo japonicus*. SUSUMU ISHII. *Dept of Biology, Waseda University, Tokyo 169-50, Japan.* We measured luteinising hormone (LH) in blood plasma of male and female toads at different stages of breeding migration in March in a field near Tokyo. Torpid toads just before the breeding migration showed low plasma LH levels (below 3 ng/ml). When they started the migration, the level went up, and then reached to about 30 ng/ml or higher in toads collected in the breeding pond. Near and in the pond, LH levels in males in amplexus were higher than those in solitary males, while there was no significant difference in the mean LH level between females in amplexus and solitary females. Migrating solitary toads were captured and kept in a plastic box with the same number of females or without females (control). The mean plasma LH level increased over 12 hours and then declined gradually in the paired males, while the level in the control males unchanged. These results suggest that the amplexus induces the LH surge in male toads. To confirm this, we kept male toads with dummies of the female. The dummy was a block (10x6xl.5cm) of Japanese traditional food "konyaku" which is highly elastic, white in color and virtually odorless. All the males clasped their dummy and formed amplexus for 12 hours or more; an LH surge indistinguishable from that with the females was observed. It is concluded that the amplexus itself is the stimulus that induces the LH surge, and subsequent spermiation, in male toads. [KEYWORDS: toad, *Bufo japonicus*, amplexus, LH surge, breeding].

Jackson & Fritts

S30

Morphological observations of venom-conducting fangs. KATE JACKSON[1] AND THOMAS H. FRITTS[2]. [1]*Dept of Zoology, University of Toronto, Toronto, Ontario M5S 1A1, Canada* [2]*U.S. Fish and Wildlife Service, National Museum of Natural History, Washington, DC 20560, United States of America.* In opistoglyphous colubrids, the maxillary dentition typically consists of unspecialised anterior teeth, followed by a smaller number of enlarged posterior teeth which may or may not be grooved. Examination of the surface morphology of the posterior fangs and other maxillary and palatine teeth, using scanning electron microscopy, revealed a high degree of morphological variation between the venom-conducting fangs of different colubrid genera. Ridges present on the lingual and labial sides of the unspecialised anterior maxillary teeth may be homologous to ridges found on the posterior fangs. If this is the case, these ridges may be useful as landmarks in determining the pathway by which the venom-conducting

fang evolved, and the phylogenetic relationships among the opistoglyphous colubrids. [KEYWORDS: Serpentes, teeth morphology, opistoglyph, SEM].

James

S06

Conservation genetics and phylogeography of the acid frogs, *Litoria olongburensis* and *L. cooloolensis*. CHRISTINA JAMES. *Dept of Zoology, The University of Queensland, St. Lucia, Qld 4072, Australia.* Acid frogs are an ecologically unique group of amphibians. They occur in the lakes and wallum areas of the coastal dunes and sand islands of southeast Queensland. *Litoria olongburensis* and *L. cooloolensis* are classified as 'protected' and 'vulnerable' species due to their ecological specialisation, restricted distribution, and the intense pressure on their habitats from forestry, urban developments, and recreational use. Sequence divergence of the mitochondrial DNA cytochrome b and control region, and allozyme profiles for 28 polymorphic loci, are analysed to produce phylogeographical profile for both species. Findings of particular relevance to the conservation of these species include strong geographical structure of the populations. The genetic distinctiveness of Stradbroke Island *L. cooloolensis* and advertisement call analysis support the recognition of this population as a third species. [KEYWORDS: anurans, *Litoria*, sequence divergence, phylogeography, mitochondrial DNA].

James & Shine

S09

Why are there so many sympatric species of lizards in the spinifex grasslands of arid Australia? CRAIG D. JAMES[1] AND RICHARD SHINE[2]. [1]*CSIRO Division of Wildlife & Ecology, P.O. Box 84, Lyneham, ACT, 2602, Australia.* [2]*School of Biological Sciences, Zoology A08, University of Sydney, NSW, 2006, Australia.* The spinifex grasslands of arid Australia harbour a large diversity of lizard species with as many as 40 species occurring on a single site. Of these, up to 10 species may be of the genus *Ctenotus*. *Ctenotus* is large genus (N = 93 sp), found in most habitats throughout Australia. In arid environments, *Ctenotus* is particularly species rich. We examine continental patterns of alpha- and beta-diversity of *Ctenotus* to test hypotheses that try to account for large numbers of sympatric lizard species in spinifex habitats. Biogeographic patterns of distribution of species showed that there were more species in the arid zone than in tropical or temperate zones, but no more than expected by virtue of the relative size of the arid zone. Large numbers of sympatric species in spinifex habitats are due to the larger geographic area of species' distributions in the arid zone. We hypothesised that larger geographic ranges of lizards in the arid zone were possible because of the lack of environmental barriers. Finally, the "climate-space" occupied by each species was compared. The implications of the results for theories about community organisation are discussed. [KEYWORDS: regional diversity, sympatry, lizards, spinifex, Australia].

Janzen

C14

Climatic change, population dynamics, and temperature-dependent sex determination in turtles. FREDERIC J. JANZEN. *Center for Population Biology, University of California, Davis, CA 95516, United States of America.* Models based on environmental physiology and quantitative genetic theory are integrated to determine the evolutionary response of a natural population to climatic temperature change. Nests of a population of painted turtles (*Chrysemys picta* : Emydidae) with temperature-dependent sex determination (TSD) were monitored to investigate the causal relationship between regional climatic variation in temperature and offspring

sex ratio. Consistent with theoretical predictions, annual offspring sex ratio was highly correlated with mean July temperature, validating concerns about the effect of climate change on population demography. The correlation between temperature and sex ratio demonstrates that even modest increases in mean temperature (< 2°C) will greatly skew the sex ratio. Behavioural data and quantitative genetic analyses indicate that populations with TSD will be unable to evolve rapidly enough to counteract the negative fitness consequences of rapid global warming. Populations of species with TSD may serve as ideal biological indicators of the impact of global warming on natural systems. [KEYWORDS: climate change, temperature, sex determination, turtles, sex ratio, heritability].

Jehle

S14

Structure, phenology and dynamics of a central European *Triturus dobrogicus* population. ROBERT JEHLE. *Dept of Zoology, University of Vienna, Althanstr.14, A-1090 Wien, Austria.* Within a long-term study (1986–1995) of a population of the Danube Crested Newt (*Triturus dobrogicus*) on an artificial island near Vienna (Austria) each individual is recognised by photographing the highly variable belly pattern. The site of reproduction ("Endelteich") is completely encycled with a permanent drift fence and pitfall traps. Daily controls enable us to monitor the population parameters of this European newt in the field and give us the possibility to trace back the life-history of every single individual. There is a decrease of the adult part of the population (1987:210 / 1992:96 adult individuals) but an increase of the juvenile recruitment (maximum in 1991: 818 individuals). Out of the 11 species occurring at the study site population data on the basis of individual recognition are also available for the Common Spadefoot toad, *Pelobates fuscus*. Structure and phenology of *Triturus dobrogicus* are compared with *Pelobates fuscus*. The man-made surrounding of the pond allows us to study the survival of some European amphibians in recreation areas intensively used by the city population. [KEYWORDS: Urodela, *Triturus dobrogicus*, population biology, long-term study].

Jennings

C30

The influence of vegetational phenology on the foraging behaviour of the desert tortoise (*Gopherus agassizii*). W. BRYAN JENNINGS. *Dept of Biology Box 19498, University of Texas, Arlington, Texas 76019, United States of America.* I studied the foraging behaviour of the desert tortoise *Gopherus agassizii* from 1991–1992 in the western Mojave Desert of California. Comparisons between tortoise diet and ephemeral plant availability revealed that tortoises selectively forage. Tortoise diet showed seasonal variation as tortoises switched food preferences several times, which coincided with the seasonal shifts in the emergence of different ephemeral plant species. Furthermore, the seasonal availability of preferred foods appeared to influence tortoise movements within home ranges (i.e. daily foraging routes) and locations of cover-sites. In early spring, most tortoises tended to be nomadic in that they never spent two consecutive nights at the same cover-site, which were nearly always non-burrow cover-sites. In middle and late spring, most tortoises showed a high degree of fidelity to a single burrow located next to (< 10m) a "patch" of a preferred food species that was in flower. Tortoises fed almost exclusively at these patches until the plants senesced (ca. 2 weeks), then they moved to another burrow similarly located near a patch of a preferred plant species. [KEYWORDS: desert tortoise, foraging ecology, herbivore, Mojave

Desert, vegetation].

Ji *et al.*

C06–077

Sexual dimorphism and reproduction of the grass lizard *Takydromus septentrionalis*. JI XIANG, ZHOU WENHUI, ZHANG XIAODONG AND GU HUIQING. *Dept of Biology, Hangzhou Normal College, Hangzhou 310036, Zhejiang Province, P.R. China.* Sexual dimorphism and reproduction in a population of *Takydromus septentrionalis*, on Xiushan Island in Zhoushan Islands were investigated during the breeding seasons of 1989-1992. Most males and females, approximately two years after hatching, reached sexual maturity at 54 and 56 mm SVL, respectively. Adult male and female *T. septentrionalis* were similar in SVL but quite different in head size characteristics, males having larger heads than females of similar SVL except near the size at sexual maturity. Mating success in males was apparently not related to increased SVL but more likely to better individual conditions. Males could copulate with females several hours before or after oviposition. The duration of intromission averaged 227 minutes. Females could lay 1–3 clutches with 2–6 pliable-shelled eggs each per breeding season. Clutch size or clutch mass was significantly correlated with SVL. Mass of individual egg was not correlated with SVL and was not correlated with clutch size. Relative clutch mass (RCM) averaged 0.149. Oviposition frequency averaged 16.7 days. [KEYWORDS: Lacertidae, *Takydromus septentrionalis*, sexual dimorphism, mating behavior, clutch size, oviposition frequency, relative clutch mass].

Jinzhong

S27

Conservation and utilisation of Chinese alligator in China. JINZHONG FU. *Inst. of Zoology, Chinese Academy of Science, 19 Zhongguancun Lu, Beijing, P.R. China.* The endangered Chinese Alligator, *Alligator sinensis* is presently protected by law being listed as a Category 1 species under the State Special Protected Animals of China Wildlife Conservation Law after March 1, 1989. Most of the species present distribution in the wild is protected as the Anhul Chinese Alligator Reserve. The current conservation status of *A. sinensis* is reviewed and activities of the Government of the People's Republic of China to manage and reverse the decline of numbers of the species in the wild are discussed. Captive farming of *A. sinensis* initiated by the Chinese Government in 1979 has proven very successful. Two farms have carried out captive breeding. ARCCAR which commenced with an original stock of 212 animals, has expanded, by 1992, to more than 4000 alligators, including approximately 700 second generation animals. Another smaller farm (ZYAF), established with a founding stock of 11 animals, had reached 140 alligators in 1992, initiated by the Government in 1979 with the establishment of two farms. The history of local utilisation and factors which contributed to the species decline in the wild are recounted. Future conservation of *A. sinensis* is presented as a suite of strategies that involve habitat restoration, reintroduction and sustainable utilisation. Future commercial use of Chinese Alligator will be the subject of carefully researched marketing strategy based on the variety of traditional uses for which the species was valued. The involvement of local communities and their willingness to conserve *A. sinensis* will be an essential factors in contributing to the long-term success of any conservation plan for the species.

Joger

S09

Biogeography of the Sahara Desert herpetofauna. ULRICH JOGER. *Hessisches Landesmuseum, Friedensplatz 1, 6100 Darmstadt, Germany.* The Saharan herpeto-

fauna is dominated by Saharo-sindian and Saharo-arabian genera. Endemism is restricted to the subgeneric level (one toad and about 18 reptiles). The two regions where endemic species are abundant are the large northern Saharan dune areas (Grand Ergs) and the Atlantic coastal desert. These regions provide special ecological conditions. The central Saharan mountain ridges are notable for the presence of both Mediterranean and Afrotropical relicts, thus reflecting the Pleistocene and early Holocene climatic shifts. Fairly recent immigrants from tropical Africa are found in the northwestern corner of the Sahara, and along the Nile. Today the hyperarid Sahara is a very effective barrier separating the completely different herpetofaunas of Afrotropis and Palaearctis from each other. The Saharo-arabo-sindian herpetofauna cannot be assigned to either of these realms, but represents a specialised, arid-adapted fauna of Asian origin, which invaded Africa in the late Tertiary, dislodging the old afrotropical fauna from most of northern Africa. [KEYWORDS: reptiles, distribution, endemism, relicts, faunal links].

Johnston

C23

Sexual dimorphism and mating system in the agamid lizard *Ctenophorus fionni*. G.R. JOHNSTON. *School of Biological Sciences, Flinders University, GPO Box 2100 Adelaide, SA 5001, Australia.* Male *Ctenophorus fionni* differ from females in size, shape and colour. Males are larger, have bigger heads and longer forelimbs than females of the same age. Immature lizards and mature females are redbrown in colour. Mature males develop bright splashes of yellow or orange on the head, a black chest patch and complex patterns of white, yellow, orange or red patches or bars on a brown, grey or black background. Four potential explanations for this sexual dimorphism were tested: 1) fecundity advantage, 2) differential predation, 3) niche differences, and 4) sexual selection. The fecundity advantage hypothesis was rejected because females reach a lower asymptotic body size than males, and no relationship was found between fecundity and female size. No differential predation between the sexes could be demonstrated in the laboratory or in the field. Differences between the sexes in the trophic, thermal, spatial and time niches do not adequately explain the observed dimorphism. The mating system of this lizard corresponds to resource defense polygyny. Both sexes are territorial and maintain home ranges exclusive of others of the same sex, but male and female home ranges may overlap. Home range overlap and/or association of heterosexual pairs during the mating season (August–September) suggest that males show greater within year variance in reproductive success than do females. These observations support the hypothesis that sexual selection may be maintaining the sexual dimorphism in this species. [KEYWORDS: sexual dimorphism, mating system, Agamidae].

Johnston

C29

Sexual selection in the lizard *Ctenophorus fionni*: the role of mate choice and male combat. G.R. JOHNSTON. *School of Biological Sciences, Flinders University, GPO Box 2100, Adelaide, SA 5001, Australia.* The agamid lizard *Ctenophorus fionni* shows a marked sexual dimorphism in colour. Immature animals and mature females are red-brown, whereas mature males are brightly coloured with splashes of yellow, orange and red on the head and dorsum, and a black chest patch ventrally. A field experiment was conducted during the breeding season (August–September) in 1992 and 1993 to test the alternative hypotheses of female mate choice (intersexual selection) or male-male competition (intrasexual selection) as explanations for the evolution of this

dimorphism. Males were randomly assigned to control and experimental groups. Experimental males were painted to resemble females and control males were painted with clear lacquer. Snout-vent length, mass, territory size and number of associations with mature females were determined for mature males during a premanipulation period, and again after the manipulation. Males in the experimental group lost considerably more weight than control males. Experimental males had smaller territories than they did prior to the experiment and also in comparison to the control group. Females associated equally with both groups of males prior to the experiment, but did not associate with the experimental group after the manipulation. These results suggest that both female choice and male-male competition are acting simultaneously to maintain the sexual differences in colour between male and female *C. fionni*. [KEYWORDS: sexual dimorphism, sexual selection, mate choice, male competition, colour manipulation, Agamidae].

Johnston & Richards

C06–078

Community structure of anuran amphibians in the Ok Tedi region of Papua New Guinea. G.R. JOHNSTON[1] AND S.J. RICHARDS[2]. [1]*School of Biological Sciences, Flinders University, GPO Box 2100, Adelaide, SA 5001, Australia.* [2]*Dept of Zoology, James Cook University, Townsville, Qld 4811, Australia.* Sixty two species of frogs are now known to occur in the Ok Tedi drainage basin in far western Papua New Guinea. We are conducting field work in the Ok Tedi area with the primary aim of examining the patterns of species occurrence for both adult and larval stages in this diverse fauna. Preliminary results show the following patterns. Between two and ten species occur at any one site. Altitude has an overriding influence on which species are found at a given site. At similar altitudes fast running mountain streams tend to harbour spatially diverse but locally small assemblages of species, whereas still waters in 'sago swamps' harbour locally more diverse but spatially consistent assemblages. An offspin of our survey work has been the collection of several undescribed and previously poorly known taxa. A substantial proportion of the species known from the Ok Tedi area await formal taxonomic description, and for many named species only the adult stage has been described. Taxonomic work, descriptions of larvae and of incidental observations on the general biology of anurans occurring in the Ok Tedi area are being undertaken in parallel with continuing work on community structure. [KEYWORDS: community ecology, taxonomy, Papua New Guinea, Anura].

Jones

C11

When is an absence an absence? Abundance of *Aprasia parapulchella* Kluge (Pygopodidae) in grassland of the Australian Capital Territory. SANDIE JONES. *Applied Ecology Research Group, University of Canberra, PO Box 1, Belconnen, ACT 2615, Australia.* *Aprasia parapulchella* Kluge (Pygopodidae) is a fossorial species which has a limited distribution, low numbers where it is present and is habitat specific. It fulfills the criteria of a rare species and has previously been classified as nationally endangered. It has been suggested that its rare status is a direct result of the difficulty of identifying the presence of the species at a site. This study aimed to address this issue and determine if *A. parapulchella* does actually occur in low abundances, or if by intensive surveying, it could be shown to be common at a site. The study located 195 *A. parapulchella* after turning 82,000 rocks, a density of 0.002378 animals per rock. The species was found to occur in low abundances (mostly 1 or 2 specimens per site, maximum 20) even though these sites contained suitable habitat and

were surveyed in optimal weather conditions. Because of the difficulty in determining whether an absence is an absence or an artifact of sampling, a method of probability of non-detection was used. It was found that 750 rocks needed to be turned to be 95 per cent confident that *A. parapulchella* was not present at a site. [KEYWORDS *Aprasia*, abundance, probability of non-detection].

Jung & Jagoe

C06–079

Effects of pH and aluminum on green treefrog (*Hyla cinerea*) tadpoles. ROBIN E. JUNG[1,2] AND CHARLES H. JAGOE[2]. [1]*Dept of Zoology, Birge Hall, 430 Lincoln Dr., Madison, WI 53706, United States of America.* [2]*Savannah River Ecology Laboratory, Drawer 13, Aiken, SC 29802, United States of America.* Post-hatch green treefrog tadpoles were exposed for 96 hours to 3 levels of aluminum (0, 100, 200, 400 μg/L Al) at 2 pH levels (4.5, 5.5). At pH 4.5, a clear dose response was observed with increasing Al (16% mortality at 100 μg/L to 84% at 400 μg/L Al), whereas no differential mortality occurred with increasing Al at pH 5.5. Body size and body sodium content were affected by treatments. In a second experiment, tadpoles exposed for 96 hours to 150 μg/L Al at 4.5 pH were preyed upon by dragonfly larvae (Libellulidae) at a faster rate than tadpoles raised in pH 4.5 alone. In both experiments, swimming performance of surviving tadpoles was reduced at pH 4.5 with Al levels 150 μg/L and above relative to other treatments. [KEYWORDS: swimming performance, body sodium content, morphology, mortality, predation, *Hyla cinerea*, tadpole, dragonfly].

Kaiser

S07

Systematics and biogeography of *Eleutherodactylus* in the eastern Caribbean. HINRICH KAISER. *Redpath Museum and Dept of Biology, McGill University, Montreal, Quebec H3A 2K6, Canada.* A comprehensive survey of the eight eastern Caribbean species of anurans was carried out over a period of four years to determine systematic relationships and to elucidate their puzzling biogeography. Southern species are morphometrically distinct from other species based largely on the first canonical variate (size) derived from lengths of tibia and snout, on the second and third canonical variates (shape) derived from tympanum size and position. Calls of southern species consist primarily of single clicks at a set frequency, as opposed to the multi-note calls, incorporating changes in frequency, of the other species. Allelic differences are much greater between northern and southern populations than within either group. Further support is provided by the presence of the typical South America genera *Leptodactylus* and *Colostethus* in the south-central Lesser Antilles, but not in the north. Populations from different islands of the most widely distributed species *E. johnstonei* and *E. mertinicensis*, are morphometrically and electrophoretically indistinguishable within the species: centroids around the factor distributions overlap completely, and very few novel alleles are present. These data point to a very recent separation of the populations from the ancestral stock, an observation which lends further support to the hypothesis that human interactions, such as colonial trade and recent tourism, have been instrumental in creating the distributions observed today. [KEYWORDS: Amphibia, Anura, *Eleutherodactylus*, electrophoresis, morphometrics, biogeography, systematics, eastern Caribbean].

Kalb & Owens

S18

Arribada vs. solitary nesters: comparison of internesting behaviour patterns in olive ridley sea turtles, *Lepidochelys olivacea*. HEATHER KALB AND DAVID OWENS. *Dept of Biology, Texas A&M University, College Station, Texas 77843, United States of America.* Female olive ridley sea turtles (*Lepidochelys olivacea*) exhibit a nesting behaviour known as an *arribada*. This is a highly synchronous nesting phenomenon with the potential for tens of thousands of females to emerge from the sea and nest on a single beach during one or more subsequent evenings. This phenomenon is unique to the genus (two species). *Arribada* beaches are located in India, Mexico and Costa Rica. Some females also nest alone out of sequence with the *arribadas*. In an attempt to understand what drives the *arribadas*, we initiated a comparison of *arribada* and solitary nesters at Nancite beach in Costa Rica. The reproductive status of post-nesters was determined with an ultrasound exam and a blood sample for testosterone analysis. Radio transmitters were affixed to the carapaces of females that would nest again (17 *arribada* & 10 solitary nesters). Internesting intervals, subsequent nesting at Nancite, and movements offshore were monitored. *Arribada* females remained within 25 km of the beach with few exceptions and nested at Nancite during the subsequent *arribada* (4–7 week internesting interval). None of these females were seen nesting at other beaches. Solitary females frequently left the vicinity of Nancite. Twenty percent were found nesting in the next *arribada* at Nancite (2–3 week internesting interval). An additional 20% were seen emerging with *arribadas* at Ostional, Costa Rica and in Nicaragua. Possible hypothesis as to why these alternative nesting strategies have evolved will be discussed. [KEYWORDS: reproduction, behaviour, olive ridley sea turtles].

Kamezaki & Matsui

C06–080

Geographic variation in skull morphology of the green turtle, *Chelonia mydas*. NAOKI KAMEZAKI AND MASAFUMI MATSUI. *Graduate School of Human and Environmental Studies, Kyoto University, Sakyo, Kyoto, 606 Japan.* This study analyses the geographic variation of skull morphology in the green turtle, *Chelonia mydas*, including the eastern Pacific population sometimes recognised as *C. agassizi*. One hundred and forty-five skulls from six nesting sites; Comoro, Seychelles, Ogasawara, Galapagos, Tortuguero, Guiana, were measured. Samples from Comoro, Seychelles, and Guiana were greater in skull length than those from Ogasawara, Tortuguero Galapagos. Discriminant analyses showed that four of the six local samples could be completely or nearly completely classified correctly. Comoro and Seychelles samples were not discriminated. The Galapagos sample was completely separated from other samples by a canonical discriminant analysis, and this result indicates distinctness of the eastern Pacific population. The Galapagos sample, however, was not differentiated from the others by any character dimension relative to skull length. From these results, we support to treat the eastern Pacific population as a distinct subspecies, *C. mydas agassizi*, and not a distinct species *C. agassizi*. [KEYWORDS: geographic variation, skull morphology, *Chelonia mydas*].

Kaplan

S15

Amphibian life histories: a model for the study of the evolution of developmental plasticity and maternal effects. ROBERT H. KAPLAN. *Biology Dept, Reed College, Portland, Oregon 97202, United States of America.* The complex life cycle and ecology of many amphibians provides a valuable entrance into general studies on the relationship between development and evolution. Phenotypic variation in early developmental characteristics such as size at, and time to, particular developmental stages is influenced by environmental characteristics, most notably temperature. In

addition, maternal effects have profound influences during early development and then tend to diminish as development proceeds. Considering that (1) early development in many amphibians takes place in aquatic environments with highly variable abiotic and biotic conditions and (2) mortality rates for pre-metamorphic stages are notoriously high, studies that focus on the evolution of variation in these early developmental characteristics have the potential to shed valuable light on evolutionary mechanisms that promote the evolution of developmental plasticity and maternal effects.

Katsikaros

C29

Sexual dimorphism in the tusked frog, *Adelotus brevis*. KALIOPE KATSIKAROS. *School of Biological Sciences A08, University of Sydney, NSW 2006, Australia.* Sexual dimorphism is demonstrated to an unusual degree in the myobatrachid *Adelotus brevis* ("the tusked frog"). Males are larger than females (atypical for a group in which females are as large as, or larger than, males in most species) and males have longer and wider heads than females. A third feature, unique among Australian frogs, is the presence of two large bony 'tusks' on the lower jaw of males which correspond to vestigial bumps on the lower jaw of females. Several processes may have contributed to the evolution of these sexually dimorphic features. Observations of reproductive behaviour and the mating system suggest that large size of the body, head and tusks enhances male reproductive success through its influence on success in agonistic interactions among males. Regular spacing patterns and call structures suggest that males defend calling sites against other males. The two sexes also differ in diets, but this divergence is likely to be a secondary consequence of reproduction-related habitat divergence, rather than a selection pressure for the evolution of this bizarre sexual dimorphism. [KEYWORDS: myobatrachid, sexual dimorphism, male-male combat, reproductive behaviour].

Keirans *et al.*

C06–081

Two new species of ticks from Australian varanid lizards. JAMES KEIRANS[1], DENNIS KING[2] AND ROBERT D. SHARRAD[3]. [1] *US National Tick Collection, Georgia Southern University, Statesboro, Georgia 30460, United States of America.* [2] *c/o WA Museum, Francis St, Perth, WA 6000, Australia.* [3] *University of South Australia, Smith Rd, Salisbury, SA 5109, Australia.* Two new species of ticks have been described from varanid lizards in northern Australia. One is an *Aponomma* and the other an *Amblyomma*, and they both appear to only be found on *Varanus glauerti* and *V. glebopalma*. The *Aponomma* belongs to a new subgenus. The known distribution of these ticks is in the sandstone country of the Kimberley region, from the Fitzroy River to Kununurra, and in the adjacent area of the Northern Territory, from Katherine to Oenpelli and south to the Nicholson River. The known distribution of *V. glauerti* has been recently extended into the Northern Territory, and its limits are not definitely known. The range of *V. glebolpalma* extends eastwards to western Queensland. It is not known whether the distribution of these ticks encompasses the entire range of their two host species.

Kennett

S15

Of droughts and flooding rains and a turtle that nests underwater. ROD KENNETT. *Faculty of Science, Northern Territory University, PO Box 40146, Casuarina N.T. 0811, Australia and Conservation Commission of the Northern Territory, PO Box 496, Palmerston N.T. 0831, Australia.* According to conventional wisdom, the evolution of the cleiodoic egg enabled the early reptiles to colonise the land and

henceforth the eggs of oviparous reptiles were laid on land. Here we report on a unique 'waterproof' egg that enables the tropical chelid turtle *Chelodina rugosa* to nest underwater. *Chelodina rugosa* occupies annually ephemeral floodplain waterholes throughout the wet/dry tropics of northern Australia. Egg-laying commences in the mid to late monsoonal wet season when there is extensive flooding and eggs are deposited in nest holes constructed under shallow water in flooded ground. Embryonic development remains arrested until water levels drop in the ensuing dry season and oxygen enters the nest through the drying mud. Locating nests involved a novel approach to radiotracking whereby egg-shaped transmitters were surgically implanted inside the oviducts of gravid females so that the transmitter would be deposited inside the nest along with the eggs. This 'waterproof' egg and the unconventional underwater nesting strategy may have evolved as a response to the unpredictable availability of dry nesting sites in a seasonally ephemeral habitat. [KEYWORDS: chelid turtle, nesting behaviour, embryonic arrest].

Keogh

C08

The North American colubrid snake tribe Lampropeltiini, a cladistic analysis of morphology. J. SCOTT KEOGH. *Dept of Biological Sciences, Illinois State University, Normal, IL 61791, United States of America. Present address: School of Biological Sciences, Zoology Building A08, University of Sydney, NSW 2006, Australia.* The intergeneric relationships of snakes of the North American tribe Lampropeltiini were examined through a cladistic analysis of squamation, soft anatomy, and natural history characters. Parsimony analysis produced a single most parsimonious tree with 48 steps and a consistency index of 0.75. The North American members of *Elaphe* and *Bogertophis* are the earliest derivatives of the radiation. *Pituophis* and *Arizona* are closely related later derivatives but are morphologically more divergent than previously thought. *Cemophora*, *Lampropeltis*, *Rhinocheilus* and *Stilosoma* are the most recent members of the radiation. *Phyllorhynchus* and *Senticolis* sometimes placed in the tribe are recommended for removal because they do not possess an intrapulmonary bronchus like the other members. Representative members of *Coluber* and *Thamnophis* were used as outgroups. [KEYWORDS: Larnpropeltiini, cladistics, phylogeny, evolution].

Killebrew & Babitzke

C06– 082

Assessment of the status of cagle's map turtle. FLAVIUS C. KILLEBREW[1] AND JOEL B. BABITZKE[2]. [1] *The Graduate School, WTAMU Box 215, West Texas A&M University, Canyon, Texas 79016-0001, United States of America.* [2] *Dept Biol. & Geosciences, WTAMU Box 808, West Texas A&M University, Canyon, Texas 79016-0001, United States of America.* Cagle's map turtle (*Graptemys caglei* Hayes & Mckown, 1974), a species endemic to the Guadalupe River of Texas, was only recently described. Recent surveys by the authors have produced no sightings of *G. caglei* in any major impoundment on the Guadalupe River or in the San Antonio River, where they were previously reported. These surveys indicate a shift from the *G. caglei*-dominated turtle community of non-impounded areas to the *Pseudemys texana*-dominated turtle community typical of Guadalupe impoundments. The turtle's future is threatened by the construction of 5 impoundments, including 2 proposed for construction near Cuero, Texas, where Cagle's map turtle populations are most successful. Thus, a petition to list Cagle's map turtle as threatened was published in the Federal Register (Vol. 56, No. 241, 6520) as a positive recommendation to list. The 12 month finding (Fed-

eral Register Vol. 58, NO. 13, 5701–5704) recommended **warranted but precluded status** and assigned the species to Category 1 in the U.S. Fish and Wildlife Service's Animal Notice of Review. Population estimations are currently being performed with a computer program, "Jolly", utilising a database of capture and recapture results gathered by the primary author since 1985. Additionally, surveys of nesting beaches are currently being conducted to determine nesting period and nest site characteristics. Preliminary interpretation of these data and an analysis of the listing criteria will be presented. [KEYWORDS: turtle, threatened species, population, nesting].

Kluge

P1

Herpetology and cladistics. ARNOLD G. KLUGE. *Museum of Zoology and Dept of Biology, University of Michigan, Ann Arbor, MI, 48109, United States of America.* Herpetologists have made numerous contributions to phylogenetic inference, and to cladistics in particular. Examples include philosophical arguments justifying parsimony, the importance of fossils, ontogeny as a basis for inferring character transformation, the singularity of history, the nature of species, biogeographic methods, the theory of coevolution, and a taxonomy that reflects precisely the natural classification of species. In addition, herpetological cladists have provided numerous exemplary empirical studies of variation in traditional and nontraditional characters within and among species. Students of amphibian and reptile biology have excellent opportunities to contribute to the further development and exemplification of cladistics. As will be discussed in some detail, herpetology provides an ideal context in which to continue to explore such important issues as the nature of cladistic evidence (e.g. taxonomic congruence versus total evidence) and the relationship between historical biogeographic pattern and the issue of priority in conservation. [KEYWORDS: amphibians, biogeography, cladistics, conservation, evidence, phylogeny, reptiles].

Knesel & Powell

C06–083

Comparative spermatology of alligator (*Macroclemys temmincki*) and common (*Chelydra serpentina*) snapping turtles. JOHN A. KNESEL[1] AND SANDRA C. POWELL[2]. [1]*Dept of Biology, Northeast Louisiana University, Monroe, Louisiana, 71209, United States of America.* [2]*Dept of Medical Technology, Northeast Louisiana University, Monroe, Louisiana 71209, United States of America.* Spermatozoa from alligator (*Macroclemys temmincki* Troost; AST) and common (*Chelydra serpentina* L.; CST) snapping turtles, the two living members of the family Chelydridae, were compared using light (LM) and scanning electron microscopy (SEM). A total of 21 electroejaculations were performed on sexually mature AST (n=7) and CST (n=6) from February through June, 1990. Ejaculate volumes ranged from 1 to 4 ml, with sperm density ranging from 1 to 56 million/ml. For LM, semen was placed on prestained (N methylene blue and cresyl violet acetate) slides. Sperm were fixed, examined, and measured at 1620× to 9500× with SEM. The spermatozoon consisted of an elongated narrow, slightly curved head with a needle-like spicule projecting from the acrosome. The midpiece was surrounded by asymmetrical lobulated bundles of mitochondria followed by the tail. Spermatozoa differed significantly (Student's t test; $P < .05$) in total length (79.96 vs 69.58 microns), head length (15.67 vs 12.43 microns), midpiece length (6.69 vs 4.97 microns), and tail (64.29 vs 57.42 microns) for AST (n=49 sperm) and CST (n=42 sperm), respectively. [KEYWORDS: *Macroclemys*, *Chelydra*, spermatozoa, electroejaculation].

Kordikova

C06–085

About the question of the homology of carapace elements in trionychids and other turtles. ELENA G. KORDIKOVA. *Institute of Zoology, 480032 Alma-Ata, Kazakhstan.* Thanks to the data on morphogenesis of skeletons received from the living trionychid and other turtles from different museums and institutes of Russia, Georgia and the USA, a new terminology of carapace elements based on principals of homology is discussed. So, it is known that neurals and costals of turtle carapaces are formed at the expense of corresponding neural arcs of vertebrae as well as ribs. This fact was reflected in the neural terminology of P. Meylan (1984) where the preneural is called by the first neural as the neural arc of the first vertebra and takes part in the formation of the first thoracic vertebra. Taking into account the morphogenesis of costals it is also necessary to change the numeration of costals as the rib of the first vertebra (which is usually reduced in most turtles) can take part in the formation of the real first costal (see specimen N PCHP - 2771), the rib of the second one — in the formation of the second costal, the rib of the third vertebra — of the third one, etc. Thus, we follow Hasan (1941) and Meylan (1984) in considering the preneural of trionychids and other turtles whose phylogenetic relationships aren't disputed to be the first neural, the first neural to be the second one, etc. And we also suggest to change the terminology of costals: former first costal formed by the rib of the second vertebra is to be called by the second one, former second one by the third costal, etc. But, the rejection from traditional terminology of carapace elements in trionychids and other turtles will lead to some problems connected with the inconvenience of numeration of costals and neurals behind the second ones in most turtles. However, the suggested united terminology of carapace elements is the most adequate reflection of the formation and origin of the elements of the axial skeleton in turtles, their accordance to the organs in various organisms and it allows a critical appreciation of the traditional idea on the origin of trionychids and some other groups of turtles. [KEYWORDS: homology, terminology, carapace, Trionychids].

Kordikova

C06–086

Fossil trionychids of Kazakhstan. ELENA G. KORDIKOVA. *Institute of Zoology, 480032 Alma-Ata, Kazakhstan.* Fossil trionychids lived in Kazakhstan from the Late Cretaceous to the Middle Miocene and are referred to three groups, Ulutrionychini trib. nov., Paraplastomenini trib. nov. and Pelodiscini Meylan, 1987 represented by four genera (*Ulutrionyx* and *Paraplastomenus* gen. nov.) and ten species. Adult Ulutrionychines are characterised by the preservation of juvenile characters (relatively slight expansion of axial skeleton elements forming the carapace and plastron, the presence of postnuchal fontanelles, the absence of sculpture on peripheral parts of shell bones, etc.). Peculiar to the earlier stages of ontogenesis of most trionychids, and adult paraplastomellines (single genus *Paraplastomenus*) — by the significant expansion of axial skeletal elements, including peripheral parts of the shell. The specific structure of the skull, the absence of the first neural, the presence of the reduced ninth pair of costals, etc., are characteristic for *Ulutrionyx*. The multiple adaptive radiation of the trionychids from an Asian continental center of origin of the distribution of the group is proposed. Ulutrionychine prochoreses probably took place in the Early Cretaceous of Middle Asia and Kazakhstan, in the Late Cretaceous — Early Paleocene — of North America through Beringia and in the Paleocene — Early Eocene — from North America to Europe. In the Early Eocene, Ulutrionychines invaded Central Kaza-

khstan, and from there appeared in the Early Miocene — Asia Anterior, where now *Rafetus euphraticus* is present. Asian aspideretines probably were derived from the ancient Ulutrionychines. Paraplastomenine dispersal from the Asian continent probably happened in the Early Cretaceous of Middle Asia and Kazakhstan, then in the Late Paleocene — Early Eocene — of Kazakhstan and from there to West Europe through the Turgay bridge. Trionychines probably evolved from late paraplastomenines which came to Western Europe at the end of the Paleogene - the beginning of the Neogene. Due to the connection between Europe and Africa, the Oligocene trionychids penetrated Africa where *Trionyx triungulis* lives now. The adaptive radiation of pelodiscines probably in the Asian continent. They inhabited Kazakhstan in the beginning of the Miocene and then expanded to South and East Asia where now *Pelodiscus* spp. live. But the Probability of a migration of Pelodiscines to North America must not be discarded. The similarity of *Pelodiscus sinensis* to *Apalone mutica* may confirm this supposition. [KEYWORDS: fossil, Trionychids, Kazakhstan].

Kordikova

C06–084

Peculiarities of postnatal and individual ontogensis of trionychid skeletons. ELENA G. KORDIKOVA. *Institute of Zoology, 480032 Alma-Ata, Kazakhstan.* Numerous collections of living trionychid skeletons from different museums and institutes in Russia, Georgia and the US were investigated. It was established that the postnatal ontogenesis of the shell and axial skeleton occurs as follows: initially, the juvenile trionychids (particularly, *Pelodiscus sinensis*, *Apalone spinifera*, *Platypeltis ferox*, *Trionyx triunguis*, etc.) haven't plates but ribs and defined thoracic vertebrae. They have an isolated unsculptured nuchal, that lies above the thoracic ribs and the separated rudiments of the hyo- and hypoplastrons. During the time of their growth, the nuchal, neural arcs of vertebrae, ribs and plastral elements are forming plates. And the nuchal begins to contact with the rib of the second thoracic vertebra and with the first (cyclanorbines and aspideretines) or with the second (most of the trionychids and other turtles) neural. The form of postnuchal fontanelles also changes with age: at first, the united transversal foramen is divided into two because of the contact of the medio-caudal part of the nuchal at the first or second neurals; sculpture appeared on callosities; costals and neurals as well as hyo- and hypoplastrons begin to contact with each other. During the turtles growth, neuro-costals and costal fontanelles at first, then postnuchal ones, begin to disappear along the whole carapace length. The anterior and posterior parts of the carapace have the most variabilty during the ontogeny of the skeleton. Variations of the skull and plastron bones happen rarely. Generally the remarked regularities characterised all members of this group. But, various trionychids of the same age have different degrees of skeleton development. So, callosities of the carapace and plastron elements appeared to be present in young specimens of *Pelodiscus sinensis*, in subadults of *Trionyx triunguis*, in adults of *Amyda cartilaginea*. But, callosities scarcely developed in the oldest specimens of *Dogania subplana*. Analysis of individual characters can be different in comparison with the usual characters of familiar and subfamiliar range (the appearance of well-formed rib of the first thoracic vertebra and the corresponding costal, prenuchal, peripherals and the additional number of neurals and costals, where they are usually absent). The high degree of individual variability of *Pelodiscus sinesis* negates the separate staus of the Far East trionychid. It was demonstrated, that the range of individual changes of the majority

of skelton elements is wide, so the complex use of characters for the identification of the fossil trionychids is appropriate in this case. [KEYWORDS: variability, carapace, neurals, costals, Trionychids].

Korsós & Gór

C06–087

Recovery program for the threatened meadow viper (*Vipera ursinii rakosiensis* Méhely, 1893) in Hungary. ZOLTÁN KORSÓS[1] AND ANDRÁS GÓR[2]. [1]*Zoological Dept, Hungarian Natural History Museum, Baross u. 13, H-1088 Budapest, Hungary.* [2]*Vág u. 89, H-1155 Budapest, Hungary.* Following a several year survey, the present situation of the most endangered Hungarian snake populations is outlined. The meadow viper is enlisted among the top priority species not only in Hungary, but in Annex II of the Berne Convention as well. Initiated by the Conservation Committee of Societas Europaea Herpetologica, a recovery program has begun in order to protect the last populations of this viper in Hungary. Distribution mapping, population size estimation and habitat characterisation form the base of the study, accompanied by a detailed description of the life history of the viper. Effects of agricultural and other human activities (mowing, grazing, habitat destruction) are analysed. Possibility and applicability of captive breeding is discussed. Recommendations are made for future conservation measures. [KEYWORDS: recovery plan, *Vipera ursinii rakosiensis*, conservation, Central Europe].

Krey & Keall

C06–088

Helping the oldest survivor survive: captive incubation and headstarting for tuatara. CHRISTA M. KREY[1] AND SUE M. KEALL[2]. [1]*Animal Facility, Victoria University of Wellington, P0 Box 600, Wellington 6001, New Zealand.* [2]*School of Biological Sciences, Victoria University of Wellington, P0 Box 600, Wellington 6001, New Zealand.* The Tuatara, *Sphenodon punctatus* and *Sphenodon guntheri*, now only occur on a few offshore islands of New Zealand. Tuatara are one of the oldest surviving reptiles, representing the 4th order of reptiles. In order to establish new populations of threatened types, biologists at Victoria University have developed ways in which to increase their numbers successfully. Eggs are taken from gravid females in the wild and taken to the University where they are incubated. The hatching success rate of these eggs is about 85% compared to an estimated hatching rate of 40% in the wild. The hatchlings are then carefully raised in a controlled environment until they are about 6 months old. Zoos and animal parks take over at this stage to accommodate the young Tuatara until they may be released back onto islands where rats have recently been eradicated. [KEYWORDS: Tuatara, eggs, incubation, hatchlings].

Krohmer

C13

A comparative analysis of aromatase activity in several regions of the red-sided garter snake brain (*Thamnopis sitalis parietalis*). RANDOLPH W. KROHMER. *Science Dept, Saint Xavier University, 3700 West 103rd Street, Chicago, IL 60655, United States of America.* In the red-sided garter snake, sex steroid hormone-concentrating neurons have been found in large numbers in specific areas of the brain. Although the male red-sided garter snake exhibits a dissociated reproductive pattern (courtship and mating not dependent on elevated levels of androgens), studies have demonstrated a link between these sex steroid hormone concentrating areas and courtship behaviour in the male red-sided garter snake. Since the only known requirement for the initiation of courtship behaviour in the male red-sided garter snake is a

period of low temperature dormancy followed by emergence into a warm environment, the role of androgens and sex steroid-concentrating neurons remain unknown. Numerous studies in mammals have shown that aspects of sexual behaviour as well as brain sexual differentiation depend on exposure to estrogens derived from neural aromatazation of circulating testosterone. This study investigates the presence and possible role of the aromatase enzyme in the specific neural areas responsible for male courtship behaviour in the red-sided garter snake. [KEYWORDS: aromatase, garter snake, androgen, brain].

Kuch

S25

Captive husbandry and reproduction of the Cuban racer, *Alsophis cantherigerus* (Bibron, 1840). Ulrich Kuch. *Hoelderlinstr. 48, D-65779 Kelkheim, Germany.* Captive husbandry and reproduction of the Cuban racer are described and discussed. *Alsophis cantherigerus* exhibits an annual reproductive cycle. In one pair, courtship behaviour and copulations were observed from 23.I.–18.IV.1986 and from 19–25.V.1987. On 16.VII.1987, the female devoured the male. Ovipositions took place on 22.VI.1986 (9; [undeveloped ova: 1], hatchlings: 7), 13.VI.1987 (12; [0], 9), 10.VI.1988 (22; [14], 1), 28.VII.1989 (19; [1], 0), 10.VIII.1990 (39; [34], 1) and in August 1992 (±15; [±15], 0); and on 7.IX.1990 (17; [11], 1) and 20.VII.1992 (14; [11], 0) in a second female. The mean mass of developed eggs was 4.0–6.3g in different clutches, and the egg size varied from 27–34 × 12–19 mm. Incubation times in vermiculite at 26–28°C ranged between 66 and 97 days. The mean mass of the hatchlings was about 4 g, and the first sloughing occurred after 11–14 days. Rearing the juveniles proved difficult, and juvenile mortality was high. The young snakes started feeding voluntarily on live fish or mice after several months of force-feeding with this food. Small frogs were readily accepted from the beginning, but were vectors of endoparasites. The growth of the juveniles was relatively slow. Two males reached 60 cm total length after 2 years and about 70 cm after 5 years, when they were able to copulate with the second female (clutch of 20.VII.1992). The low hatching success from 1988–1992 indicates that *Amphigonia retardata* is only poorly developed in *Alsophis cantherigerus* and that multiple copulations (>16 in the 1986 breeding season) are necessary to ensure a sufficient hatching rate. Depending on the kind and size of the food and on the individual snake, *A. cantherigerus* swallows its prey alive, kills it by constriction, or uses envenoming to quickly kill its prey. [KEYWORDS: Serpentes, Colubridae, *Alsophis cantherigerus*, husbandry, reproduction].

Kuch & Freire

C06– 090

Geographical distribution and variation of the eyelash palm-pitviper, *Bothriechis schlegelii* (Berthold, 1846), in Ecuador. Ulrich Kuch[1] and Antonio Freire[2]. [1]*Hoelderlinstr. 48, D-65779 Kelkheim, Germany.* [2]*Dept Ofidios, Instituto Nacional de Higiene y Medicina Tropical, Casilla 3961, Guayaquil, Ecuador.* Data of 71 specimens of *Bothriechis schlegelii* from 16 localities in six Ecuadorian provinces fill a 300 km gap between several localities north of 0°35'S (previously considered to be the southern distributional limit of *B. schlegelii*) and a recently discovered locality near Tumbez along the Ecuador-Peru border. The presence of *B. schlegelii* is recorded for the province of Chimborazo for the first time and confirmed for the province of Guayas. Reported localities lie between sea level and 1500 m elevation. Present data strongly suggest a continuous distribution of the eyelash palm-pitviper along the western versant

of the Cordillera Occidental and suitable adjacent lowland habitat from the Colombian border in the north to the Ecuador-Peru border in extreme southwestern Ecuador. Variation in the number of ventrals, subcaudals, dorsals, supralabials, infralabials and intersupraoculars as well as in total length and head and tail ratio was recorded from 39 specimens and found to be in the range of the known variation of this species. However, the broad range of ventral and subcaudal counts, with a relatively high mean and mode (142–162, mean 152.7 ± 5.2 SD, mode 153 [n=35], and 45–65, mean 56.5 ± 5.1 SD, mode 54, 56 [n=26], respectively), do not support the earlier view that the number of ventrals and subcaudals of *Bothriechis schlegelii* is clinal and that a lower number occurs in the southern portion of the range. As do most other animal species of the Ecuadorian coastal lowlands and the adjacent Cordillera Occidental, *B. schlegelii* faces the serious danger of continuing extensive deforestation. [KEYWORDS: Serpentes, Viperidae, *Bothriechis schlegelii*, distribution, variation, Ecuador].

Kuch & Freire

C06–089

A contribution to the knowledge of the chocoan forest-pitviper, *Bothriopsis punctata* (Garcia, 1896). Ulrich Kuch[1] and Antonio Freire[2]. [1]*Hoelderlinstr. 48, D-65779 Kelkheim; Germany.* [2]*Dept Ofidios, Instituto Nacional de Higiene y Medicina Tropical, Casilla 3961, Guayaquil, Ecuador. Bothriopsis punctata* (Garcia, 1896) (of which *Bothrops osbornei* Freire, 1991 and *Bothriechis mahnerti* Schatti & Kramer, 1991 are junior synonyms) is a rarely encountered and poorly known species distributed from Panamá to southern Ecuador. External morphology data of 26 Ecuadorian specimens lie in the range of variation reported by Campbell & Lamar (1992), except for ventral and subcaudal counts, which may be as low as 169 and 59. The maximum total length of *B. punctata* is at least 1400 mm as evinced by a female from the province of Chimborazo which gave birth to 18 juveniles on 13.V.1992. The juveniles had a mean mass of 4.6 g (3.4–5.6g) and a mean total length of 287mm (275–294mm); a juvenile collected on 29.IV.1992 measured 270mm. Neither the juveniles nor the adult used their long tails as prehensile tails, and they did not turn out to be good climbers, either, thus questioning the frequently suggested arboreality of this species. In terraria, the juveniles preferred resting on the ground and on branches 10–20 cm above the ground and invariably fell down when disturbed. The use of their pale tail tips as caudal lures, however, was extensive. Force-feeding with small mice resulted in significant weight increase, but rearing was unsuccessful for this food became unavailable later, offered anurans proved toxic, and six snakes were killed by ants. The female readily accepted mice as food. The venom of *Bothriopsis punctata* is slightly more toxic to mice than the other Ecuadorian pitviper venoms tested to date, and its preliminary (*in vitro*) characterisation indicates a moderately high proteolytic and high kinin-releasing, but relatively low clotting activity. [KEYWORDS: Serpentes, Viperidae, *Bothriopsis punctata*, life history, behaviour, venom].

Kuchling & Bradshaw

S12

Spermatogenesis and plasma concentrations of sex steroids in *Chelodina steindachneri* (Testudines: Chelidae). Gerald Kuchling and S. Donald Bradshaw. *Dept of Zoology, University of Western Australia, Nedlands, WA 6009, Australia. Chelodina steindachneri* inhabits semi-permanent and temporary wetlands in arid parts of Western Australia. Blood and testis biopsies were collected in the field during the months January, February, May, June, September, and October. Plasma

concentrations of testosterone, estradiol and progesterone were measured by RIA and spermatogenetic stages determined histologically. The germinal epithelium is quiescent during winter, spermatogonia start to multiply in spring, followed by spermatocytogenesis in late spring and summer. Spermiogenesis peaks in January and February and continues until early June. Spermiation starts during summer and continues until winter. Plasma progesterone peaks during spermatocytogenesis in spring, testosterone is at high levels during summer and autumn when spermiogenesis and spermiation occurs; no seasonal changes were found in concentrations of estradiol. A long (six months) plateau of high plasma concentrations of testosterone during the annual spermatogenetic cycle has not been reported in studies of turtles of other families. [KEYWORDS: spermatogenesis, sex steroids, Testudines, Chelidae].

Kuhn

C12

Life history strategy in female toads *Bufo bufo bufo* (L.). JOACHIM KUHN. *Max-Planck-Institut für Verhaltensphysiologie Seewiesen, 82319 Starnberg, Germany.* Reproductive and life history strategies are investigated in three populations of the European common toad *Bufo b. bufo* (L.) in southern Germany. **Fecundity:** Females lay 800 to 8000 eggs, with body length determining maximum fecundity and a fat store threshold determining minimum fecundity. Previous history of an individual female strongly influences fecundity, as shown by comparing females spawning for the first time, females that reproduced several years in succession, and females that interrupted reproduction for one year or more. Fecundity is independent of age. **Size and age at maturity:** Females are 3 to 7 years of age when breeding for the first time. The size threshold for initiating reproduction decreases with age. As soon as sexual maturity is attained, females' growth slows down or even stops. **Mortality and lifetime reproductive success:** Reproduction is linked with very high mortality. Most of the females are semelparous. Only 5 to 25 percent manage to reproduce more than once (up to five times). Maximum age is 9 years. Lifetime reproductive success primarily depends on the first clutch. **Differences between populations:** Mainly due to climatic factors, the populations studied differ considerably in demography, population dynamics and life history traits such as size and age at first reproduction, though the distances between them are only 10–20 km in latitude and 60–160 m in altitude. [KEYWORDS: life history strategy, lifetime reproductive success, population differences, toad, *Bufo*].

Kupriyanova

C06–091

Effect of hybridisation in parthenogenetic lizards. LARISSA A. KUPRIYANOVA. *Zoological Institute, Russian Academy of Sciences, 199034 St Petersburg, Russia.* Successful hybridisation is a relatively rare phenomenon owing to system of genome canalisation which restricts evolutionary potential of hybrids. The lack of genome coordination in rare hybrids arising between bisexual and unisexual species of the family Lacertidae has led to their hybrid sterility. Moreover, in comparison with their parental, bisexual species hybrid parthenogenetical species have also shown a shift of genomic homeostasis: chromosomal and genomic changes, disharmony in their genome interaction, disturbances which resemble destabilisation of mobile elements in dysgenesis. And as a result, we observe an increase of genotypical diversity. However adaptive mechanisms decreasing their diversity have been also recorded for: inversions, disturbances of conjugation, limited recombinations, chromosomal association, and imprinting. These mechanisms may be responsible for reproductive isolation in sympatric populations.

In fish, amphibians and reptiles (lizards) hybridisation often leads to disturbances in similar genes controlling of meiosis, but not to meiosis of parthenogenetical type. Only about 1% of lizards are hybrid parthenogenetical species. Hybridisation as a result of disturbances of genomic operation may lead to high genetic diversity in hybrids and create a basis for selection on new adaptive gene combinations. The latter may be retained when unisexuality arises. Therefore, hybridization and parthenogenesis are two related and dependent events which play a great role in the evolution. Evolutionary pathways of hybrids and of hybridogenetic speciation of unisexual species as a whole depend on interaction of both processes. [KEYWORDS: lizards, parthenogenesis, hybridisation, genome].

Kuzmin

C06–092

Amphibian declines on the territory of Commonwealth of Independent States. SERGIUS L. KUZMIN. *Institute of Evolutionary Morphology and Ecology of Animals, Russian Academy of Sciences, Leninsky prospect, 33, Moscow 117071, Russia.* Analysis of the past and recent studies made by members of DAPTF/CIS Working Group revealed the most species of Amphibia on the CIS territory to be subject to local declines. The main cause of this is anthropogenic influence, primarily the urbanization, industrial pollution and destruction of habitats. The species possess differential sensitivity to these factors. On some territories long-term changes occurred in species composition probably due to climatic changes. Generally, Caudata are more vulnerable than Anura. Narrow-ranged and stenotopic species are on average more vulnerable than widespread and polytopic species. Among the widespread ones, *Triturus cristatus* probably declined on the most part of the territory. From the other side, *Bufo viridis* and especially *Rana ridibunda* widened their ranges due to malioration and thermal pollution of the environment (along with local declines). These species appear to be most tolerant to anthropogenic activity and comprise a good subject to synantropization. Formation of vistas with ponds in forests by men leads to increase of populations of the forest species complex.

Kuzmin

S20

The problem of food competition in amphibians. SERGIUS L. KUZMIN. *Institute of Evolutionary Morphology and Ecology of Animals Russian Academy of Sciences, Leninsky prospect, 33, Moscow 117071, Russia.* Competition occurs for the concrete resources and may be estimated only by its results. It must be reflected both on the state of resources and competitors, changing the condition of the latter to worse. Original data and analysis of 180 published works concerning the food competition in Amphibia revealed the following. Conclusions and speculations in literature on this event are based commonly on the facts of negative interactions of individuals; density-dependent reactions without estimation of food resources; differences in biology of syntopic species; feeding rate variability; amphibian influence on the food resources without estimation of the consumers' condition; density-dependent reactions with estimation of food resource condition. Only in the last case one can say on the food competition, if the depletion of food was demonstrated to interact with amphibians' negative interactions. These were demonstrated only in few experimental works, but not in nature. Moreover, the lack of food competition was demonstrated in some natural situations. Food competition would be rather exclusion in natural amphibian groups.

Labra

C06–094

Thermoregulation in *Pristidactylus* lizards (Polycridae): the effects of social interactions. ANTONIETA LABRA. *Depto. Cs. Ecológicas, Universidad de Chile, Casilla 653, Santiago, Chile.* The thermoregulation in ectotherms as a mechanism to attain and maintain a body temperature, depends on different factors. In this work, the effects of social interactions on mean selected body temperature (SBT) and other aspects of thermoregulation, such as thermal niche breadth, were studied in two species of *Pristidactylus* lizards from forest and scrubland habitats. Both species reduced significantly SBT in group condition, compared with SBT of single lizards. However, in grouped lizards, SBT was unaffected by size of the group. The specific diel patterns of acquisition and maintenance of SBT were independent of the number of competitors. In the scrubland species the breadth of the mean body thermal niche increased with the number of individuals, but it decreased in the forest species. Both species, increased the time spent in warmer areas during interactions. These results indicate that social interactions change some of the most important characteristics of thermoregulation, including a possible temperature decrease in the set-point of the selected body temperature. [KEYWORDS: social interactions, body temperature, thermoregulation, selected body temperature].

Lampo *et al.*

S16

The reproductive ecology of *Bufo marinus*. MARGARITA LAMPO[1], VICTORIA MEDIALDEA[1], PETER BAYLISS[2] MARK HEARNDEN[3] AND ROSS ALFORD[3]. [1]*Centro de Ecologia, Instituto Venezolano de Investigaciones Cientificas, Aptdo. 21827, Caracas 1020-A, Venezuela.* [2]*Depto. de Ecologia, Instituto Nacional de Pesquisas da Amazonia, CP 478, 69011- 970 Manaus AM, Brazil.* [3]*Dept of Zoology, James Cook University, Townsville, Qld. 4811, Australia.* The reproductive success of a species is largely determined by when and how it reproduces. The timing of reproduction in *Bufo marinus* differs from site to site. Whereas in some areas reproduction appears to be associated with the beginning of the rainy season, in others that is not the case. The amount of energy an individual can invest in reproduction is partly limited by its maintenance requirements. The proportion of body weight *B. marinus* allocates to reproductive tissues were found to be inversely correlated with that in fat bodies. This study describes the reproductive ecology of *B. marinus* at different sites in Venezuela, Brazil and Australia, and explores factors affecting the phenology and reproductive strategies of this species. The proportion of weight allocated to gonads and fat bodies are analysed in relation to the seasonal changes in climatic variables. The phenology and reproductive strategies of *B. marinus* will be discussed in view of its reproductive success and their implications for the control of this species. [KEYWORDS: *Bufo marinus*, reproductive ecology, S. America, Australia, biological control].

La Nafie *et al.*

C06–093

Chemical properties of femoral gland secretions among populations of the agamid lizard *Ctenophorus fionni*. N. LA NAFIE[1], G.R. JOHNSTON[2] AND R.H. PRAGER[1]. [1]*School of Physical Sciences, Flinders University, GPO Box 2100, Adelaide, SA 5001, Australia.* [2]*School of Biological Sciences, Flinders University, GPO Box 2100, Adelaide, SA 5001, Australia.* The chemistry of femoral gland secretions of twenty male *Ctenophorus fionni* from four populations were investigated. The secretions consisted of about 90% protein and about 10% lipid material. The lipids were characterised by chromatography and mass spectrometry as fatty acids C14–C26

and at least five sterols. There was considerable variation in lipids between individual lizards, but these individual differences masked any differences between populations. The proteins have been partially resolved by HPLC. All proteins identified in *C. fionni* were present in all individuals of that species, but individuals differed in the amount of each protein present. Some different proteins, not found in *C. fionni*, were found in another agamid (*Pogona vitticeps*) and an iguanid (*Iguana iguana*). Overall *P. vitticeps* secretions were more similar to those of *C. fionni* that to those of *I. iguana*. A substantial amount of divergence has occurred in the protein fraction of the femoral gland secretions among populations of *C. fionni*. At the same time the level of intrapopulation variation in both the lipid and protein fractions of the secretions suggest that the femoral gland secretions may be used in individual recognition. This raises the possibility that olfactory cues may be more important than previously recognised among agamids, a group which is generally thought to use primarily visual modes of communication. [KEYWORDS: Agamidae, femoral glands, pheromones, individual recognition].

Lardner

C19

Loss of larval competitive ability in an allopatric island population of the moorfrog *Rana arvalis* - an experimental study. BJÖRN LARDNER. *Dept of Ecology, University of Lund, Ecology Building, S-223 62 Lund, Sweden.* On the Baltic island of Gotland, the moorfrog *Rana arvalis* has escaped its mainland competitor the common frog *Rana temporaria*. By raising larvae from mainland and island *R. arvalis*-populations (ORIGIN) in inter- as well as intraspecific regimes (SPECIES) of different densities (DENSITY), I tested if the competitive escape of the Gotlandian *R. arvalis* has led to a genetic change in developmental strategy and competitive ability of its larvae. Gotlandian *R. arvalis* had significantly longer larval periods than mainland conspecifics. Their weight at metamorphosis did not differ; consequently the Gotlandian larvae had a lower growth rate than mainland larvae. The Gotlandian larvae did not respond more strongly to competition with *R. temporaria* than mainland larvae did, as would be expected if a loss of genetically based competitive ability towards *R. temporaria* had occurred. The Gotlandian larvae, however, showed a loss of competitive ability in general, i.e. to inter- as well as intraspecific competition: their larval periods were significantly more extended by a raised larval density, than that of the mainland larvae. When competing with a stronger competitor, this loss of competitive ability in general gives the same effects as a loss of competitive ability towards that specific species. Only by simultaneously testing density and interspecific effects can the ORIGIN × SPECIES and ORIGIN × DENSITY interactions be separated. [KEYWORDS: competition, competitive release, developmental strategy, *Rana arvalis*].

Lau

C33

The ecology and conservation of *Philautus romeri* Smith (Rhacophoridae), an endemic frog in Hong Kong. MICHAEL W.N. LAU. *Dept of Zoology, The University of Hong Kong, Pokfulam Road, Hong Kong.* *Philautus romeri* has only been known from four offshore islands in the territory of Hong Kong. Due to the ongoing construction of a new airport and associated port development, the frog habitats on Chek Lap Kok Island have been destroyed while those on Lantau Island will be affected. Habitat use of this species has been studied in detail for two years: *P. romeri* selects breeding sites opportunistically and can utilise very small (less than 0.1 m^2) seasonally

inundated wetlands. The restricted distribution of this species reflects land use changes in the past, and predation by exotic fish (Poeciliidae). A translocation program using both wild-caught and captive-bred animals of the Chek Lap Kok population has just been initiated and preliminary results will be presented in this paper. [KEYWORDS: *Philautus romeri*, habitat use, fish predation, translocation].

Lee

C06– 095

***Eunotosaurus* reinterpreted as an aberrant synapsid.** MICHAEL S.Y. LEE. *University Museum of Zoology, Downing St., Cambridge CB2 3EJ, United Kingdom.* A restudy of *Eunotosaurus*, a bizarre reptile of previously uncertain affinities, reveals that it is a highly modified caseid pelycosaur, i.e. a "mammal-like reptile". It exhibits all the synapomorphies diagnosing synapsids (such as a lower temporal fenestra; a plate-like, sloping occiput; and reduced posttemporal fenestra), all those diagnosing caseasaurs (such as a rostrum on the snout and a posterior spur on the supratemporal), and all those diagnosing caseids (such as an enlarged external naris; shortened facial region; and a maxilla that extends posteriorly beyond the orbit). *Eunotosaurus* represents the first undoubted record of a pelycosaur from the Southern Hemisphere, and is also the last surviving pelycosaur, coexisting with a diverse variety of therapsids in the *Tapinocephalus* zone of southern Africa. The persistence of caseids, and no other pelycosaurs, well into the late Permian is consistent with the suggestion that caseids were the most arid-adapted pelycosaurs, and that pelycosaurs went extinct because of increasing aridity. Caseids appear to have been fossorial, and the unique traits of *Eunotosaurus* (reduced presacral count expanded ribs) appear to be further elaborations for this lifestyle. [KEYWORDS: synapsid, pelycosaur, *Eunotosaurus*, fossorial].

Lee

S02

The origin of turtles reconsidered (again). MICHAEL S.Y. LEE. *University Museum of Zoology, Downing St., Cambridge CB2 3EJ, United Kingdom.* It has recently been proposed (Lee, in press, *Science)* that pareiasaurs, and not captorhinids or procolophonoids, are the sister group of turtles. Here, it is suggested that the relationships between pareiasaurs and turtles might be more intimate: pareiasaurs are not just the monophyletic nearest outgroup to turtles, precluded from being the direct ancestors by numerous autapomorphies. Rather new evidence suggests that pareiasaurs are the paraphyletic ancestral group of turtles. The latest and most derived pareiasaurs (e.g. *Anthodon*) share numerous derived traits uniquely with turtles: anteriorly-positioned basal tubera; 19 or fewer presacral vertebrae; absence of cleithrum; humerus with reduced torsion and ectepicondyle; pubic and ischial processes; femur with dorsally directed head and proximally-located, ventrally-directed trochanter major; and extensive dermal armour. Parsimony dictates that the few apparent autapomorphies of pareiasaurs have to be reinterpreted as secondarily absent in turtles. This phylogeny also suggests that many of the most distinctive features of turtles arose earlier, in their pareiasaur ancestors, in connection with inertial homeothermy. [KEYWORDS: turtles, pareiasaurs, phylogeny, thermoregulation].

Leigh & Breed

C06–096

Sperm storage sites in *Hemiergis peronii* and *H. decresiensis* (Lacertilia: Scincidae). CHRIS M. LEIGH AND W.G. BREED. *Dept of Anatomy and Histology, The University of Adelaide, SA 5005, Australia.* The two small South Australian, litter dwelling, skinks *Hemiergis peronii* and *H. decresiensis* have unusual reproductive

cycles with spermatogenesis occurring in autumn and ovulation and fertilization of the eggs in spring. This necessitates sperm storage over winter. Monthly samples of the male and female reproductive tracts of these two species have been examined over a two year period to determine the sites of sperm storage and functional activity of the reproductive organs. The lumen of the male tract is lined by a pseudostratified epithelium and predominantly composed of secretory cells. There are no glands in the ductus epididymis, but the vas deferens has many branched tubular glands. Secretory activity of these cells coincides with autumn spermatogenic activity and exocrine secretion of electron dense material occurs into the lumen. Spermatozoa released from the testes of both species are initially stored throughout the epididymides and vasa deferentia from which the highest sperm counts were obtained in late autumn in *H. peronii* and in mid winter in *H. decresiensis*. *H. peronii* mate in autumn thus sperm are stored in both the male and female reproductive tracts during winter. By contrast *H. decresiensis* individuals do not mate until spring hence sperm are only stored in the male tract over winter and present in the female tract for a maximum of five weeks before ovulation. In females of both species sperm are stored in longitudinally orientated mucosal crypts, lined with both ciliated and secretory epithelial cells, located in the posterior region of the oviduct. The secretory activity of the cells in the reproductive tracts and how their activity relates to sperm storage in these two species, with markedly different times of insemination, will be discussed. [KEYWORDS: sperm, storage, morphology, Scincidae].

Lemckert

C06–210

Effects of forestry operations on herpetofaunal assemblages in three state forest areas in New South Wales. FRANCIS L. LEMCKERT. *Research Division, State Forests of New South Wales, PO Box 100, Beecroft, NSW 2119, Australia.* This is a summary of the findings of surveys which were conducted in the Urbenville, Grafton/Casino and Glen Innes Management Areas (State Forests of NSW) to provide information on the distribution and abundance of reptiles. A standardised survey format was developed and followed to provide quantitative data which was analysed for each area as part of a series of Environmental Impact Statements. Reptile diversity and abundance, both for individual species and as a group, were analysed in areas of different management regimes to determine the effects of logging, burning and grazing. The results have indicated, not surprisingly, that different species are affected in different ways and to different degrees. There were no consistent decreases in overall abundance or diversity of reptiles when comparing logged and unlogged areas, although individual species did show some effect (e.g. *Ctenotus taeniolatus* which decreased with increased logging and *Eulamprus murrayii* which preferred mid-aged forests). Burning appeared to have the greatest impact in reducing numbers and diversity, especially on moist-forest dependant specics (significant effect in Grafton/Casino and Glen Innes). The effects of grazing were difficult to determine, due to the connection of this activity with burning. Decreases in ground foraging reptile species richness correlated with reduction in ground log site (e.g. Urbenville study $r = 0.235, p = 0.04$). Overall, the results suggested that logging had little impact on the reptile assemblages, but burning and perhaps grazing are a more serious long term threat due to their alterations to the substrate. [KEYWORDS: abundance, burning, diversity, grazing, impacts, logging, reptiles].

Leontyeva

C06–098

The character of hunting behaviour of four amphibian species inhabiting

one biotope. OLGA A. LEONTYEVA. *Dept of Biogeography, Moscow State University, Moscow, 119899 Russia. Bufo bufo*, *Pelobates fuscus*, *Rana temporaria* and *R. arvalis* inhabiting together the herb layer in various types of biotopes of the forest zone differ in their manner of hunting. *Bufo bufo* is active in finding the "food spots" (ant roads) and then it sits down near such roads and gathers ants running past. *Pelobates fuscus* can be related to "finders". During hunting period it always moves along the territory by steps, stopping not for a long while its movenment. Brown frogs (*R. temporaria*, *R. arvalis*) are "waiting hunters". They are sitting at one place for a long period of time (10–15 min) and catch all invertebrates which appear in the field of their vision. Then they change hunting place. While jumping to another place they do not hunt. Because of the various methods of finding the prey the species of anuran amphibians are feeding on different invertebrates by species, the inhabiting layer, the speed of movement and so on. [KEYWORDS: anuran, amphibians, hunting behaviour, move, catch].

Leontyeva

C06–097

Dynamic of quantity of anuran amphibian populations in the mixed forest zone (Moscow region). OLGA A. LEONTYEVA. *Dept of Biogeography, Moscow State University, Moscow, 119899 Russia.* Distribution and quantity of anuran amphibians depends on microclimate of habitats, compactness of soils, character of plant cover and others. Under the anthropogenous influence together with the change of these qualities of natural ecosystems the characters of amphibian populations inhabiting them changes too. Our research in different ecosystems of European centre of Russia showed that the species abundance of anuran amphibians decreases till 1–4 species in transformed ecosytems. At the same time quantity of the species remaining there becomes 2–10 times higher, populations primarily are composed of young individuals (1–3 years old). As a result of anthropogenous influence changes the sex population composition, year and day activity, the manner of hunting behaviour, the food. Amphibians can be good species monitors of transformation of ecosystems. [KEYWORDS: anuran, amphibian, habitat, distribution, quantity].

Li & Wang

C06–099

APUD cell found in thymus of amphibians and reptiles and their evolution. LI PI-PENG AND WANG PING. *Dept of Biology, Peking University, Beijing 100871, China.* The main primary lymphoid organ, thymus, of amphibians and reptiles are composed of reticular epithelial cells and thymocytes, as well as abundant myoid cells, interdigitating cells and secretory cells. Some of the secretory cells have been found to be impregnated with silver with the argentaffin reaction. They are more abundant in thymus of adult snake than that of adult *Bufo* and salamander, and are scattered mainly in the medulla of thymus. Some of them are near thymic cysts, even a few as a part of the cyst. The argentaffin cells are variant from round, spindle to irregular triangle in shape and from 7 to 18 μm in size. With immunocytochemical study using anti-serotonin (5-HT) and anti-gastrin sera, some of the cells are 5-HT positive and a few gastrin positive. At the ultrastructural level, the most characteristic feature of the cells is the presence of small dense granules in the cytoplasm. According to the shapes and sizes of the granules, the cell can be grouped into 3 types.The ultrastructural features of the cells are similar to cells of APUD (Amine Precursor Uptake and Decarboxylation) series in digestive, urogenital and respiratory tracts. So, the cells in thymus of amphibians and reptiles are regarded as a new group of APUD cells.

Their function, development and evolution are discussed from amphibians to reptiles. [KEYWORDS: amphibian, reptile, thymus, APUD cell].

Liang

S30

Clinical experience in treatments for the viper-bite keeping oozing blood. LIANG GUOCHENG. *Emergency Centre, Xi Jiang Plastic Manufactory, Wuzhou City, Guangxi Province, China.* It's known that the venom of a viper is a kind of toxin for blood circulation, the main poisonous element of which is a toxin destroying thromboplastin. When the venom enters a human body, it mainly harms the blood circulatory system of the body and causes hemolysis, hemorrhage and anti-coagulation. If treated incorrectly, for example, to be cut open by mistake, the wound will ooze blood seriously without stop. And the serious case may suffer from shock caused by excessive loss of blood and from circulatory exhaustion, which will bring the case serious result. In the recent years, the writer has got satisfactory results by applying wound Wan Hua Oil, frozen normal saline and adrenaline hydrochloride to stop blood oozing. Our new treatment is as follow. The composition of the medicines: Wan Hua Oil bottles (10g), frozen normal saline 500 ml (1°C–2°C), adrenaline hydrochloride 2mg. The use of the medicines: Apply Wan Hua Oil (4–8 g) to a part of the wound, then apply to the wound and its surrounding tissue a big cotton pad wetted with frozen normal saline (500 ml) and adrenaline hydrochloride (1 mg), and bind up the wound with pressure. Change a new pad every 30 minutes until the wound stops oozing.

Lim & Diong

C02

The structure and some functional aspects of the shell (oviposited and oviductal) of eggs of *Calotes versicolor* (Reptilia, Squamata, Agamidae). T.M. LIM[1] AND C.H. DIONG[2]. [1]*Dept of Zoology, National University of Singapore, Kent Ridge 0511, Singapore.* [2]*Division of Biology, Nanyang Technological University, National Institute of Education, 469 Bukit Timah Road 0511, Singapore.* The egg shell of the squamate *Calotes versicolor* expands throughout the incubation period as the embryo develops within. In order to understand this interesting property, we examined the egg shell under the scanning electron microscope and the confocal laser scanning microscope. The variability in the morphology of the calcareous layer of egg shell was evident in the polar and equatorial regions and could be attributed to the random mobilisation of calcium during embryo development. The egg shell is stratified into a layer of calcareous crust, four fibrous layers, and an inner membrane separating the shell from the albumen. Each layer of stratification has its distinctive features. The outer-most layer is calcified and the fibrils are arranged loosely. The layer beneath the calcified zone is made of closely packed parallel fibrils running in the equatorial orientation. This layer is associated with some amorphous matrix of organic compounds. The fibrils in the third layer are also closely packed but they run perpendicular to the second layer, i.e. in the longitudinal directions. The fourth fibrous layer is a loose network of fibrils usually not more than two-strand thick. The fifth stratification is the inner-most layer of the egg shell and it is a bi-layer membrane. The flexible nature of this egg shell is due to its fibrous organisation. We found that egg expansion during incubation is mainly due to stretching of the fibrils along the longitudinal directions. The stretchable property of the fibres is the main reason behind the expandable nature of the *Calotes* egg shell. The adaptive significane of this property of the egg shell is discussed. [KEYWORDS: Agamidae, Squamata, egg shell, SEM, confocal microscopy].

Lima

C28

Overlap in the diets of leaf litter anurans in Central Amazonia: interaction between recruitment season and ontogenetic shifts in the diet. ALBERTINA P. LIMA. *Deptę de Ecologia, Instituto Nacional de Pesquisas da Amazônia, CP 478, 69011-970 Manaus AM, Brazil. Adenomera andreae, Colostethus marchesianus, C. stepheni* and *Dendrophryniscus minutus* forage syntopically during the day in the leaf litter of forests of central Amazônia. The feeding niches of the four species change during ontogeny. Small individuals eat small arthropods that are principally mites and collembolans, and larger frogs eat bigger prey of other types. The ontogenetic shifts in diet result in animals of the same species, but of different sizes, having different diets. A cluster analysis based on 16 categories of prey types for 845 individuals of the four species, indicated that size is more important than the species of frog in determining diet. The interaction between the ontogenetic shifts in diet and the juvenile recruitment period causes the species in this community to have different diets in the same season, even though they have similar adult sizes and size-specific diets. [KEYWORDS: ontogenetic change, diet, recruitment].

Lima-Verde & Borges

C06–100

Snakes, lizards and amphisbaenians geographical distribution in the principal vegetation types in the State of Ceará, Brazil. JOSÉ SANTIAGO LIMA-VERDE AND DIVA MARIA BORGES. *Regional Ophiology Laboratory of Portaleza, Federal Univesity of Ceará, Pici Campus, 60.455 Fortaleza, Ceará, Brazil.* Under the phytogeographic point view, the State of Ceará is included in morphoclimatic region of the Caatingas. Although its vegetation can be separated into eleven vegetation types, the greatest part of the State (88%) is covered by xerophyll vegetation of the Caatingas. The other more important vegetation types concerning geographic distribution are the rainforest (Tropical Semidecidous Forest), River margins vegetation (Gallery Forest of Mixed Dicotilo-Palmacea Forest) and the littoral zone vegetation complex. The rainforests situated at the more elevated parts of the cristalline mountains and at the higher sides of "Chapada do Apodi" and the north of the "Planalto da Ibiapaba", have special meaning, as in these environments are found reptiles that constitute important elements for the historic reconstruction of the tropical South America, concerning principally the paleoclimate changes that occurred during the Quaternary Age. Among the 40 species or subspecies of snakes and the 31 species and/or subspecies of lizards and amphisbaenians that occur in Ceará, respectively 21 and 19 are found in the Caatingas and 26 and 22 are present in rainforests, 19 species of snakes are found respectively in the littoral zone vegetation complex and the river margins vegetation. With regard to lizards and amphisbaenians, 14 species are distributed in littoral zone vegetation complex and only 9 species were found on the river margins vegetation. All species referred to in paper are presented on Tables I and II. (Research grant from the Brazilian National Research Council (CNPq)). [KEYWORDS: snakes, lizards, amphisbaenians, zoogeography, northeast Brazil].

Limpus *et al.*

S18

Intra and inter specific variability in pivotal temperature during incubation of marine turtle eggs. COLIN J. LIMPUS, JEFFREY D. MILLER AND PHILLIP C. REED. *Queensland Dept of Environment and Heritage, Brisbane, Qld 4000, Australia.* Sand temperature at nest depth on marine turtle nesting beaches is variable, being a function of latitude, season, orientation of the beach to the sun, vegetation cover and

sand colour. The pivotal temperature for marine turtles is variable between species and between independent stocks within a species. Results of constant temperature incubation studies of *Caretta caretta*, *Chelonia mydas* and *Natator depressus* from eastern Australian nesting populations are summarised. The timing of the breeding season and the location of the rookeries used by a stock appear to be selected to provide a range of nest temperatures above and below the pivotal temperature rather than temperatures coinciding with the pivotal temperature.

Lindell

C28

Effects of variation in food abundance on growth rates and amount of stored fat in adders (*Vipera berus*). LARS ERIK LINDELL. *Dept of Zoology, Uppsala University, Villavägen 9, S-752 36 Uppsala, Sweden.* In the Swedish archipelago outside Stockholm adders feed almost exclusively on field voles (*Microtus agrestis*). These rodents are known to fluctuate greatly in numbers between years. I have investigated how the snakes respond to this variation in food abundance over a five-year period. When comparing growth rates and weight status in two populations among years it appears that lowered food abundance primarily decreases the snake's weight/size ratio. Among years the elevation of the regression lines of $\log_e$weight vs. SVL decreased with decreasing vole abundance, whereas there were no significant difference in elevation of growth rates vs. $\log_e$SVL. It is also evident that there is a trade-off between these two characters so that individuals that put much energy in growth have less stored as fat. [KEYWORDS: food abundance, growth rates, weight status, trade-offs].

Lips

C20

Clutch characteristics and embryonic development and mortality in *Hyla lancasteri*. KAREN R. LIPS. *University of Miami, Dept of Biology, P.O. Box 249118, Coral Gables, FL 33124, United States of America.* I studied a population of *Hyla lancasteri*, a montane stream-breeding treefrog in Costa Rica during the breeding seasons of 1991, 1992, and 1993. I observed reproduction between April and December, and present information on the timing of reproduction and development of eggs. Clutches ranges from 6 to 36 eggs, averaging 15 eggs per clutch, and were deposited along vegetation over the stream. Embryonic development ranged from 23–36 days from date of oviposition until hatching. This variation probably results from the varying amount of rainfall during development. Those clutches with a longer developmental period hatched at a significantly larger average total length, and a smaller average body width. Embryonic mortality was high, only 26% of the 324 clutches observed hatched. The cause of mortality varied during the course of the year, with clutches laid early suffering mortality from desiccation or being washed away by floods; clutches laid later in the year were most often destroyed by maggots of a drosophilid fly. Early clutches had a greater probability of survival; by the end of the breeding season clutch mortality was over 90%. Complete (100%) hatching success within a clutch was rare, usually due to developmental anomalies within individual eggs of a clutch. Of the 81 clutches that hatched tadpoles, 8.9 tadpoles hatched on average (sd = 6.0). The number of tadpoles that hatched ranged from 1 to 25 per clutch for an average hatching success of 53.4%. Implications of this reproductive scheme and the effects of rainfall on population structure will be discussed. [KEYWORDS: clutch, development, population, reproduction, eggs, mortality, Drosophilidae, tadpoles].

Lira-da-Silva & Nunes

C31

Aspects on reproductive biology of *Bothrops leucurus* Wagler, 1824 (Serpentes; Viperidae). REJÂNE M. LIRA-DA-SILVA AND TANIA B. NUNES. *Dept of Zoology, University of Bahia, Salvador, Bahia, Cep 40170-110, Brazil.* *Bothrops* is responsible for the majority of the accidents (94%) and deaths in Bahia State (62.4%). Although *Bothrops leucurus* snakes come originaly from tropical forests in the north-east of Brazil, it can also be found in urban areas (Salvador city). Despite its medical importance (unique causal agent in the metropolitan area of Salvador city), there is hardly any studies about the reproduction of this species. The purpose of this paper is to present some aspects observed during the accompanying of three pregnant females captured in the State of Bahia and brought to our laboratory. They were kept in captivity where variation of humidity, luminosity and temperature were registred (25.2–32.8°C). The registered data includes period of pregnancy and birth, average number of youngs/brood, sexual dimorphism, growing and death rates, and captivity adaptation. In fact the minimum pregnancy period correspond to the maximum observed in captivity during the works, which was 92 days. The births occurred mainly during the Summer (January to March); these data suggest that mating of *B. leucurus* may occurred at the end of rainy period (September/October). An average of 12 youngs/brood, 60% males and 40% females (average weight and length = 6.9 g and 26.2 cm) were born, but the nativity of 47 youngs from a 150 cm female (brood 1) have showed a close relation between its length and the number of youngs/brood. In spite of this, the influence of other factors (physiological and environmental) cannot be ignored. The conspicuous bright yellow tail at neonate and young males defined the sexual dimorphism for this species. The monthly average length and the increasing of weight were 1.8 cm and 2.2 g respectively, with major data (2.3 cm and 2.9 g) for brood 1. Every young went through moult a week after they were born and then about 45 days later. The great majority was fed regularly showing its adaptability to captivity. Mortality rate of young which were submitted to venom extraction was higher (39%) than those which were not (5%) (brood 3). (Supported by Foundation Bank of Brazil). [KEYWORDS: reproduction, snakes, *Bothrops*, Brazil].

Liu & Liu

C06–102

Researches on artificial breeding and problems concerned of *Magalobatrachus davidianus*. LIU GUO-JUN AND LIU QING-BO. *Institute of Megalobatrachus davidianus, Wuling University, Dayong City, Hunan Province, China.* *Megalobatrachus davidianus* is the rare economical animal, its systematic hierach is Amphibia, Urodeta, Cryptobranchidae. It is the second kind protecting animals in China. There is important scientific value in biological evolution, and wide future in economical and medicinal uses. To reproduce and preserve the rare source, we have been making research on artificial breeding recently, and we have successfully obtained larvas by artificial insemination. It will help to increase and preserve the source. The following aspects have been approached: 1) *Megalobatrachus davidianus* could spawn and breed under the artificial environmental conditions. A whole set of successful law has been found in the experiments. 2) Problems found in the experience of its breeding have been learned clearly. 3) There used to be different views on the type of fertilisation. Experiments proved that it is internal fertilisation. [KEYWORDS: *Megalobatrachus davidianus*, artificial breeding, insemination, fertilisation].

Loman

C19

Metamorphosis strategy in tadpoles (*Rana temporaria*) from different ponds — microevolutionary effects. JON LOMAN. *Dept of Animal Ecology, University of Lund, S-223 62 Lund, Sweden.* The purpose of this study is to detect differences in growth and development rate of tadpoles of the common frog (*Rana temporaria*) originating from different ponds in southern Sweden but raised under identical conditions. Newly hatched tadpoles were taken from 8 ponds, maximum overall distance between ponds was 35 km. Four of the ponds were shallow; during dry summers all tadpoles in these were killed by drought before metamorphosis. The other four were deep; they hardly ever lose all water. The ponds also differed with respect to tadpole density. This was measured with the index; *spawn clumps laid/pond area*. The tadpoles were raised in 801 containers. From each pond tadpoles were taken to be raised in four containers; two densities (10 and 40 tadpoles per container) and two replicates for each density. The two response variables: *time to metamorphosis* and *size at metamorphosis* were measured for each tadpole. The average value for each container was used in the analysis. There was no effect of pond type (dry vs. shallow), at either tank density, on either of the response variables (2-way ANOVAs, all $P > 0.05$). However, *tadpoles from ponds where tadpoles experience high competition metamorphosed earlier* than those from ponds with less competition. This was significant when tested with Pearson correlation coefficient within both sets of tank densities (both $P < 0.01$). However, there was no significant effect on size at metamorphosis from pond competition. Genetic and non-genetic explanations for this pattern will be discussed. Although drying up is a more drastic effect than competition, it might be a less powerful force for individual selection. Only in years when a pond dries up in the middle of the metamorphosis period does it help a tadpole to have a high development rate. The selective pressure of high competition is on the other hand always present in high density ponds. [KEYWORDS: Anura, development, evolution, drying ponds].

Losos

S08

The evolution of community structure in West Indian *Anolis* communities: macroevolutionary hypotheses and microevolutionary tests. JONATHAN B. LOSOS. *Dept of Biology, Campus Box 1137, Washington University, St. Louis, MO 63130, United States of America.* Phylogenetic analyses of the radiations of *Anolis* lizards on Jamaica and Puerto suggest that not only are extant communities convergent, but they have evolved to this state by a very similar set of intermediate communities. This analysis suggests that anole communities have evolved by repeated episodes of microhabitat specialisation as new species enter the community. This hypothesis was tested in extant communities in two ways: by experimentally introducing *A. sagrei* to tiny islands in the Bahamas, and by comparing populations of *A. sagrei* and of *A. carolinensis* among larger Bahamian islands differing in habitat structure and number of sympatric congeners. These studies indicated that anoles do differentiate morphologically in response to differences in habitat use among islands; further, the direction of differentiation is identical, but lesser in scale, than that displayed in macroevolutionary comparisons. However, a second hypothesis, that anoles should reverse evolutionary direction and become more generalised in morphology on islands lacking competitors, was not supported. [KEYWORDS: *Anolis*, community, macroevolution, competition, habitat use].

Love

S27

The trade in living reptiles and the role of captive breeding — a trader's perspective. WILLIAM B. LOVE. *P.O. Box 643 Alva, Florida 33920, United States of America.* The trade in living herptiles is a relatively recent phenomenon when our history of animal domestication and petkeeping is considered as a whole. For only about a century have herps been viewed as anything other than creatures to be feared and avoided, or to be eaten and skinned, to human populations in general. The past couple decades have witnessed a broad-based enlightenment of our knowledge of ecology. This has in turn stimulated a large and growing interest in the world's diversity of wildlife and thus a mushrooming demand for specimens as many people seek to fulfil their newfound appreciation of nature with new exotic pets. Eco-consciousness and the resulting protected status granted many species has coincided with (and helped force development of) the advent of modern herpetoculture. Human enthusiasm is successfully tackling many of the problems of inducing herps to propagate in captivity, particularly when the incentive of economic gain is realised to further finance such endeavors. Initially preserving natural habitats from development, and then continuing to protect them and their resident wildlife, is struggling to keep pace. The seemingly purely altruistic merits of such goals are not always immediately recognisable or "affordable" by the indigenous peoples who would be directly affected. While we can hope that the world's natural diversity will be saved before many more species are lost, we can be sure that the demand for animals and their products will escalate steadily. A twofold realistic approach to supplying the demand is slowly taking shape and gaining acceptance. It will involve allowing a limited sustainable harvest of wild individuals for breeders and researchers needing new pure bloodlines, and encouraging large scale herpetocultural efforts to produce the bulk of specimens used in the pet, meat, hide and chemical trades. An overview of current progress will be presented, particularly mass-production efforts in the United States. Restrictive laws governing the keeping and movement of live herptiles nationally and internationally often impedes advancement of these goals. Suggestions for improvements that reflect the changes rapidly affecting the new business of herp-keeping and breeding will be offered. Numerous colour slides will illustrate the talk. [KEYWORDS: pet trade, herpetoculture, commercialism, legislation].

Luksch & Walkowiak

C25

Auditory communication in anurans: midbrain sensorimotor interface. HARALD LUKSCH AND WOLFGANG WALKOWIAK. *University of Cologne, Weyertal 119, D-50923 Köln, Germany.* The auditory pathway of anurans has been thoroughly characterised anatomically and physiologically. Nevertheless, major questions, e.g. evaluation of auditory evoked excitation and generation of motor output, have remained unanswered. Behavioural as well as physiological studies indicate that the midbrain torus semicircularis might be part of the sensorimotor interface. Taking the subnuclear organisation of the torus into account, our tracing-studies indicate that the subnuclei subserve different tasks: nucleus principalis is the main target for the tonotopically arranged auditory afferents, nucleus magnocellularis and especially nucleus laminaris are heavily interconnected with various auditory and non-auditory premotor nuclei. The reaction of anurans to sensory stimuli is strongly dependent on the inner state of the animal. A possible site for hormonal and neuromodulatory action within the auditory pathway is the nucleus laminaris. Its neurons accumulate sex steroids and dense terminal webs immunopositive to antibodies against Serotonin, Substance P,

Leu-Enkephalines have been demonstrated. For further investigation, we recorded responses of toral neurons intracellularly *in-vivo* and in an *in-vitro* approach in which the auditory input was replaced by electrical stimulation of the auditory branchlets of the NVIII. Types of responses did not differ significantly in both preparations. This implies that response characteristics of neurons strongly depend on the intrinsic properties of the auditory network. Intracellular staining revealed that both dendritic and axonal morphology are far more complex than demonstrated previously. In summary, our data suggest a dominant role of laminaris neurons in audio-motor interfacing. [KEYWORDS: auditory communication, sensorimotor interface, modulation].

Mable

C03

Frog phylogenies and PCR: why nuclear genes have not been used as often as mitochondrial genes. An example. BARBARA K. MABLE. *Dept of Zoology, University of Texas at Austin, Austin, TX 78712, United States of America.* The grey treefrogs of North America are a complex of diploid and tetraploid frogs whose evolutionary histories have not been completely resolved. While phylogenies based on mitochondrial gene sequences predict multiple origins of the tetraploid and identify at least two independent lineages of diploids in the complex, mechanisms of origin (allopolyploid or autopolyploid) are difficult to resolve without knowledge of paternal contributions. Allozyme data is relatively uninformative in this respect because there are few fixed allelic differences between populations, and diploids and tetraploids share most of the same alleles. To investigate whether sequences from nuclear genes can provide more information on the relationships in this group of closely related "species", I have been attempting to sequence intron regions of several nuclear genes . One gene, EF-1a, gave consistent multiple banding patterns in PCR mediated amplifications. Gel isolation and sequencing of some of these products revealed that the strongest band was that of a processed pseudogene that did not include the intron sequence. Pseudogenes sequenced from diploid and tetraploid treefrogs were identical and were only 8% divergent from functional gene sequences in *Xenopus*. Comparison with several known pseudogenes sequenced in *Xenopus* revealed approximately 16% sequence divergence in the *Hyla* sequences. Therefore, comparison of the pseudogenes did not appear to be useful for population level analyses. Due to preferential amplification of the pseudogene and problems with heteroduplex formation between the pseudogene and the larger gene products, gel isolation and cloning attempts of the putative intron- containing bands have been unsuccessful. Similar problems with multiple banding have also been found in another conserved gene, NCAM, that is not known to have pseudogenes in *Xenopus*. The potential benefits and limitations of population level comparisons using intron regions of nuclear genes will be discussed in light of these results. [KEYWORDS: polyploidy, PCR, evolution, treefrogs, pseudogenes].

Macey *et al.*

C06–103

A mitochondrial DNA based phylogenetic hypothesis for the Hynobiidae as an indication of an old northern mesic Asian fauna. J. ROBERT MACEY[1], ALLAN LARSON[1], ZHILI FANG[2], THEODORE J. PAPENFUSS[3]. [1]*Dept of Biology, Box 1137, Washington University, St. Louis, MO, United States of America.* [2]*Sichuan Environmental Protection Agency, Chengdu, Sichuan, China.* [3]*Museum of Vertebrate Zoology, University of California, Berkeley, CA, United States of America.* Reliable phylogenetic hypotheses for groups spanning large areas of Asia are limited to a few

recent data sets on the arid Asian fauna. The Hynobiidae represents a mesic Asian group that occurs from Kazakhstan to Japan in the north, and from Iran to Taiwan in the south. We have examined taxa from all major geographic regions where the family is known to occur. Using a double stranded sequencing protocol we sequenced 1500 bases of the 12S and 16S ribosomal mitochondrial genes, and the intervening gene encoding the valine transfer RNA. A great deal of resolution appears in this phylogenetic hypothesis. The northern genera of *Salamandrella*, *Ranodon* and *Onychodactylus* appear basal on the cladogram and the southern genera *Pachyhynobius*, *Batrachuperus* and *Hynobius* appear nested. During the glacial periods Asia was never extensively glaciated as North America and Europe were. Our data with all northern genera in a basal position suggest an old northern history for this family. It is possible that when other groups are examined that this may appear as a major biogeographic pattern unique to Asia. [KEYWORDS: Amphibia, Asia, biogeography, DNA, Hynobiidae, 12S RNA, 16S RNA].

Madsen

S22

Determinants of mating success in male adders, *Vipera berus*. THOMAS MADSEN. *Dept of Animal Ecology, University of Lund, S223 62 Lund, Sweden.* Seven years behavioural observations on a population of adders in southern Sweden provided data for a quantitative analysis of the behavioural determinants of male mating success. Male adders are subject to strong intrasexual selection. The number of matings obtained by a male adder was enhanced by higher male mobility (distance travelled during the breeding season), mate-finding ability (females located per metre travelled), and ability to defeat rival males in combat bouts (proportions of bouts won). Male success rates in combat bouts were strongly dependent on body size (and hence, age), and reproductive tactics shifted concomitantly. Small males fought other males (especially, large males) only rarely, and achieved most of their matings in the absence of other males. Larger males fought other males more frequently, and displayed mate-guarding behaviour on some occasions. Although mating success of male adders was strongly enhanced by larger body size, age *per se* appeared to exert no independent influence on mating success. Overall, the mating system of adders imposes strong sexual selection on male abilities to locate females and to conquer rival males in battle.

Madsen & Shine

S15

Costs of reproduction influence the evolution of sexual size dimorphism in snakes. THOMAS MADSEN[1] AND RICHARD SHINE[2]. [1]*Dept of Animal Ecology, University of Lund, S 223 62 Lund, Sweden.* [2]*Zoology Dept, The University of Sydney, NSW 2006, Australia.* We use detailed data on a field population of adders (*Vipera berus*) in southern Sweden to test alterative explanations for the greater adult body sizes of females than males in this species. Larger body size enhances reproductive success in both sexes: litter size increases with body size in female adders, and fighting ability and mating success increase with body size in males. Within any single year, the intensity of selection for large size is greater in males than in females. Why, then, do female adders grow larger than males? This paradox is resolved by examining reproductive success on a lifetime basis rather than a per-season basis. Field data and simulation models suggest that sex differences in costs of reproduction may influence adult body sizes through effects on optimal size at maturation. Because high fecundity-independent costs of reproduction reduce their survival rates, females are likely to have

only one opportunity to reproduce. Hence, they can maximise their lifetime production of offspring by delaying maturation until they reach a large body size and thus can produce a large litter. In contrast, males maximise fitness by maturing at smaller sizes (younger ages) and devoting little effort to risky reproductive activities in the first few years of adult life. Maturation at small sizes may enhance male reproductive success because small males can achieve significant numbers of matings in some years (when many reproductive females are available in the population, so that male-male competition is less intense). The small adult body size of males is a consequence of their early maturation. [KEYWORDS: body size, costs of reproduction, maturation, natural selection].

Madsen & Shine

S27

Water pythons (*Liasis fuscus*) in the top end — a viable commercial resource? THOMAS MADSEN AND RICHARD SHINE. *School of Biological Sciences, University of Sydney, NSW 2001, Australia.* The Adelaide River floodplain in the Top End of the Northern Territory supports large numbers of water pythons, a resource that could be of considerable commercial value. High-quality skins from pythons support a lucrative trade in other parts of the world, although this trade has severely depleted python numbers in some areas (e.g. West Africa). In practice, commercial utilisation of water python products from the Top End is unlikely to be feasible on a long-term basis. Harvesting large numbers of snakes from the wild is not sustainable, because the animals are long-lived and reproduce only episodically. Collecting eggs (as is carried out with sympatric crocodiles) is unlikely to succeed because the oviposition sites (e.g. goanna warrens, paperbark root systems) are scarce and relatively inaccessible, and any attempts to remove eggs would necessitate considerable damage to these sites. Rearing of hatchlings in captivity is also fraught with problems; the young snakes feed only on lizards and small mammals, and must be caged separately during feeding. However, the water pythons of the Adelaide floodplain do have significant economic potential for tourism. We know of no other place in the world where a tourist can be virtually guaranteed of seeing a wild python, and we believe that "python safaris" could generate substantial revenue.

Madsen & Shine

S14

Biggest mobs of snakes — water pythons (*Liasis fuscus*) in the top end. THOMAS MADSEN AND RICHARD SHINE. *School of Biological Sciences, University of Sydney, NSW 2001, Australia.* Since 1986, we have marked more than 4,000 water pythons on the Adelaide River floodplain 60 km southeast of Darwin, NT. Our mark-recapture estimates suggest that the biomass of pythons averages 0.5 to 1.0 tonnes/km^2. The main prey for all size classes of water pythons is the dusky rat (*Rattus colletti*). Rat biomass on the floodplain sometimes exceeds one tonne/km^2, but varies dramatically among years. During a period of low prey availability (1989–90), survival rates of pythons remained high but reproduction virtually ceased. In contrast, most adult female pythons reproduced in the "good" years of 1991 and 1992. Thus, the population dynamics of water pythons on the Adelaide River floodplain are heavily influenced by prey abundance, primarily via its influence on the reproductive output of the pythons.

Magnusson

C32

The rise and fall of a population of *Hyla boans*. WILLIAM E. MAGNUSSON. *Depto de Ecologia, Instituto Nacional de Pesquisas da Amazônia, CP 478, 69011-970*

Manaus AM, Brazil. A population of *Hyla boans* was studied for 10 years. It increased by about 50% from 1982 to 1988. In 1989 the population crashed to the level observed in 1982 and only one individual was seen in 1990. Intensive searches have failed to reveal the species in subsequent years. The area is relatively undisturbed, the breeding habitat is intact, and the species still occurs in other areas within the region. I believe that the crash was a natural phenomenon, perhaps caused by disease. However, if such local extinctions are typical for anurans it does not bode well for species in isolated reserves. [KEYWORDS: Amphibia, extinction, population dynamics].

Mahony

C25

Reproductive ecology of the hip-pocket frog *Assa darlingtoni* (Anura: Myobatrachidae). MICHAEL J. MAHONY. *The Dept of Applied Science and Technology, The University of Newcastle, Callaghan, NSW 2308, Australia.* To test our theoretical understanding of the evolution of sex differences, animals in which the sex roles have been reversed offer most suitable models for study. Species that have male parental care are often considered to represent cases of sex role reversal, however this should not be assumed. The first requirement in such cases is to show that sex role reversal occurs. Sex role reversal occurs when, contrary to the usual pattern in most animals, females compete more intensely than males for access to mates. This can most reliably be measured by the operational sex ratio and by comparing potential reproductive rate between males and females. These features were measured in the Australian Hip-Pocket frog *Assa darlingtoni* which shows a form of highly specialised male pregnancy. The male of this species has two lateral pouches in which the tadpoles are brooded from hatching to post metamorphosis. Preliminary results indicate that the operational sex ratio is male-biased. The number of females is equal to males in areas where breeding occurs, but observations indicate that potential reproductive rate of males is greater than that of females; males can care for more eggs than a female can produce within the same time span. Males call in small choruses, but appear to defend a small territory. When a female is attracted there appears to be no choice by the male, rather females appear to select males. However, males may mate sequentially and carry young from more than one female, usually at different stages of development. It is not known whether females can partition their reproductive effort and selected several males over the breeding season. A great deal remains to be understood about the ecological factors that have led to the mating system in this frog [KEYWORDS: parental care, operational sex ratio, parental investment, potential reproductive rate, sexual selection].

Mahony & Donnellan

S01

The origin and persistence of bisexual polyploidy in the genus *Neobatrachus* (Anura: Myobatrachidae); evidence from karyology and molecular biology. MICHAEL J. MAHONY[1] AND STEPHEN C. DONNELLAN[2]. [1]*Dept of Applied Science and Technology, The University of Newcastle, Callaghan, NSW 2308, Australia.* [2]*Evolutionary Biology Unit, South Australian Museum, North Terrace, Adelaide, SA 5000, Australia.* Bisexual polyploidy is known only in the lower vertebrates (fish and amphibians). Within the Amphibia there are less than 30 reported cases worldwide. Polyploidy followed by karyotypic and genic diploidisation has been implicated as an important step in the ancestry of vertebrates, and polyploidy is one of the few certain examples of sympatric speciation. However, we lack an adequate explanation of the rarity of polyploid speciation among animals or an understanding of the processes

involved. Karyological and molecular genetic techniques have been used to investigate the origin and persistence of bisexual polyploidy in the Australian frogs of the genus *Neobatrachus* (Myobatrachidae). Currently this genus is thought to comprise ten species, found in sub-humid, semi-arid and arid areas. Standard and differentially stained karyotypes are known from all ten species, six being diploid (2n=24) and four being tetraploid (4n=48). The tetraploids are considered to be examples of autopolyploidy, based on mitotic chromosome morphology and synapsis during meiosis. Natural hybridisation has been detected between: diploid and polyploid, polyploid and polyploid, and diploid and diploid species. Because hybridisation has been postulated to have a central role in polyploid evolution, these situations have been examined by cytogenetic and molecular techniques. The evolutionary origin of the four tetraploid species is not resolved by available karyotype data. The level of nuclear genome differentiation within and between the species has been assayed by allozyme electrophoresis. All six diploid species are well differentiated genetically, with percentage fixed differences of loci between species ranging from 11% to 59%. In contrast the tetraploid species shared electropmorphs at all the loci examined. The tetraploids were examined for the presence of electromorphs specific to individual diploid species. The majority of these electromorphs were observed in tetraploid species. Where the range of a tetraploid species contacts that of a diploid species and the diploid can be characterised by unique electromorphs, then evidence of current gene flow was found in the direction of the tetraploid populations, indicating reticulate evolution. In order to further investigate the age and mode of origin of the polyploids, sequencing of sections of the Mitochondrial genome of the various diploid and polyploid species and populations is underway.

Malhotra & Thorpe

C10

Parallels between island lizards in morphology and mitochondrial DNA. ANITA MALHOTRA AND ROGER S. THORPE. *Dept of Zoology, University of Aberdeen, Aberdeen AB9 2TN, Scotland, United Kingdom.* The selective neutrality of mitochondrial DNA is often assumed but seldom tested. Island faunas have proved valuable in providing evidence of natural selection on morphological traits. In particular, comparisons between related taxa from ecologically similar islands with independent histories has documented striking morphological parallels resulting from parallel selection. We report a study of parallels between two Lesser Antillean lizards, *Anolis oculatus* and *Anolis marmoratus* from the ecologically heterogenous islands of Dominica and Basse Terre (Guadeloupe). Not only are there many parallels in morphological traits, which are correlated with similar ecological gradients, but also in mitochondrial DNA variation. A steep morphological cline along the Caribbean coast of Dominica is examined by comparing sequence variation in the cytochrome b gene to morphological and ecological clines. Variability in cytochrome b sequences is exceptionally high, and shows striking geographical patterning. This pattern is congruent with morphological clines, and with moisture gradients along the coast. *Anolis marmoratus* shows a parallel pattern along the Caribbean coast of Basse Terre, raising the question of natural selection as a cause. [KEYWORDS: mitochondrial DNA, cytochrome b, natural selection, *Anolis*].

Malhotra et al.

C06– 104

Evolution of South-East Asian vipers. ANITA MALHOTRA[1], ROGER S. THORPE[1] AND S. CASTELLANO[2]. [1]*Dept of Zoology, University of Aberdeen, Aberdeen AB9 2TN, Scotland, United Kingdom.* [2]*Dipt di Biologia Animale, Universita di Torino, 10123*

Torino, Italy. The genus *Trimeresurus* contains a number of species (which may be sympatric) that are remarkably similar in superficial appearance. Our ongoing study of the systematics of medically significant snakes focuses on a core group of species in this genus (*T. albolabris*,*T. popeorum*, *T. stejnegeri*,*T. erythrurus*, *T. gramineus*) and involves the use of multivariate morphometry and mitochondrial DNA sequencing to study both inter- and intra-specific relationships. An example of the latter is the within-island geographic variation of *T. stejnegeri* in Taiwan. We show that geographic variation occurs in the scalation and body proportions, and evidence of a causal relationship with ecology is provided, using canonical correlations and partial Mantel tests. Head shape was found to be primarily associated with mean annual temperature and altitude, and head scalation with the annual range of temperature. Body scalation was found to be influenced by altitude, mean annual temperature and mean annual rainfall. Tail length is primarily associated with the range of temperature and rainfall and secondarily with the mean annual temperature and altitude. Geographic proximity was found to be less important in the explanation of the observed geographic pattern than some ecological factors, supporting an ecogenetic origin of morphological variation. [KEYWORDS: vipers, *Trimeresurus*, morphology, mitochondrial DNA, systematics].

Malone

C25

The impact of anuran larvae on temporary pond communities: an experimental approach. BRIAN MALONE. *Dept of Zoology, La Trobe University, Bundoora, Victoria 3083, Australia.* Anuran larvae are likely to influence community dynamics and structure of temporary ponds, where they often become the most conspicuous components of the system as a result of their high densities, rapid growth rates and large body sizes. Tadpoles are likely to play a major role in structuring temporary pond communities by regulating primary production either by grazing on algae or by releasing for photosynthesis inorganic nutrients in their faeces, and by regulating secondary production either by feeding on detritus or by providing organic nutrients in their faeces for consumption by benthic invertebrates. To investigate the effects of Brown Tree Frog (*Litoria ewingii*) larvae on a temporary pond community I used a controlled, replicated (10 times) experiment using artificial ponds constructed to be as close to identical as possible. Faunal composition, species abundances and both primary and secondary production were measured at monthly intervals over a five month period (September–January) in order to determine the influence of larvae on the characteristics of production and the structure of the community. Results of the experiment will be presented and discussed. [KEYWORDS: anuran larvae, temporary ponds, community structure, community processes].

Marantelli

S25

Observation on development in some Victorian frog species — increasing survivorship in captive anuran larvae. GERRY MARANTELLI. *24 Pascoe Street, Pascoe Vale, Victoria 3044, Australia.* Observations were made on the tadpoles of 10 species of Victorian frogs. Variation between minimum and maximum recorded larval life spans ranged from 126% in *Litoria lesueuri* to over 1000% in *Limnodynastes tasmaniensis*. Variation between minimum and maximum recorded size at metamorphosis ranged from 140% in *Geocrinia laevis* to 200% in *Litoria ewingii*. It was confirmed that water temperature and crowding effect influenced the duration of larval life and size at metamorphosis in some species. Microscopic food particles in suspension increased the

rate of development and the size at metamorphosis in most of the species investigated. A series of tanks with a continuous slow water changing system was designed and used in conjunction with a feeding regime that incorporated a high proportion of commercially available liquefied fish fry food. These techniques achieved close to 100% success rates from eggs to metamorphosis and maximised the size of frogs at metamorphosis. [KEYWORDS: tadpole husbandry, Victorian frogs, development].

Márquez

C06-105

Size of egg and tadpoles at hatching in the midwife toads *Alytes obstetricans* and *A. cisternasii*: implications for female choice. RAFAEL MÁRQUEZ. *Depto. Biología Evolutiva, Museo Nacional de Ciencias Naturales. José Gutiérrez Abascal 2. 28006 Madrid, Spain.* Male midwife toads provide parental care of the eggs on land by carrying batches of eggs twined around their ankles. The eggs carried by a male could be the result of one to three or more matings. Each male releases all the eggs in its batch at once, 23–33 days after its first mating. In the Iberian Peninsula two populations were studied: a population of *A. obstetricans* with a prolonged breeding system, and a population of *A. cisternasii* with an explosive mating system. In both cases larger males obtained more matings and more eggs. However, there was no correlation between male size and hatching percentage in *A. obstetricans*, and in *A. cisternasii*, only in one season male size was negatively correlated with hatching percentage. In both populations hatching percentage, average mass per egg, and tadpole size at hatching were all positively correlated. While in *A. obstetricans* the relationship between total number of eggs and average egg size was negative, in *A. cisternasii* the trend was positive. This trend may be due to the fact that *A. cisternasii* has to face a higher risk of desiccation of the eggs during tending, and water loss of the egg batch may be decreased in large batches with a lower surface/volume ratio. For *A. obstetricans*, egg batches with a higher number of eggs produced smaller tadpoles. This trend was not significant in *A. cisternasii*. This result suggests that the cost of mating with a male carrying a large number of eggs is reflected only in the prolonged breeder where some asynchrony may occur in the development of embryos from different females in the same male batch. [KEYWORDS: male parental care, hatching success, tadpole size, explosive and prolonged breeders].

Marquez *et al.*

C06– 111

Bioacoustical study of Bolivian leptodactylids. R. MÁRQUEZ, J. BOSCH AND I. DE LA RIVA. *Depto. Biología Evolutiva, Museo Nacional de Ciencias Naturales, José Gutiérrez Abascal 2. 28006 Madrid, Spain.* Anuran mating calls are important species-specific characteristics which may play an important role in reproductive isolation. Tropical anurans show great diversity in their mating calls. This diversity is perhaps best reflected in the family Leptodactylidae which includes species with some of the most elaborate sound displays. We analyse the mating calls of 24 species of Leptodactylidae from Bolivia. A characterisitic oscillogram and audiospectogram are presented for each species. A total of 12 quantitative variables were measured on several calls. Using multivariate and graphical techniques, we explore the intrageneric affinities between the advertisement calls. We also studied the relationship of several call parameters (duration, pulse repetition rate, dominant and fundamental frequency) with some morphological and ecological characteristics of the species (size, type of vocal sacs, habitata type). The results were finally compared at the generic and family level

with the data obtained from more than thirty additional anuran species form Bolivia. [KEYWORDS: Leptodactylidae, Bolivia, mating call].

Martin C32

Standardised survey of anurans in the Sierra Nevada. DAVID LAMAR MARTIN. *Dept of Biology, University of California, Santa Barbara, California, 93106, United States of America.* Randomised surveys to document the presence or absence of anuran populations in the Sierra Nevada of California, USA, were conducted in four National Forests from June 1992 to August 1992, and repeated in June 1993 to August 1993 with two additional forests added. The Sierra Nevada Anuran Survey Protocol, which was written for this project, was used to standardise the method of data collection and provide a survey technique which can be repeated over time. Surveys of native anurans, including the California red-legged frog (*Rana aurora*), foothill yellow-legged frog (*Rana boylii*), mountain yellow-legged frog (*Rana muscosa*), Northern leopard frog (*Rana pipiens*) Pacific chorus frog (*Pseudacris* (=*Hyla regilla*), Western toad (*Bufo boreas*), and the Yosemite toad (*Bufo canorus*) revealed extremely patchy distributions and small populations. Results from the first year's surveys indicate that *Rana boylii*, *R. muscosa* and *B. canorus* were found in only a few localities and in small populations, and should be considered for endangered status. Populations of the more common *B. boreas* and *P. regilla* also revealed reduced population sizes. *Rana aurora* was not located during any of the randomised site surveys, or during any historical locality surveys, and should be considered critically endangered. These trends suggest a large scale decline of anuran species in the Sierra and possibly a shared contributing factor to the decline of these animals. Results from the second years survey will be discussed. Utilising a standardised protocol for surveying anurans over successive years, could reveal clues as to the decline of these animals and hopefully will elicit a plan of action to help ensure their future survival. [KEYWORDS: Anuran, decline, standardised, survey, Sierra Nevada].

Martin C09

Geographic variation in life history traits of the timber rattlesnake (*Crotalus horridus*) in eastern North America. W.H. MARTIN. *Rt. 3, Box 804, Harpers Ferry, WV 25425, United States of America.* Variation in regional climates can be expected to produce variation in life history traits. I examined growth, molting, and maturation rates, and reproductive intervals in *C. horridus* populations over a 21 yr period. The primary study area is located in the Blue Ridge and the Ridge and Valley Physiographic Provinces of the Appalachian Mountains where the active season averages 5.4 months (4.9–5.9 months). Additional sampling was also done in the Piedmont and Coastal Plain of SE North America where the active season is 7–9 months and on the Allegany Plateau where the active season is 4.5 months. Growth, molting, and maturation rates, and reproductive intervals were found to be fairly predictable when examined in terms of cumulative active time. Rattlesnakes reach the extreme of their climatic limits on the Allegany Plateau where the youngest reproductive female was a 10 yr old and females reproduced at 4 yr intervals. Emergence occurs in midday and ingress in late September. Parturition usually occurs in mid to late September. Below normal temperatures during some years delayed parturition and forced pregnant females into hibernation before birthing with the result that about one third of the age-class cohorts are missing from the sample. Thus the climate, through constraints

placed on reproduction, is a primary limiting factor on the distribution of the species. [KEYWORDS: rattlesnake, active season, growth, reproduction, demography].

Immunocytochemical localisation of serotonine in the brain of *Typhlonectes compressicaudus* (Gymnophiona). LUCK MARTIN-BOUYER. *Laboratoire de Biologie Animale, Faculté Libre des Sciences, 13 rue de Toul, 59046 Lille Cedex, France.* The brain of *Typhlonectes compressicaudus* was examined in frontal sections by using immunocytochemical technics. Serotoninergic perycaya were found in different parts of the *Typhlonectes compressicaudus* brain: Hypothalamus: praeoptic nucleus and pars dorsali; Inter pedoncular ganglia; Sulcus medianus internus; Central nucleus; Raphe nucleus; Commisura intertrigemini; Tegmentum. Moreover, sectioned fibres were found in: Lateral pallium, dorsal pallium and medial pallium; Septum; Lateral forebrain bundle; Basal part of the medulla oblongata. [KEYWORDS: brain, *Typhlonectes compressicaudus*, serotonine, immunocytochemistry, Gymnophiona]. Martin-Bouyer S13

Chemical ecology of pheromonal mediation of reproduction in snakes. ROBERT T. MASON. *Dept of Zoology Oregon State University Corvallis, Oregon 97331, United States of America.* Garter snakes of the North American genus *Thamnophis*, are dependent on pheromones to initiate and mediate sex behaviour. Currently, there are three separate and distinct pheromone systems known to play a role in orchestrating sex behavior. Sex attractiveness pheromones are produced on the female's dorsal surface identify these females as reproductively active, unmated females. These pheromones have been identified as a novel series of long-chain methyl ketones. A second suite of male sex recognition pheromones is located on the male's dorsal surface. These skin lipids identify males as inappropriate individuals to court. Squalene has been identified as one of several compounds that serves this function. Finally, during and immediately after copulation, females become unreceptive and unattractive to further courtship for 24–36 hours. This copulatory pheromone can be transferred from one female to another and cause unmated females to become unattractive. Interestingly, a small subset of males produce female pheromones and not the male sex recognition pheromones. These "she-males" are courted as if they were females and essentially confuse other courting males and thus gain a reproductive advantage in the highly competitive mating aggregations. Mason S19

Male-male competition, female choice and territoriality in terrestrial salamanders. ALICIA MATHIS. *Dept of Biology, Southwest Missouri State University, Springfield, Missouri 65804-0095, United States of America.* I propose a model that describes the operation of male-male competition and female choice for species in which both males and females defend feeding territories. The model is based on experiments with *Plethodon cinereus*, but should also apply to species with similar spacing systems. Territories provide benefits in terms of energy gains, and nonterritorial individuals are predicted to attempt to win territories. Females can accept or reject potential mates. Because there is intersexual overlap of territories, females may have the opportunity to assess the quality of a male's territory as well as as other characteristics indicative of male quality (e.g. body size). Males compete to occupy the highest quality territories and also compete in direct contests over females (i.e. for courtship opportunities). Fe- Mathis S22

males can mate more than once and can store sperm for relatively long periods of time, so successful mating may not necessarily translate into the production of offspring for males. [KEYWORDS: territoriality, sexual selection, *Plethodon cinereus*].

Mavroidis & Gibson

C06–106

Thermoregulation and activity in Massasauga rattlesnakes. SPIRO M. MAVROIDIS AND A. RALPH GIBSON. *Dept of Biology, Cleveland State University, Cleveland, Ohio 44115-2403, United States of America.* We studied the activity and thermoregulatory behaviour of 9 juvenile massasauga rattlesnakes (Serpentes, Viperidae, *Sistrurus catenatus)* in the laboratory, for comparison with similar data obtained earlier for young garter snakes (Serpentes, Colubridae, *Thamnophis elegans*). The rattlesnakes were housed in an arena (2.4 × 1.8 m) where they could choose among 4 shelters, each fixed at one of four temperatures (22°C, 25°C, 30°C, or 34°C). We used a low-light video camera and time-lapse recording to provide essentially continuous assessment of activity and temperature selection over 14 weeks. Photoperiod was held constant at 12:12 LD. Once a week we fed the animals an average of 30% of their body weight. Over the 14 weeks of this study, use of the hottest shelters (30°C or 34°C shelters, HSU) declined while the level of activity and the time spent "exposed" (outside any shelter) increased. HSU increased across the light phase (0700–1900) and decreased over the dark phase; the amount of activity and time exposed were higher at night then during the day. Feeding increased HSU and decreased activity and time exposed; over the remainder of the feeding week, HSU decreased and activity and time exposed increased. During the two weeks preceding ecdysis, HSU apparently increased, but activity and time exposed decreased. Massasauga rattlesnakes are more thermophilic and less active than are garter snakes, although these behaviours are influenced by similar factors in the two species. [KEYWORDS: thermoregulation, activity, daily cycles, seasonal patterns, feeding, thermophily, molt thermophily, Serpentes, Viperidae, *Sistrurus catenatus*].

Mead & Bell

S02

Late Pleistocene and Holocene herpetofaunas of the Great Basin and the Colorado Plateau, North America. JIM I. MEAD[1] AND CHRISTOPHER J. BELL[2]. [1]*Quaternary Studies Program and the Dept of Geology, Northern Arizona University, Flagstaff, AZ 86011, United States of America.* [2]*Museum of Paleontology and the Dept of Integrative Biology, University of California, Berkeley, CA 94720, United States of America.* Together the Great Basin and the Colorado Plateau encompass approximately 726,000 square kilometers in arid western North America. The Great Basin has a remarkably dynamic record of mammalian colonisation, extirpation, and extinction. The study of the late Pleistocene mammalian community from the Colorado Plateau is extremely poor outside of the Grand Canyon. A bias in site selection is probably responsible for our relatively poor understanding of the herpetofaunas in these regions at this critical time. Most of the examined late Pleistocene localities in the Great Basin are selected for study based on the surface exposure of archaeological remains. On the Colorado Plateau the reported fossil localities are heavily biased toward packrat (Rodentia: Cricetidae: Neotoma) accumulation deposits. Lizard and snake taxa are reasonably well represented in both regions, and their remains are locally common in packrat- and raptor-accumulated deposits. Amphibian remains, especially of salamanders, are uncommon in both regions. Localities that incorporate anuran remains usually contain raptor deposits and are situated adjacent to an aquatic system. The

Pleistocene herpetofaunas of the Great Basin and the Colorado Plateau are known predominantly for only a portion of the Wisconsin Glacial (50,000 to 11,000 radiocarbon years ago) and the Holocene; remains from the previous glacial and interglacial have not been found. Packrat deposit analyses have been largely responsible for the record of late Pleistocene herpetofaunas in the two regions, however, limestone cave deposits containing raptor and small carnivore bone accumulations have also provided small but important herpetofaunal records. [KEYWORDS: Pleistocene, Great Basin, Colorado Plateau, herpetofaunas].

Meirte

C06–107

The geckoes of the Comoro Islands. DANNY MEIRTE. *Kon. Museum Midden-Afrika, Leuvensesteenweg 13, B-3080 Tervuren, Belgium.* Recent herpetological surveys on the four Comoro Islands, yielded the following results: morphological, ecological and ethological data suggest that *Phelsuma v-nigra pasteuri* of Mayotte is quite likely a separate species. Two species of the *Phelsuma lineata*-group are found, both are endemics: *Phelsuma comorensis* to Grand Comoro and *Phelsuma nigristriata* to Mayotte. Their distribution is larger than formerly accepted, although limited to higher forested zones. *Phelsuma robertmertensii*, endemic to Mayotte, lives predominantly in mangroves and the surrounding coastal area. This biotope, combined with their shy behaviour and camouflage, makes them difficult to observe. Although *Phelsuma robertmertsensii* is locally quite abundant, the agricultural impact on their biotope makes this species vulnerable. Its speciation is highly intriguing, because on this island four other *Phelsuma* species are found. Recent invaders are the larger sized *Phelsuma dubia* and *Phelsuma laticauda*, the latter only on the eastern islands Mayotte and Anjouan. In Anjouan this species enters houses and remains active at night, actually replacing *Hemidactylus frenatus.Hemidactylus* is represented both by the Asiatic *Hemidactylus frenatus* and the African *Hemidactylus mabouia.* Their ecological separation both in human habitats as in the wild are discussed. *Paroedura sanctijohannis*, endemic to the Comoros, is apparently restricted to wet forest zones. Its current presence on Mayotte and Anjouan could not be confirmed. The deforestation on the latter island is probably responsible. However, *Ebenavia inunguis*, also a forest species, was found on all islands. In this species the Comorian populations seem not to differ from the Madagascan ones. The same is true for *Geckolepis maculata*, but here the introduction is easier to explain as it is found in highly arid as well as in wet forest zones. [KEYWORDS: Comoro Islands, Gekkonidae].

Mendelson

C03

An evaluation of the systematics of the *Bufo valliceps* group of middle America. JOSEPH R. MENDELSON III. *Museum of Natural History and Dept of Systematics and Ecology, The University of Kansas, Lawrence, Kansas 66045, United States of America.* The poorly defined *Bufo valliceps* group is distributed through most of Middle America, and by some accounts includes nearly every species of *Bufo* existing in this broad and complex area. My recent work has made progress toward solving some of the systematic problems within this group. Several populations previously included under *B. valliceps* or *B. cavifrons* are worthy of specific recognition. Taxa previously considered problematic, such as *B. ibarrai* and *B. cycladen*, have been evaluated and some represent valid species. Evidence suggesting the existence of natural *B. cristatus*, *B. coccifer*, and *B. valliceps* groups is beginning to emerge, however, relationships

among these groups remains unclear. This work is based on data collected from external morphology and morphometric analyses. [KEYWORDS: systematics, Bufonidae, Middle America].

Mendelson C06–108

Comparisons of the caudal morphology of fragile-tailed colubrid snakes. JOSEPH R. MENDELSON III. *Museum of Natural History and Dept of Systematics and Ecology, The University of Kansas, Lawrence, Kansas 66045, United States of America.* Several genera of colubrid snakes (e.g. *Scaphiodontophis*,*Rhadinaea*, *Natriciteres*) from different areas of the world include species which exhibit very high frequencies of tail breakage in museum collections. This fact and recent behavioural observations suggest that tail breakage is an antipredator mechanism utilised by these snakes. These species all have relatively long tails, a feature they share with many non-fragile tailed species. Comparisons among these long tailed species has revealed a consistent caudal morphology which is associated with tail breakage. This morphology includes a long and relatively thick tail, composed of a high number of vertebrae, skeletal similarities, and males have very short copulatory apparati (hemipenis + hemipenial retractor muscle). Other workers have placed these genera into different clades indicating that tail-fragility has evolved independently several times. [KEYWORDS: tail breakage, snakes, antipredator mechanisms, morphology].

Mendelssohn C23

Social behaviour of *Agama* (*Pseudotrapelius*) *sinaita*. H. MENDELSSOHN. *Dept Zoology, Tel Aviv University, Ramat Aviv 69978, Israel.* *Agama sinaita* is a solitary, heliothermic *Agama*, inhabiting rocky deserts in the Near East. Each specimen, male and female, guards a territory that extends for 80–100 m along the lower part of rocky slopes. Most of the day is spent perching on high rocks, from which *A. sinaita* can survey the surroundings for insects. Normal activity body temperature is around 38°C. During most of the year their colour is a cryptic yellowish-brown. Males are larger (about 24 g) and have conspicuously big heads. Females are smaller (about 16 g) and have a more rounded abdomen. Breeding begins in March and continues until June. During this period males adopt a brilliant blue colour on head and shoulders, which fades and reappears within minutes, according to the social status of the male. Reproductive females have reddish-brown spots on the back, that remain unchanging as long as the female is reproductive. These spots strongly stimulate copulatory behaviour in the males. Females copulate only during oestrus, that lasts for 3–5 days. They employ two efficient methods of repulsing the male when not in oestrus: 1) blue head; 2) arched back, lifted and wagging tail, lowered head, directed towards the male and butting. These behaviour patterns are also used to evict males from female territories during the rest of the year. Males threaten one another by staring and species-specific push-ups and head bobs. When fighting, they adopt a greyish-brown colour with many small, indistinct light spots and reddish-grey heads. They move around each other in an anti-parallel fashion and butt the flanks of the adversary. The loser either flees or adopts a submissive, flat posture. Females are able to recognise submissive males as males even without the blue colour, possibly because of their large head, and behave towards them according to whether they are in oestrus or not. [KEYWORDS: *Agama*, social behaviour, colour change, reproduction, communication].

Menzies S07

Patterns of distribution in the frogs of New Guinea. J.I. MENZIES. *University of Papua New Guinea, Port Moresby, New Guinea.* The frog fauna of New Guinea is composed almost equally of members of the Hylidae and Microhylidae with Ranidae and Leptodactylidae playing a relatively small part. The relationships of the New Guinea Hylidae are clearly with the Australian fauna. The relationships of the New Guinea Microhylidae, all belonging to endemic genera, with those of the Indo-Malayan region are obscure. The following distribution patterns may be discerned. Some lowland species (e.g. *Litoria infrafrenata*) are widespread, and may extend beyond the borders of New Guinea. Some lowland species are restricted to southern New Guinea (e.g. *Litoria timida*) while others occurring in southern New Guinea are shared with northern Australia (e.g. *Litoria rothi*). Lowland species with a northern-only distribution include *Rana papua*. Patterns of distribution among the montane fauna are less clear as many species are known from their type localities only. Some species (e.g. *Litoria angiana*) appear to occur throughout the mountains but the possibility of sibling species within such species cannot be discounted. Clearer patterns are presented by species of *Xenobatrachus* and *Barygenys*. The first genus is restricted to the western half of New Guinea and the other to the eastern half with little overlap. Such patterns are almost certainly related to the complex geological history of New Guinea. [KEYWORDS: New Guinea, frogs, distribution].

Mills & Hudson C09

Population ecology of *Nerodia taxispilota* on the Savannah River, USA. MARK S. MILLS AND CHRIS J. HUDSON. *University of Georgia, Savannah River Ecology Laboratory, Drawer E, Aiken, SC 29802, United States of America.* *Nerodia taxispilota* (brown water snake) is common in the southeastern United States. A study of this species on the Savannah River adjacent to the Dept of Energy's Savannah River Site is being conducted to investigate basic questions about their ecological role in this system. From 16 May 1992 to 25 June 1993, we marked 241 *N. taxispilota* with passive integrated transponders (PIT tags). The sex ratio was near unity (1:0.94), and we sampled all size classes. We estimated that there were approximately 41 snakes/km of river, although their distribution was patchy and seemed to be associated with higher water velocity. Fifty-three percent of the recaptured snakes moved less than 100 m and two snakes moved greater than 1000 m. Ten percent crossed the river, and these were all larger snakes (>80 cm SVL). Nineteen percent had food in the gut, and of the identifiable items 70% were catfish (Ictaluridae). Based on observation and radiotelemetry data, the brown water snakes in our study area were active year round. [KEYWORDS: *Nerodia taxispilota*, snake, PIT tag, ecology, movement, diet].

Mirtschin *et al.* S30

Snake bite in humans and domestic animals can be used as a guide for a decline in snakes and small native animals. P.J. MIRTSCHIN[1], S. SUTHERLAND[2], J. CANN[3], D. PATON[4] AND P. MASCI[5]. [1]*Venom Supplies, PO Box 541 Tanunda, SA 5352, Australia.* [2]*Commonwealth Serum Laboratories Ltd, 45 Poplar Rd, Parkville, Vic 3052, Australia.* [3]*26 Yarra Way, Phillip Bay, NSW 2036, Australia.* [4]*Dept of Zoology, The University of Adelaide, SA 5005, Australia.* [5]*Dept of Medicine, University of Queensland, Brisbane, Qld 4102, Australia.* Antivenom used to treat humans envenomated by dangerous snakes fell from 196 in 1979 to 89 cases in 1990 despite the use of non-snake antivenoms either remaining the same or increasing. One interpreta-

tion of this is that snake numbers and therefore their food animals have also declined dramatically. In a survey of 10% of Australia's 3,300 veterinary surgeons. we were able to establish a baseline in domestic animal envenomation for use as an indicator of snake population status (and therefore small animal status). While most snake types appear to have declined, brown snakes, *Pseudonaja* spp., are now causing the highest human death rates in Australia (61%) and likewise, 72% of all bites to domestic animals are caused by this genus. The claim therefore, that there has been an apparent increase in the status of this genus has some credence. Cats and dogs received the highest incidence of snake bites. Due to the established high tolerance to snake bite in cats (over 3 times more resistant than dogs to *Notechis* envenomation), which suggests many are bitten without being noticed, it is likely that these highly destructive introduced animals are preying on many snake species of all sizes. The fact also that they prey on many animals which form part of most snake diets could mean they are one of the main causes for snake population decline. [KEYWORDS: antivenom, snake population status, domestic animals, envenomation, small animals, baseline, decline].

Misyura *et al.*

C06–110

Some biochemical peculiarities of anurans under technogenic impact. ANDREW N. MISYURA, OLGA V. POLOZ AND SERGE V. CHERNYSHENKO. *Biology Institute, State University, 72 Gagarin Ave., 320010 Dnepropetrovsk, Ukraine.* Anurans are closely linked to aquatic environment in the breeding season. Just this environment are subjected to strong pollution to a large extent. Our study was conducted in the zone of entering sewage of chemical and metallurgical plants. The animals from the biotopes of the Dnieprovsko-Orelsky Nature Reserve were as a control. The study showed the presence of modifications of protein, lipid and hydrocarbon metabolism of anurans. That manifested as the altèration of free and bonded amino acids proportion, of lipid fractions and of hydrocarbons level in liver, skin and muscles. All these modifications were different for various species. As this take place, it is observed the distinctions in stability state of four amphibians species inhabiting biotopes adjoining sewage. The most stable to toxicants impact was the background species - the lake frog *Rana ridibunda* immediately inhabiting sewage. In descending order of stability, other species ranked as follows: *Bombina bombina*, *Pelobates fuscus* and *Rana arvalis*. Populations of all investigated species are characterized by absence of larvae in polluted water bodies and by absence or extremely low abundance of underyearlings and young (1–2 years old). Apparently, the biochemical changes may be considered in prognosis making of the state of anurans populations. [KEYWORDS: anurans, biochemical indices, population stability, prognosis].

Mohanty-Hejmadi & Mahapatra

S05

Induction of homeotic transformation in anurans by vitamin A. P. MOHANTY-HEJMADI AND P. MAHAPATRA. *Dept of Zoology, Utkal University, Vani Vihar, Bhubaneswar-751 004, Orissa, India.* Homeotic transformation was induced by Vitamin A in tadpoles in four species of anurans, the common Indian toad *Bufo melanostictus*, the marbled balloon frog *Uperodon systoma*, the common Indian jumping frog *Polypedates maculatus* and the ornate frog *Microhyla ornata*. Following amputation through the middle of the tail at the hind limb bud stage, tadpoles were exposed to 10IU per ml vitamin A palmitate for 24, 48, 72, 96, 120 and 144 h. There was retardation in development as metamorphosis was delayed in the experimental sets. Longer treatment

suppressed growth of tails. The most stunning result was the development of ectopic supernumerary limbs from amputated tail stumps in all the four species. This revealed that Vitamin A can cause radical reprogramming of tail tissues in causing homeotic transformation into legs. The ectopic hind limbs (EHL) were shorter than the corresponding normal hind limbs (NHL). The proximal elements of the skeleton in the limbs were similar, however, there were many anomalies in the distal elements of the skeleton between the EHL and NHL.

Moody

C06–114

A critical review of the phylogenetic classifications of iguanian acrodont lizards (Agamidae, Chamaelontidae, Leiolepididae). SCOTT M. MOODY. *Museum of Zoology, Ohio University, Athens, OH 45701, United States of America.* During the past decade, different phylogenetic classifications of the iguanian lizards have been proposed and argued by several herpetologists (Moody, Estes, Gauthier, Etheridge, de Queiroz, Frost, Williams, Lazell, Bohme, Klaver, Joger, Borsuk-Bialynicka, Rieppel, Ananyeva etc.). The families Agamidae, Chamaeleontidae and Leiolepididae comprise a monophyletic taxon (referred to by some workers as the Acrodonta) characterised by the synapomorphy of acrodont cheek teeth and other features, but some have questioned the homology of this tooth character. The cladistic position of the chamaeleons within the "acrodonta" varies depending on which characters are weighted. Congruence of morphologically defined clades with continental drift depends on which plate tectonic model of eastern Asia is accepted and used. Recognition of the above traditional families as only subfamilies ignores the data suggesting divergence times in the Mesozoic. This presentation will be synthetic (all evidence) review of morphology, fossils, molecules and historical biogeography. The resultant phylogeny will focus on testable hypotheses for future work. [KEYWORDS: Agamidae, Chamaeleontidae, Leiolepididae, phylogeny].

Moody

C06–113

Wallace's line and the basal clades within the Agamidae (Iguania, Lacertilia) or do morphologies and molecules clash. SCOTT M. MOODY. *Museum of Zoology, Ohio University, Athens, OH 45701, United States of America.* Darlington, in his classic book on zoogeography, discussed several animal distributions which violated (crossed over) Wallace's Line in the Indonesian Region. Several of the taxa were lizards of the family Agamidae. Moody (1980) revised the family at the generic level and discovered that several of the "violations" were the result of polytypic genera. Two genera which continued to straddle the line comprise the water dragons *Physignathus* and *Hydrosaurus*: on the basis of numerous morphological characters, they are representative of the most primitive agamids. The two large monophyletic derived groups of agamids are the Australian-Papuan and the Asian-African radiation. Evolutionary divergence of these two clades is congruent with the tectonic underpinning of Wallace's Line. So it is of interest that the two species of *Physignathus* exist on both sides: *cocincus* in SE Asia and *lesueurii* in Australia. A recent cladistic analysis, however, demonstrates that *Physignathus* is paraphyletic, with *lesueurii* and *Hydrosaurus* sharing a common ancestor, with *concincus* being the sister group. I am now examining sequence data for the water dragons compared with several other agamid representatives. [KEYWORDS: Agamidae, Wallace's Line, phylogeny, biogeography].

Moore & Hews

S10

Alternative reproductive strategies in tree lizards (*Urosaurus ornatus*): hormonal influences during early development. MICHAEL C. MOORE AND DIANA K. HEWS. *Dept of Zoology, Arizona State University, Tempe, Arizona 85287-1501, United States of America.* Alternative reproductive strategies are often associated with multiple male morphs that differ in traits known to be influenced by hormones such as colour, size and behaviour. However, little is known about how hormones influence differentiation of these morphs. We studied the tree lizard, a species with territorial and nonterritorial morphs which differ in size, behaviour and colour. First, we measured levels of the steroid hormones testosterone, dihydrotestosterone and corticosterone. These hormones are known to exert the greatest influence over expression of male secondary sex characters. Nevertheless, the levels did not differ between adults of the two morph types. This suggested a role for these hormones early in development analogous to the organisational role that sex steroid hormones play to bring about permanent differences between the sexes. To test this hypothesis, we manipulated levels of testosterone on the day of hatching in male tree lizards. Castrated hatchling male tree lizards all developed into the nonterritorial morph, whereas testosterone-implanted hatchlings developed almost entirely into the territorial morph. These results suggest that within-sex differentiation may be influenced by hormones through a mechanism identical to that operating during sexual differentiation. They further suggest more generally that early hormone differences may be a significant cause of inter-individual differences in behaviour and morphology. [KEYWORDS: hormones, territoriality, *Urosaurus*, lizard, reproduction].

Moreira & Barreto

C06–115

Effect of seasonal variation in rainfall and temperature on anuran diversity in a savanna of central Brazil. GLÓRIA MOREIRA[1] AND LARISSA BARRETO[2]. [1]*Dept de Ecologia, INPA, CP478, Manaus, CEP 69083, AM, Brazil.* [2]*Dept de Biologia, UFMA, Largo dos Amoles 21, CEP 65020, São Luis, MA, Brazil.* Diversity patterns of a male breeding comunity were followed in a permanent pond located close to the city of Brasilia (15°S 47°W). The number of calling males appearing during the night in a period of 15 months was counted and the diversity was calculated based on the maximal number of calling males. The Shannon-Weaver index and species richness reached their highest values in the period of October to December (first half of the rainy season). The lowest values were measured in the driest and coldest months (June and July). The diversity was significantly correlated to previous week total rainfall, but there was no significant correlation with previous month total rainfall. This effect can be clearly observed for some species such as *Bufo paracnemis*. This species had a short reproductive period of two months, that was synchronised with the first rains at the onset of the rainy season. The Shannon-Weaver index was also positively correlated with minimum monthly temperature and inversely related to the monthly range in air temperature. [KEYWORDS anuran diversity, Central Brazil, savanna, reproduction].

Mori

S21

Antipredator behaviour of Japanese lacertid lizards against a snake predator. AKIRA MORI. *Dept of Zoology, Faculty of Science, Kyoto University, Sakyo, Kyoto, 606-01 Japan.* Behavioural responses of the Japanese lacertid lizard, *Takydromus tachydromoides*, to its natural snake predator, *Elaphe quadrivirgata*, and to a sympatric non-predator lizard, *Eumeces latiscutatus*, were examined under laboratory conditions. *Takydromus tachydromoides* moved significantly less frequently in the presence of *Elaphe quadrivirgata* than in the presence of *Eumeces latiscutatus*. It is suggested that immobility of *T. tachydromoides* is an antipredator behaviour to avoid detection by a visually orienting predator. Just before fleeing away from an approaching snake, *T. tachydromoides* often thrashed its tail rapidly from side to side for short intervals (less than 0.5 sec). This tail vibration behaviour appears to distract the snake away from the vulnerable parts of the body to the tail, since tail vibration occurred more frequently when the head of the snake was closer to the lizard's head than its tail. [KEYWORDS: antipredator behaviour, tail vibration, immobility, *Takydromus tachydromoides*, *Elaphe quadrivirgata*].

Mori

C06–116

Development of prey-handling behaviour in three species of young ratsnakes. AKIRA MORI. *Dept of Zoology, Faculty of Science, Kyoto University, Sakyo, Kyoto, 606-01 Japan.* The feeding behaviour of *Elaphe quadrivirgata*, *E. climacophora* and *E. taeniura* on mice was observed to examine differences across species and age groups with respect to effects of prey size on prey-handling method, direction of ingestion, and condition of prey at ingestion (alive or dead). Three age groups, hatchlings, yearlings (about one year old), and juveniles (about two years old) were compared. Feeding behaviour of *E. climacophora* and *E. taeniura* was similar to each other in all age classes. *Elaphe quadrivirgata* showed less efficient feeding behaviour in mouse predation compared to the other species. Feeding behaviour of hatchlings was more similar to that of adults in *E. climacophora* and *E. taeniura* than in *E. quadrivirgata*. Further, the former two species attained adult-like behaviour in shorter period than the latter. The relationship between the ontogenetic differences of feeding behaviour among these snakes and their natural food habits are discussed. [KEYWORDS: prey-handling, constriction, behavioural development, *Elaphe quadrivirgata*, *Elaphe climacophora*, *Elaphe taeniura*].

Moritz

S01

Inferring population histories from intraspecific phylogeny. CRAIG MORITZ. *Centre for Conservation Biology and Dept of Zoology, University of Queensland, Qld 4072, Australia.* The ability to construct phylogenies of alleles as well as examining their distribution has greatly increased our ability to investigate the history of species, in particular to make inferences about historical biogeography. Studies of "intraspecific phylogeography" have most often used restriction site or sequence variation in mitochondrial DNA, this molecule being particularly effective because of its rapid evolution and clonal inheritance. These approaches will be illustrated by studies of the historical biogeography of a ring species of salamander (*Ensatina eschscholtzii*) and of parthenogenetic lineages of the gekko (*Heteronotia binoei*). The approach needs to be extended to single copy nuclear genes in order to test for congruence of gene and organismal phylogenies. Some progress in this direction will be discussed in relation to rainforest skinks (*Gnypetoscincus* spp.).

Moritz

P6

Applications of genetics to the conservation and management of natural populations. CRAIG MORITZ. *Centre for Conservation Biology and Dept of Zoology, University of Queensland, Qld 4072, Australia.* Population genetics has assumed a prominent place in conservation biology, particularly in relation to the management of

insular or critically threatened species. Studies of insular reptiles have been important in developing the principles of conservation genetics and continue to be an important testing ground for new ideas. Assays of molecular variation can contribute to conservation in two distinct ways; (i) in the description and management of evolutionary and genetic diversity; and (ii) as a tool for investigating population processes. These two applications have often been confounded, reducing the effectiveness of the use of genetics in conservation. The former application includes the recognition of cryptic species and "evolutionary significant units". The latter application includes studies of population fragmentation and the use of genetic markers to define breeding populations and, for migratory species, to measure the contributions of different stocks to mixtures in feeding grounds or harvests. These applications will be illustrated primarily by ongoing studies of rainforest-restricted lizards and of marine turtles.

Moyer *et al.*

C06– 117

Photothermal influences on melatonin rhythms in pineal explants obtained from the gekkonine gecko, *Christinus marmoratus*. R.W. MOYER[1], B.T. FIRTH[1] AND D.J. KENNAWAY[2]. [1]*Dept of Anatomy and Histology, The University of Adelaide, SA 5005, Australia.* [2]*Dept of Obstetrics and Gynaecology, The University of Adelaide, SA 5005, Australia.* It is generally accepted in reptiles that both environmental light and temperature influence the production of pineal melatonin, which serves as a chemical signal for synchronising the appropriate circadian and circannual physiological events with the environment. Recent work in diurnal reptiles suggests that temperature may well have a more profound effect on pineal melatonin synthesis than light. In this sense, the gekkonine gecko *Christinus marmoratus* (a nocturnal parietal eyeless lizard of temperate regions of Australia) offers an interesting model due to its photophobic habits, suggesting that thermal stimuli are the main environmental cues modulating the melatonin message. Pineal organs were explanted from the animals and kept in superfused culture over a 5 day period under different photothermal regimes. Culture medium was collected every two hours and melatonin determined by RIA. Our results indicate that superfused pineal explants are sensitive to light in spite of possessing rudimentary photoreceptor elements. Pineal melatonin secretion is damped and becomes desynchronised during constant light, but seems capable of re-entraining to a 12L:12D photoperiod, albeit with a lower amplitude. Melatonin production completely ceased at a constant temperature of 37°C in a 12L:12D photoperiod. Amplitude was much larger at 30°C than at 20°C. At 10°C melatonin production was detectable although rhythmicity was lost. Temperatures in the 20–30°C range did not significantly affect the period of the melatonin secretion rhythm under a 12L:12D photoperiod. Temperatures in the 10–30°C range are frequently encountered by these animals in nature. The profound effect of thermal changes within this range on the production of melatonin *in vitro* indicates that temperature may be an important factor in the circadian organisation of these animals. Efforts to determine the relative importance of light are presently in progress.

Müller *et al.*

S05

Structure and pattern in retinoid-induced ectopic limbs of anuran tadpoles. GERD B. MÜLLER, JOHANNES STREICHER AND ROMANA WURM. *Dept of Anatomy, University of Vienna, Währingerstraße 13, A-1090 Wien, Austria.* Ectopic limb development was induced in regenerating tails of *Rana temporaria* and *Rana ridibunda* tadpoles, applying the retinoid method of Mohanty-Hejmadi *et al.* 1992 (see also present symposium). The study investigates how complete such ectopic limbs are in terms of their cellular composition and their morphological differentiation. The patterns of internal structures of ectopic limbs are compared with those in normal hindlimbs. The data are interpreted within the framework of current models of pattern formation in vertebrate limbs. [KEYWORDS: retinoic acid, limb development, pattern formation].

Müller

P2

Patterns of distribution analysis: for a better understanding of phylogeny, landscape history and conservation strategies. PAUL MÜLLER. *Institute for Biogeography, University of Saarland, 60041 Saarbrucken, Germany.* Biogeography is the evaluation of the patterns of distributions of populations in space and time, by means of clarification of the structure, history, function and indicator significance of the "Arealsystems". The subject is a quantative attempt at deciphering the information available from the patterns of distributions concerning the ecological potential, genetic variability and phylogeny of populations and biotic communities as well as the spatially and temporarily varying behaviour of environmental factors. In recent years, the concepts and methods of quantative biogeography and dispersal centres have produced new information to explain the evolution of the animals, the dynamics of patterns of distribution and the landscape history. But biogeographical data bases are not only important for the reconstruction of the phylogeny of taxa and landscape evolution. The relationships among refuge area phases, ecological changes in those areas, migrations, genetic differentiation, and patterns of distribution dynamics can be used today as an important basis for developing better conservation strategies. It is desirable to know the spatial distribution of each plant and animal group, but difficulties arise. On the one hand, the task is made more difficult by world wide anthropogenic changes, and the burden on the ecosystems and individual animal species; on the other hand, it is gaining increasing importance due to the fact that living organisms, once their ecological potentials have been assessed, can be used as indicators of environmental quality.

Murphy & Myers

C23

The behavioural ecology of wild *Phelsuma astriata semicarinata* on Aride Island Nature Reserve, Seychelles. TRICHA J. MURPHY AND ALAN A. MYERS. *Dept of Zoology, Lee Maltings, Prospect Row, University College Cork, Ireland.* A population of the diurnal gecko *Phelsuma astriata semicarinata* was studied during the wet season in a banana grove situated on the plateau area of Aride Island Nature Reserve. The geckos were identified on the basis of individual characteristics or colouring on the body. Four other species of reptile occurred in the site (*Mabuya sechellensis*,*M. wrightii*,*Ailuronyx seychellensis* and *Lycognathopis seychellensis*) as well as a number of bird species. The diurnal activity rhythms of *Phelsuma* showed a typical bimodal pattern which was correlated with perch height above the ground-geckos basking higher in the vegetation in the morning, retreating at midday to shaded areas of the trunk and feeding from banana inflorescences in the late evening (*Phelsuma* feed on nectar and pollen from inflorescences). Perch height was also significantly correlated with sex, males perched higher than females and spent more time in the top third of the vegetation. A dominance hierarchy was determined and dominant individuals were also found to occupy significantly higher perches. Dominant individuals exhibited a higher site fidelity than submissive animals but this was not related to the presence

of inflorescences. Co-occurrences between males and females were more likely to occur than between individuals of the same sex but females were more likely to co-occur than males. Matings were observed and an epigamic display-action-pattern was established. Hind-leg lifting and 'chik-chik' vocalisations were negative responses by females to male courtship advances. [KEYWORDS: *Phelsuma*, activity, perch height, dominance, site fidelity, epigamic displays].

Mushinsky *et al.*

C12

Anuran biodiversity on an upland habitat in Florida. HENRY R. MUSHINSKY, EARL D. MCCOY, AND PABLO R. DELIS. *Dept of Biology, University of South Florida, Tampa, Florida 33620, United States of America.* Recent reports have alerted the scientific community to a possible global decline in amphibian populations. The paucity of long term studies, however, coupled with acute fluctuations of amphibian populations have hampered attempts to verify changes in amphibian populations. We report our findings from a seven year study (1982–88) of anuran occurrence on a xeric upland sandhill habitat which is partially surrounded by a riverine swamp. The upland habitat has been subject to periodic controlled burning since 1976. We captured 2,396 individuals from 13 species; the four most abundant speclies comprised over 98% of the anuran community. Repeated controlled burning had little influence on the abundance of most anurans. Distance of a plot from the edge of the nearby wetlands was correlated inversely to the number of anurans captured. We found positive correlations among monthly rainfall patterns and monthly captures of anurans. Anuran abundance varied by an order of magnitude, from a high of 22.8, in 1982, to a low of 1.8 individuals per trap array in 1984. Three of the four most abundant species, *Bufo terrestris*, *Gastrophryne carolinensis*, and *Scaphiopus holbrooki*, are burrowing species that likely spend much time on the upland sandhill habitat. Each of these species exhibited considerable annual variation in number of individuals captured per unit effort and their variation was asynchronous. [KEYWORDS: Anurans, conservation, fire, population fluctuation, rainfall, upland habitat].

Musso *et al.*

S16

Possible biological agents for the control of *Bufo marinus*. MA.CRISTINA MUSSO[1], GUSTAVO LOPEZ[1], C. LUISA LOUREIRO[1], HELEN GARNETT[2] AND FERDINANDO LIPRANDI[1]. [1]*Centro de Microbiologia y Biologia Celular, Instituto Venezolano de Investigaciones Cientificas, Aptdo 21827, Caracas 1020-A, Venezuela.* [2]*Australian Nuclear Science and Technology Organisation, Lucas Heights, NSW 2234, Australia.* *Bufo marinus* was introduced into northern Australia in 1935, and since then it has spread rapidly. Because of the detrimental effects *B. marinus* is thought to have on Australian native fauna, there has been interest in the feasibility of developing biological control techniques. Several microorganisms have been reported to cause disease in *B. marinus*, however none of these agents appears suitable for bio-control and there have been no published virological studies of this species. We screened eighty-eight adult *B. marinus* for the presence of viral agents; males and females, sick and healthy in appearance, from a variety of sites in Venezuela. DNA cytoplasmic viruses were isolated from the blood and organ cultures of five toads, and these are currently being cultured and characterised. These results, and their pathogenic implications, will be discussed. [KEYWORDS: *Bufo marinus*, virus, disease, Venezuela, biological control].

Muth

C11

Biopolitics and biology: the creation of a habitat conservation plan for the Coachella Valley fringe-toed lizard. ALAN MUTH. *Boyd Deep Canyon Desert Research Center and Dept of Biology, University of California, Riverside, CA 92521, United States of America.* *Uma inornata* is listed as and Endangered Species by the State of California and as a Threatened Species by the US Fish and Wildlife Service. *U. inornata* is endemic to the Coachella Valley of Southern Claifornia, and is restricted to Aeolian sand habitats. Aspects of the biology of the species are reviewed in relation to aeolian environments and the loss of habitat development of luxury resorts. The process leading from confrontation to conservation is discussed as is the creation of a Habitat Conservation Plan (HCP) to ensure the survival of the species while allowing the taking of the species in otherwise lawful activity. The plan provided mechanisms for funding and acquisition of three reserves. Ongoing monitoring and management of the reserves are discussed. The HCP and political processes developed in the Coachella Valley can serve as models for other conservation efforts.

Nagy & Bradshaw

S11

Energetics, osmoregulation and food (consumption by free-living desert lizards (*Amphibolurus nuchalis*): K.A. NAGY[1] AND S.D. BRADSHAW[2]. [1]*Dept of Biology, University of California, 405 Hilgard Avenue, Los Angeles, CA 90024-1606, United States of America.* [2]*Dept of Zoology, University of Western Australia, Nedlands, Perth, WA 6009, Australia.* The ecophysiology of the agamid lizard *Amphibolurus nuchalis* was studied near Shark Bay, Western Australia, during three seasons, over three years. We measured water influx and efflux rates and field metabolic rates with doubly labelled water, sodium fluxes with radiosodium, and osmotic status (plasma osmotic and ionic concentrations) in free-ranging adults of both sexes, as well as juveniles. Feeding rates were calculated from diet composition information in conjunction with rates of water and sodium intake, and body condition indices were also determined. There were marked seasonal differences in body condition, and in rates of body mass gain or loss. These changes apparently were correlated with seasonal variation in feeding rates. Plasma osmotic concentration varied seasonally as well, reflecting high NaCl concentrations in autumn of one year. The annual pattern of energy, water and salt balance in this species was compared with those of other species of desert reptiles. [KEYWORDS: condition index, doubly labelled water, field metabolic rate, Na turnover, water flux].

Nardi *et al.*

S01

The European plethodontid salamanders and their evolutionary relationships: a cytomolecular approach. I. NARDI, R. BATISTONI AND S. MARRACCI. *Dept of Physiology and Biochemistry, University of Pisa, 56100 Pisa, Italy.* *Speleomantes* (formerly *Hydromantes*) is the only member of the Plethodontidae family living in Europe, where it is confined to small areas in south-eastern France, north-central Italy and Sardinia Island. The taxonomy of the European plethodontids has been reinvestigated on the basis of morphological, electrophoretic and karyological data and they are currently thought to consist of six species. In spite of such comparative studies, the relationships within *Speleomantes* remain an open question. Another problem still unresolved concerns the origin of *Speleomantes* as well as its relation to the American *Hydromantes* species. To gain further insight into the evolution of this group of plethodontids we have carried out a characterisation of the *Speleomantes* genome by a

combined karyological and molecular approach utilising both chromosome *in situ* hybridisation and molecular analysis of three repetitive DNA families. The data obtained have been used to infer a phylogenetic framework describing relations between *Speleomantes* species. Interestingly, all the three repetitive DNA families are absent from the genome of the American *Hydromantes shastae*, a member of the closest relatives of the European *Speleomantes*, of which they were considered congeneric until recently. [KEYWORDS: Urodele, Amphibians, genome evolution, repetitive DNA].

Naulleau & Bonnet

S11

Comparative reproductive strategies in female *Vipera aspis* (viviparous) and *Elaphe longissima* (oviparous). GUY NAULLEAU AND XAVIER BONNET. *C.N.R.S., Centre d'Etudes Biologiques de Chizé, F-79360, Villiers en bois, France.* In *Vipera aspis* and *Elaphe longissima* studied in West Central France, there is a positive relationship between maternal body length and clutch size. Using a Body Condition Index (BCI), we have shown that body reserves (fat bodies, liver) must exceed a certain threshold for reproduction to take place, both in *V. aspis* and *E. longissima*. Nevertheless the value for this threshold is much higher in *V. aspis*(0.7 as compared to 0.55) which needs large body reserves for complete vitellogenesis. BCI at the beginning of vitellogenesis correlated strongly with the litter size in *V. aspis*; this effect was stronger than that of maternal body length. There is therefore a trade-off between maternal body length and BCI since both influence reproductive success positively, and resources used for growth are not available for reserves. This relationship does not exist in *E. longissima*. After laying, mean BCI in female *E. longissima*(0.51) was close to the reproductive threshold value (0.55), thus females may reproduce in successive years. By contrast, postparturiant female *V. aspis* have very low BCIs (0.51) relative to the reproductive threshold (0.7) and need one or more years to recover their body reserves to reproduce again. Maternal body length is an important determinant of reproductive success in females *E. longissima*. After reproduction female *V. aspis* invest energy intake into recovery of reserves and *E. longissima* invest energy intake into growth. These differences are related to the contrasting ecology and morphology of the two species: ambush predation, moderate locomotor performances, short excursions, high population density and stocky-fat bodies in *Vipera aspis*; active predation, high locomotor performances, long distance excursions, low population density and long muscular bodies in *Elaphe longissima*. The mean number of offspring are similar in the two species (6 to 7) but the reproductive strategies are very different. Female *V. aspis* can reproduce without feeding, all reproductive females have large body reserves (BCI $\geq$ 0.7). Every year only 30% of the females are potentially reproductive in the wild, although the diet is very specialised (98% micromammals) the influence of food availability remained relatively moderate during the year considered. The reproductive strategy in *V. aspis* is based on a reproductive cycle of 3 years (the time to reach a BCI $\geq$ 0.7). In female *E. longissima* reproduction requires good foraging success, indeed some reproductive females have little body reserves. About 80% of the females are potentially reproductive, the diet is eclectic and may compensate the fluctuations of prey availability. In *E. longissima* the reproductive strategy is based on a annual cycle, vitellogenesis being dependent on foraging success, the reproductive threshold of BCI is linked to general body condition which enable the females to be efficient predators. [KEYWORDS: body condition, reproduction, trade-off].

Newman

S23

Recovery of McGregor's skin, *Cyclodina macgregori*, following removal of mice from Mana Island, New Zealand. DONALD G. NEWMAN. *Science and Research Division, Dept of Conservation, PO Box 10-420, Wellington, New Zealand.* In August 1989 a programme was commenced to eradicate mice from Mana Island (217 ha); no mice or their sign have been seen there since February 1990. Mana Island is one of four known island habitats of McGregor's skink, *Cyclodina macgregori*, the other three each being rodent-free and < 5 ha in area. During the past 10 years, all captures of McGregor's skink on Mana Island have been within a small area (< 5 ha) along the NE coast. Study of *C. macgregori*, started prior to the mouse eradication programme, revealed a significant decline in capture rate (pitfall traps) of the threatened lizard during autumn 1988. This decline is attributed to increased predation by mice following a build-up of mouse numbers after cattle (the only stock then present) were removed from the island in April 1986. With cattle gone, pasture grasses became rank and in season went to seed providing high quality food able to sustain intensive breeding by mice. The capture of 10 juvenile *C. macgregori* between November 1988 and March 1990 indicated that breeding of the skink was still occurring and suggested that the population, although depleted, had the capacity to recover once mice had been removed. Indeed, continued monitoring has revealed significant increases in both total captures and individuals of *C. macgregori* caught each trapping season since the 1989/90 summer. Of 64 individuals caught to April 1988, only three have been recaptured since February 1990 (when the last mouse was caught). [KEYWORDS: *Cyclodina macgregori*, species recovery, conservation, *Mus musculus* eradication].

Nilson *et al.*

C08

Systematics and phylogeny of the vipers of Caucasus. Göran Nilson[1], Boris S. Tuniyev[2], Nikolai Orlov[3], Mats Höggren[4] and Claes Andrén[1]. [1]*Dept of Zoology, University of Göteborg, Sweden.* [2]*Caucasian State Biosphere Reserve, Sochi, Russia.* [3]*Zool. Inst., Russ. Acad. Sciences, St Petersburg, Russia.* [4]*Dept of Genetics, University of Uppsala, Sweden.* The alpine *Vipera dinniki* populations in upper Great Caucasus show a pronounced and geographical polymorphism. Different morphs can be represented within the same litter in certain populations. *Vipera dinniki* is further found to be locally sympatric with the Caucasian representative of the *Vipera ursinii* complex. This last taxon shows a similar degree of polymorphism, which is a unique phenomenon for the *ursinii* complex. Due to morphological and molecular distinction both are considered it to be evolutionary taxonomic units. Separate and combined cladistic analyses of morphological and biochemical characters yielded largely congruent cladograms. The montane populations of Great Caucasus comprise of two polymorphic species; *dinniki* throughout the whole range and locally sympatric with '*ursinii*' in central and east parts. *Vipera kaznakovi* occurs at lower altitudes, *Vipera renardi* on the steppes at the north and *Vipera* (*ursinii*) *eriwanensis* at the south. *Vipera darevskii* is an isolated Armenian taxon of this complex. [KEYWORDS: Viperidae, *Vipera*, Caucasus, taxonomy, phylogeny].

Nishikawa *et al.*

S04

Functional morphology of tongue protraction in frogs. KIISA C. NISHIKAWA[1], DAVID C. CANNATELLA[2] AND JAMES C. O'REILLY[1]. [1]*Dept of Biol. Sci., Northern Arizona University, Flagstaff, Arizona 86011, United States of America.* [2]*Texas Memorial Museum, University of Texas, Austin, Texas 78705, United States of Amer-*

ica. Previous studies of tongue protraction in toads proposed a ballista model, in which the tongue is "stiffened" into a rod that is catapulted out of the mouth by the contraction of wedge-shaped muscles at the base of the tongue. This model was tested in a several anuran species using high-speed video motion analysis and nerve transection experiments. These experiments show that at least three different mechanisms are used for tongue protraction. (1) In *Bufo* the wedge-shaped submentalis muscles are not necessary for tongue protraction, and the tongue is pulled forward out of the buccal cavity by contraction of the genioglossus muscle. A similar mechanism is found in discoglossoids, except that the tongue is much shorter. (2) In *Spea*, the hyoid is not fused to the cranium, and protraction of the hyoid is also necessary for protraction of the large tongue. (3) In termite-eating *Hemisus* tongue protraction is accomplished by a hydrostatic mechanism. Microhylids appear to use a similar mechanism for aiming the tongue. The diversity of tongue protraction mechanisms found among frogs is consistent with our phylogenetic studies which show that highly protrusible tongues have evolved several times independently.

Norman *et al.*

S18

Inferences about feeding ground distributions from genetic markers. J. NORMAN[1], C. LIMPUS[2], J. MILLER[3] AND C. MORITZ[1]. [1]*Dept of Zoology and Centre for Conservation Biology, University of Queensland, Brisbane, Qld 4072, Australia.* [2]*Dept of Environment and Heritage, PO Box 155, Brisbane, Qld 4000, Australia.* [3]*Dept of Environment and Heritage, Pallarenda, Qld 4011, Australia.* Information on the source of turtles in feeding ground habitats is typically limited to recaptures of adult females originally tagged while nesting at rookeries. Recent observation of large differences in mitochondrial DNA (mtDNA) allele frequencies among regional breeding populations suggests that these variants may be useful as genetic markers for estimating the source of turtles, both mature and immature, in mixed populations. We have defined a series of genetic markers for green turtles from the Indo-Pacific by sequence analysis of mtDNA control regions. These markers were used to estimate the composition of the green turtle populations resident at two major feeding grounds in eastern Australia. Maximum likelihood analysis indicates that both adult and immature turtles from the northern Great Barrier Reef (NGBR) and south-west Pacific (SW-Pacific) stocks are common in both feeding grounds (15–82%) with only minor contributions (< 3.5%) from other Indo-Pacific rookeries. A significant difference in the proportion of NGBR and SW-Pacific turtles resident at each feeding ground was observed, with Shoalwater Bay dominated by turtles from the SW-Pacific (79%) breeding colonies and Clack Reef dominated by turtles from the NGBR (82% of adults and 65% of immatures) breeding colony. These results are consistent with the distribution of post-nesting recaptures of females from the NGBR and SW-Pacific (particularly the southern GBR) rookeries and confirm the presence of discrete but overlapping feeding ranges for these colonies within east Australian waters. The detection of a significant difference in genotype proportions between adult and subadult males at Clack Reef suggests that there may be age-related and sex-specific differences in the distribution of turtles in these feeding grounds.

Norris

S10

Changes in catecholamine activity and neuropeptides in the amphibian brain associated with metamorphosis and sexual development. D.O. NORRIS. *Dept of Environmental, Population, and Organismic Biology University of Colorado, Boulder, Colorado 80309-0334, United States of America.* Environmental factors are correlated with the events of amphibian metamorphosis and seasonal reproductive events in amphibians. These environmental factors presumably operate through transduction by the nervous system to activate various endocrine axes. Changes in catecholamine activity, corticotropin-releasing hormone-like immunoreactivity (CRH-IR), thyrotropin-releasing hormone-like immunoreactivity (TRH-IR), and gonadotropin-releasing hormone-like immunoreactivity (GnRH-IR) are examined in the brain of tiger salamanders and comparisons are made with other amphibian species. Immature larvae, sexually mature larvae (neotenes), and metamorphosed tiger salamanders are compared in an attempt to differentiate neuroendocrine factors that might be involved in sexual development from metamorphic factors.

Notes on the reproductive biology of oviparous snakes in Bahia State, Brazil. TANIA B. NUNES[1], LUCIANA L. CASAIS-E-SILVA[1], REJÂNE M. LIRA-DA-SILVA[1] AND ILKE BIONDI-QUEIROZ[2]. [1]*Dept of Zoology, University of Bahia, Salvador, Bahia, Cep 44100, Brazil.* [2]*Dept of Biological Sciences, University of Feira of Santana, Bahia, Cep 44100, Brazil.* There are still few studies on reproduction of tropical snakes; the majority of them come from temperate and subtropical regions. This work contributes to knowledge of the reproductive aspects of some oviparous snakes in Bahia State, Brazil. Data were obtained from eggs laid by snakes kept in captivity (temperature = 25 to 33°C) and from preserved eggs (from prior births or dissected females). Incubation period, number of eggs, length (major and minor axis), average weight and hatching date were registered for each egg laid. Data obtained about young were, eggs number/eggs laid, length and weight average (except for preserved eggs and young). Ten Colubridae (*Chironius carinatus*, *Clelia occiptolutea*, *Leptodeira annulata*, *Liophis poccilogyrus*, *Oxyrhopus trigeminus*, *Oxybelis aeneus*, *Philodryas nattereri*, *P. olfersii*, *Pseudoboa nigra*, *Waglerhopbelis merrimii*) and one Elaphidae (*Micrurus* sp. - *lemniscatus* group) eggs laid were analysed. Among colubrids, the eggs number and eggs laid period varied from species to species, during the year; the unique Elapidae eggs laid happened in December. Incubation period and hatching were observed for *C. occiptolutea* and *W. merremii* (about 84 and 54 days respectively), both during hot months (January, March, November and December). Number and length average of eggs (major and minor axis) in crescent order of length were 9/19.7 × 11.4 mm (*L. poecilogyrus*); 6/21.7 × 9.3 mm (*C. carinatus*); 4/26.5 × 6.3 mm (*P. olfersii*); 7/29.5 × 13.9 mm (*O. trigeminus*); 11/29.7 × 7.0 mm (*W. merremii*); 4/31.0 × 10.1 mm (*Micurus* sp.) (*O. trigeminus*); 11/29.7 × 7.0 mm (*W. merremii*); 4/31.0 × 10.1 mm (*Micurus* sp.) 6/31.4 × 14.7 mm (*L. annulata*); 2/33.6 × 18.4 mm (*O. aeneus*) 6/33.9 × 15.9 mm (*P. nigra*); 6/46.0 × 19.1 mm (*P. nattereri*); 11/49.5 × 29.4 mm (*C. occipitolutea*). The idea of the correspondance between length and number of eggs/eggs laid reported by other works is reforced here. Other factors like sperm supply, female length and physiological or environmental ones may explain the great number of eggs/eggs laid by *W. merremii* and the few ones by *O. aeneus*. (Supported by: Foundation Bank of Brazil). [KEYWORDS: snakes, oviparous, Brazil].

Nunes *et al.*

C09

A critical analysis of antibiotic treatment regimes currently used in herpetology. ANTHONY OGNJAN[1], RICHARD POKRIEFKA[2], CRAIG WEATHERBY[3], FRANK *al.*

Ognjan *et*

C31

PAUL[1], AND RICHARD AMENTA[1]. [1]*Mt. Clemens General Hospital, 1000 Harrington, Mt. Clemens, MI 48043, United States of America.* [2]*Detroit-Riverview Hospital, 7733 E. Jefferson, Detroit, MI 48214, United States of America.* [3]*Biology Dept, 110 S. Madison, Adrian College, Adrian, MI 49221, United States of America.* Historically, antibiotic dosages for reptiles and amphibians were extrapolated from human data. Investigators using these dosage regimens generally met with poor success. They noted little impact on morbidity and mortality, and side-effects (such as nephrotoxicty) were frequently seen. As additional antimicrobial pharmacokinetic studies are performed, it is increasingly evident human dosage regimens often do not achieve therapeutic serum levels in reptiles, and may place animals at risk of drug toxicity. There are several reasons for this lack of concordance. First, reptilian metabolism is relatively slow which greatly prolongs drug half-life. If drugs are administered to reptiles too frequently (such as daily, as in humans) potential toxic levels of antimicrobial agents and their metabolites may accumulate. Conversely, if a dosing interval is inappropriately prolonged, adequate serum levels cannot be obtained and control over the infectious process will not be achieved. Examples of this are found in studies of aminoglycosides, penicillins and cephalosporins. Bioavailability through drug absorption and volume of distribution also varies. For example, fluoroquinolones (ciprofloxacin) when administered at a standard human dose of 250 mg orally do not achieve therapeutic serum levels in turtles. Therefore, the practice of applying human pharmacokinetic models to reptiles and amphibians should be abandoned and researchers should endeavour to develop accurate antimicrobial treatment regimes though new research. [KEYWORDS: disease, drug therapy, health, medicine, reptile].

Olson

S22

The arms race of anuran sexual selection. DEANNA H. OLSON. *Pacific Northwest Research Station, USDA Forest Service, 3200 SW Jefferson Way, Corvallis, Oregon 97331, United States of America.* Anuran amphibian male forelimb (arm) size selection can occur by sexual selection via male-male competition (e.g. to maintain amplexus during dislodgement attempts) and by natural selection if male arms are considered primary sexual characteristics (clasping appendages) and are size-matched to female body sizes. I examined sexual arm dimorphism patterns in comparison to mating systems and body size distributions in sympatric anurans of the Oregon Cascade Range (United States of America). Greater male arm/body length ratios were found for explosively breeding western toads (*Bufo boreas*) and Cascades frogs (*Rana cascadae*), but not for prolonged breeding Pacific treefrogs (*Hyla regilla*). Male Cascades frogs had an intermediate rate of male-male and male-pair interactions, and intermediate ratios of arm/body sizes in comparison to the other two species. In western toads, body size distributions varied among populations, and there was a positive association between male arm/body ratios and population body size distributions: males had relatively longer arms in populations with larger-bodied females. Interestingly, examination of nonrandom mating patterns at 15 breeding aggregations (3 sites × 5 years) revealed size dependent patterns occurred variably in association with body size distributions. Small male mechanical clasping constraints were apparent in aggregations with larger-bodied females. Opportunity for sexual selection was the most important contributor to male western toad reproductive success, yet values of selection indices from yearly male mating success were sometimes extremely low (I=0.26). Thus, an "arms race" is

supported for Cascades Range anurans with explosive breeding, predictably varies with mating system and population size distribution, and can be related to size dependent mating patterns and the opportunity for sexual selection. [KEYWORDS: sexual selection, mating patterns, sexual dimorphism].

Montane amphibian declines: fragmentation, metacommunity dynamics and spatial scales for management. DEANNA H. OLSON AND GAY A. BRADSHAW. *Pacific Northwest Research Station, 3200 SW Jefferson Way Corvallis, Oregon 97331, United States of America.* The integrity of montane amphibian populations and communities may be disrupted by a variety of disturbance regimes affecting habitat suitability and population structure. We examine the differential impacts of disturbances varying in spatial and temporal scale on sympatric species in the Cascade Range of Oregon, United States of America. In this montane system, suitable aquatic habitat for amphibians is naturally fragmented, reflecting both physiographic and microclimatic heterogeneity. Satellite imagery was used to detect heterogeneous patches of potential amphibian habitat at the landscape scale, whereas field surveys were necessary to identify suitable microhabitats and amphibian distribution patterns. Models of population dynamics were parameterized with field data collected over a 12 year period. Combined field and simulation results demonstrate that the impacts of a range of disturbance regimes (including drought, recreational activity, exotic introductions) can have a commensurate range of temporal and spatial scales. Variability among species in their basic ecology (e.g. population/metapopulation structure including distribution and abundance patterns, life history, biotic interactions) results in differential influences of given stressors among populations. Our results indicate that amphibian conservation in such temperate montane communities will require management designs considering broad spatial scales to accomodate the interactions of spatial heterogeneity, interspecific differences, and the varying spatial and temporal scales of disturbances. [KEYWORDS: fragmentation, population structure, declines].

Olson & Bradshaw

S24

Evolution of developmental mechanisms: pigment patterns in larval ambystomatid salamanders. LENNART OLSSON. *Dept of Zoology, Uppsala University, Villavägen 9, S-752 36 Uppsala, Sweden.* In salamanders, larval pigment patterns are formed by the migration of neural crest-derived pigment cells of two types, melanophores (black) and xanthophores (yellow). At the cellular level, two different pattern formation mechanisms have been described. In the first, pattern formation is based on interactions between the pigment cells and the extracellular matrix. This mechanism leads to a pigment pattern consisting of horizontal stripes seen in for example *Ambystoma maculatum* and certain salamandrids. The second pattern formation mechanism is based on interactions between the different pigment cell types and gives a pattern of vertical bars seen in a number of ambystomatids. I have described pigment pattern formation in several species of ambystomatid salamanders and traced the evolution of patterns and mechanisms on cladograms for the group. My results indicate that the cell-cell-interaction mechanism leading to vertical bars has evolved once and been lost twice or evolved twice and been lost once. Smaller changes in patterning can be attributed to changes in e.g. the number and adhesive properties of pigment cells. A mathematical model of the cellular automata type has been developed to explore the

Olsson

S05

effects of changes in adhesion between and within pigment cell types, proliferation rate, directionality of migration and other parameters that are hard or impossible to make biological experiments with. [KEYWORDS: neural crest, pigment patterns, cell migration, evolution of development].

Olsson

S15

Implications of sperm competition for reproductive tactics in male and female sand lizards (*Lacerta agilis*). MATS OLSSON. *Dept of Zoology, University of Göteborg, Medicinarogatan 18, S-400 31 Göteborg, Sweden.* How do sperm performance and competition among sperm in the uterus affect adaptive reproductive behaviour? A male's sperm matures during the first ten days of the mating season; conception with immature sperm yields unfertilised eggs. In the laboratory, females that emerge from hibernation at the same time as males reject males longer and have lower fertilisation success. Thus, a female's postponed computation may be a trade off between the costs of delated embryonic development and the benefits of a reduced risk of insemination with immature sperm. Once receptive, females mate multiply which in a natural population yields mixed paternity, higher hatching success, and lower frequency of deformed young. By inducing sperm competition, females may 'sieve' good genes as sperm performance seems to covary with male genetic quality. Male sand lizards are polygynous and guard a female for 1.4 days on average after copulation. Mate guarding is not synchronised with ovulation. Males allowed to transfer kidney secretions only, and not sperm, do not lower the fertilisation success of another copulation the following day. Mating order has no significant influence on a male's probability of paternity. However, the interval between males' successive copulations correlates positively with probability of paternity. Thus, in species with sperm competition and short search time for females, males may be selected to replenish sperm before they resume mate search. Temporary post-copulatory mate guarding could, hence, be a corollary to selection for sperm replenishment.

Orgeig *et al.*

S13

The development of the surfactant system during metamorphosis in the tiger salamander *Ambystoma tigrinum*. SANDRA ORGEIG[1], CHRISTOPHER B. DANIELS[1] AND ALLAN W. SMITS[2]. [1]*Dept of Human Physiology, School of Medicine, Flinders University, Bedford Pk, SA 5042, Australia.* [2]*Dept of Biology, Box 19498, University of Texas, Arlington, TX 76019-0498, United States of America.* The tiger salamander has a fully aquatic larval life stage which respires exclusively via gills. The lung is apparently functionless and poorly developed. This stage we term stage I. As the animal grows, the gills decrease in size and the lungs develop first as a buoyancy aid and later have a steadily increasing respiratory function (stage II). The animal then metamorphoses into a fully terrestrial form without gills and with a completely developed pair of lungs (stage III). The concomitant compositional and functional development of the surfactant system was investigated. Lung washings were analysed for total phospholipid (PL), disaturated phospholipids (DSP) and cholesterol (Chol). To test whether salamander surfactant functioned as an "antiglue", (i.e. preventing apposing epithelial surfaces from adhering together), opening pressures of collapsed lungs were measured. Both total PL and Chol were present in the lungs of all three stages in identical amounts. DSP/gram wet lung weight (gWL) tended to decrease from stage I to III and the DSP/PL ratio was greatest in stage I animals. The increased

level of phospholipid saturation in fully aquatic stage I salamanders possibly reflects first their higher body temperature, and secondly the external hydrostatic compression forces. Opening pressure prior to lavage decreased from stage I to stage 111, indicating a decrease in resistance to opening with lung development. Stage I opening pressures decreased after lavage, possibly indicating destruction of the muscle tone through the lavaging process. In contrast opening pressures of stages II and III were elevated following lavage, indicating that the surfactant in stage 11 and 111 salamanders has an antiglue function. Inflation compliance after initial opening was not affected by lavage and did not differ between stages. (Supported by ARC (CBD) and NIH (AS).[KEYWORDS: surfactant, salamander, metamorphosis, phospholipids, antiglue, temperature].

Orlov

C06–122

Some general terms on captive breeding of the snakes. NIKOLAI ORLOV. *Dept Herpetology, Zoological Institute, Russian Academy of Sciences, St. Petersburg 199034, Russia.* The experience of captive breeding of different species of boids (*Boa*, *Epicrates*, *Eryx*, *Corallus*, *Acantophis*, *Liasis*, *Python*, *Chondropython*), colubrids (*Coluber*, *Eirensis*, *Elaphe*, *Rabdophis*, *Pytas*), elapids (*Naja*), viperids (*Vipera*, *Echis*, *Trimeresurus*, *Agkistrodon*) in terraria of Zoological Institute is analysed. It is important to realise that every natural climatic region from where animals are orginated has original complex of factors what usually determines sexual activity and following fertile mating. For the snakes of northern and moderate regions the length of photoperiod is most stable factor what is not influenced by fluctuation of other parameters. The length of photoperiod changes strongly regularly from season to season and regulates many aspects of animal life including reproductive activity. For tropical snakes the shift from dry to wet season, temperature changes, UV-radiation etc., were used as the factors stimulating sexual activity. The social stimulation is also of importance for the success of breeding. [KEYWORDS: snakes, reproduction, captive breeding].

Ortega-Rubio *et al.*

C26

Spatial resource partitioning in a Spanish mountain lizard guild. ALFREDO ORTEGA-RUBIO, HEIDI ROMERO-SCHMIDT AND CERAFINA ARGUELLES-MÉNDEZ. *Centro de Investigaciones Biológicas de Baja California Sur. A.P. 128 La Paz, 23000, B.C.S. México.* The spatial resource partitioning of a mountain lizard guild, located at la Sierra de La Guadarrama in Spain, was studied during the summer of 1984. The four main types of vegetation of the study site were systematically searched for lizards during two months. The habitat partitioning and microhabitat specialisation of the guild, which is composed of six abundant species, shows that there exist a clear separation among most of the species. The guild is spatially subdivided into two categories: those species restricted to almost a single habitat, and those species widely distributed along several habitat types. Among the latter subset the species it is possible to further differentiate among the species restricted to the ground and those specialist in the use of the rocks, and finally, there exists among the latter species differences in the size of the used rocks. The ecological significance of such differential spatial usage and their relationship with resource partitioning is discussed. [KEYWORDS: lizard, spatial organisation, resource partitioning, Spain].

Osborne

C12

Continuing population declines in the Australian corroboree frog: evidence of a deterioration in climate? WILLIAM S. OSBORNE. *ACT Parks and Conser-*

vation Service, PO Box 1119, Tuggeranong, ACT 2901, Australia. Corroboree frogs (*Pseudophryne corroboree*) are a terrestrial, high-altitude species with a very restricted distribution in the southern alps of Australia. Observations between 1955 and the late 1970's indicated that the frogs were abundant within their restricted range. However, by 1984 it was apparent that the frogs had declined in abundance with the possibility of the species suffering a considerable contraction of its range. Bioclimatic modelling, in conjunction with analysis of monthly precipitation patterns, implicates reduced spring and early summer rainfall as a possible cause of the decline. However, this does not explain why population recovery has not commenced during the last six years of more favourable precipitation. These findings have implications for the conservation of other high-altitude frog populations. [KEYWORDS: amphibian, decline, weather, Snowy Mountains].

O'Shea

C06–121

The herpetofauna of Kar Kar Island, Madang Province, Papua New Guinea with particular reference to three unusually common species. MARK T. O'SHEA. *Durrell Institute of Conservation & Ecology, University of Kent, Canterbury, CT2 7NZ, United Kingdom. Address for Correspondance: 46 Buckingham Road, Penn, Wolverhampton, WV4 5TJ, United Kingdom.* Three species of amphibians, 22 species of lizards and eight species of snakes have so far been recorded from Kar Kar Island, a 360 sq.km, active volcanic island off the northeast coast of Papua New Guinea. Kar Kar Island has an extremely fertile soil and much of the lower slopes of volcanic Mt Uluman are clothed by long-established coconut and cocoa plantations. The herpetofauna of Kar Kar Island demonstrates two typical characteristics of island faunas in that a) it appears to possess a lower diversity than the neighbouring mainland 17 km away, and b) certain species appear to be extremely common on Kar Kar whilst they are much scarcer, even rare, on the mainland. Three species are unusually common on Kar Kar; the crocodile skink *Tribolonotus gracilis*; New Guinea ground boa *Candoia aspera* and the small-eyed or ikaheka snake *Micropechis ikaheka*. Particular emphasis has been placed on these three species which occur in large numbers in the discarded coconut husk piles. *T. gracilis* is a curious rugose-skinned skink with a series of four raised 'spines' which extend from the rear of the lizard's large casque-like head to the base of the tail. The species also possesses abdominal and both palmar and plantar glands of unknown purpose; females only possess a single functional oviduct but two ovaries and both sexes can vocalise loudly. *C. aspera* is a stout bodied terrestrial boid which occurs in large numbers in sympatry with the slender bodied arboreal phase of *Candoia carinata* which inhabits the island's cocoa trees. *M. ikaheka* is a dangerous elapid and the species which initially brought the author to Kar Kar when engaged in a venom research project. Seasonally present in large numbers, this New Guinea endemic has been responsible for a number of human fatalities but currently no specific antivenom exists to treat its bite, the symptoms and effects of which include neuromuscular paralysis, rhabdomyolysis, myoglobinuria and renal failure. This poster aims to present the preliminary results of four visits to Kar Kar Island during 1990 and 1993 and initiate discusion concerning future fieldwork on Kar Kar, and neighbouring islands, which might help to explain how and why long-established man-made island coconut plantations, which retain discarded husk piles, provide such favourable habitats for otherwise apparently quite rare reptiles. [KEYWORDS: herpetofaunas, island

Ota

S08

Systematics and biogeography of the genus *Japalura* (Agamidae: Squamata) in the Ryukyu Archipelago and Taiwan. HIDETOSHI OTA. *Dept of Biology, University of the Ryukyus, Nishihara, Okinawa 903-01, Japan.* The genus *Japalura* encompasses approximately 23 species, including four endemic species distributed in subtropical islands of East Asia. These are: *J. polygonata* from most islands of the Ryukyus and the northern part of Taiwan Main Island, *J. swinhonis* from the low altitude area around Taiwan Main Island and a few adjacent islets, and *J. brevipes* and *J makii* from high altitudes of Taiwan Main Island. Because of their very close morphological similarities with each other and a wide distributional gap with other congeneric species occurring in the Asian continent, it is assumable that the four species have diversified from each other exclusively. Morphological, chromosomal, and ecological data suggest that the primary divergence had occurred within Taiwan Main Island, which gave rise to the four species. On the other hand, results of detailed analyses of geographic variation in the two widely distributed species (*J. polygonata* and *J. swinhonis*) indicate that subsequent differentiations have taken place in each of them after their colonization and isolation in small islands. [KEYWORDS: Reptilia, *Japalura*, East Asia, differentiation, dispersal].

Overall & Dunham

S29

Thermal effects on development, growth, and survivorship of *Sceloporus merriami* eggs and hatchlings: is warm and wet better? KAREN L. OVERALL[1,2] AND ARTHUR E. DUNHAM[2]. [1]Dept of Zoology, University of Wisconsin, Madison, WI 53706, United States of America. [2]Dept of Biology, University of Pennsylvania, Philadelphia, PA 19104, United States of America. Lizard eggs are ectohydric and developmentally sensitive to the surrounding thermal habitat. Although the primary thermal effect in most reptiles is on developmental time, there are also effects of the thermal and hydric environments on size and shape parameters of hatchlings, developmenal abnormalities, and survivorship. In *Sceloporus merriami*, the effects on survivorship extend through the first year of life and can affect whether a lizard survives to reproduce. [KEYWORDS: eggs, growth, hatchlings, temperature, survivorship].

Owens

S12

Endocrine effects on sea turtle behaviour. DAVID WM. OWENS. *Dept of Biology, Texas A&M University, College Station, TX 77843-3258, United States of America.* Field and lab studies of five marine turtle species suggest several important endocrine/behaviour axes. Elevated testosterone (T) has been closely correlated with mating receptivity and migration in both sexes (4 species). Circulating T has utility in females for predicting ovulatory stage and clutch number, especially in *Lepidochelys*. The adrenal hormone corticosterone (B), which is known as a stress hormone, also shows interesting behavioural correlates. Prior to hatching there is a strong surge in B which coincides with successful emergence from the egg. About five days later a second surge in B occurs as the hatchlings emerge from the nest. We hypothesise that B may be involved in chemosensory and/or other imprinting systems at this time. Nesting females have low B which suggests a suppressed HPA axis. This HPA suppression, along with a surge in arginine vasotocin, may facilitate female emergence and the well known trance-like behaviour during nesting. Descending environmental temperatures corre-

late with lower circulating thyroid hormones in young *L. kempii* and *Chelonia mydas*. At 15°C the *L. kempii* became hyperactive while the *C. mydas* became quiescent. At 10°C both species were quiescent, did not feed and appeared to be "hibernating", with ventilation rates greatly reduced. Endocrine/behaviour research protocols for endangered species can be especially problematical; however, the life history and conservation insight to be gained warrants the extra effort. [KEYWORDS: behaviour, hormones, marine turtles, steroids].

Packard & Packard

C17

How do hatchling painted turtles survive the cold of winter? GARY C. PACKARD AND MARY J. PACKARD. *Dept of Biology, Colorado State University, Fort Collins, Colorado 80523, United States of America.* Baby painted turtles usually spend the first winter of their life inside the shallow, subterranean nest where they completed embryonic development the preceding summer. Temperatures in nests commonly decline to minima between -5°C and -10°C in mid-winter, yet some hatchlings survive exposure to these conditions and then emerge from their nest when the soil thaws the following spring. We used an ecologically realistic protocol to expose hatchling painted turtles to subzero temperatures, and discovered that the only animals that survive exposure to subzero temperatures are those that remain unfrozen. A state of supercooling is sustained even by animals that make contact with ice in the frozen soil, because the skin of these turtles resists the propagation of ice into body compartments from the environment. However, the cutaneous barrier is not perfect, so some animals are inoculated–and die–after intervals that depend on both temperature and duration of exposure. Thus, the adaptive strategy for overwintering in hatchling painted turtles is based on their avoidance of freezing instead of their tolerance for freezing. [KEYWORDS: *Chrysemys picta*, freezing, inoculation, supercooling].

Palacios-Orona & Gadsden-Esparza

C28

Food partition of lizard guild at the sand dunes in the South Chihuahuan Desert, México. L. PALACIOS-ORONA AND H. GADSDEN-ESPARZA. *Instituto de Ecología A.C. Carret. Mazatlán y Blvd. de los Remedios. Apdo. postal 632, C.P. 34100 Durango, Dgo, Mexico.* A comparative study of trophic niches was worked in a lizard guild in 1990 in sand dunes of the Bolsón de Mamipí, Durango, Mexico. The guild is principal constituted for *Cnemidophorus tigris*, *Uma paraphygas* and *Uta stansburiana*. Stomachs were examined and were determined the Importance Value (adds of relative abundance, relative volume and constancy of prey). Shannon's Index in *C. tigris* was H' < 1.5 and H'v > 1.5 with preference in *Isoptera*. *Uma paraphygas* and *Uta stansburiana* too had H' and H'v > 1.5 without preference, but Formicidae were the most important order for the three species. We found bulky prey with importance. There are significant difference (t) between the prey length for the three species. The intraspecific niche overlap (O_{jk}) is more large during all year. The interspecific overlap is more large between *Uma paraphygas* vs *Uta stansburiana* and less between *C. tigris* vs *Uma paraphygas* and *Uta stansburiana*. Females of three species presented less variation of prey length than the males. However, the males present more variablity of SVL than females. The difference between the prey length, different activity hour and foraging sort in these species to give possibility of biotic sympatry in this habitat. [KEYWORDS: Mexico, Durango, Bolsón de Mamipi, smportance value, Shannon's and Overlap Index].

Palmer

C15

Novel roles of natural and xenobiotic estrogens in turtles. BRENT D. PALMER. *Laboratory of Vertebrate Reproductive Biology, Dept of Biological Sciences, Ohio University, Athens, Ohio 45701-2979, United States of America.* Many environmental pollutants are known to have estrogenic activity in animals. Xenobiotic estrogens include many organochlorines, such as the pesticide DDT. The impact of such common pollutants on reptilian reproductive success, particularly in threatened or endangered species, may be considerable. My laboratory is now elucidating the roles of natural and xenobiotic estrogens in reptiles, particularly in turtles. The effects of estradiol-17β (E_2) treatment on the functional morphology and cytology of the ovariectomised turtle oviduct were examined. Adult female turtles (*Trachemy scripta*) were ovariectomised, maintained for up to 35 days, and subsequently injected i.p. with either vehicle of E_2 for up to 28 days. The oviducts were then removed and tissues prepared for histology using standard techniques. Effectiveness of the experimental regime was verified by radioimmunoassay. E_2-treated specimens presented a typical vitellogenic cytology. Control specimens exhibited various degrees of cytological regression, dependent on cell type. Experimental treatment was tested against oviductal mass, length, epithelial cell height, mucosal gland diameter, and mucosal thickness. The effects of ovariectomy on oviductal regression were investigated using individual animals as their own control. Oviductal regression was shown to be a gradual process that continues for weeks following ovariectomy. These data show a distinct effect of E_2 on oviducal cytology. However, limited morphometric effects suggest that regulation of oviductal structure is less dependent on E_2 than previously thought, and that other factors may be involved. The estrogenic activity of common xenobiotic compounds, including diethylsilbesterol (DES), the pesticide DDT, and the herbicide atrazine, was tested. Adult male turtles were given i.p. injections of each compound at various doses, and the estrogenic effect determined by measuring the induction of serum vitellogenin. Dose-response relationships for induction of vitellogenin by each xenobiotic estrogen were determined. The biochemical properties of vitellogenin were determined by electrophoretic characterisation and EDTA precipitation. These data indicate that xenobiotics do have estrogenic actions in turtles. The impact of these compounds on the reproductive biology of wild populations, particularly threatened or endangered species, may be considerable. [KEYWORDS: turtles, oestrogen, xenobiotics, oviducts, vitellogenin, reproduction, conservation].

Papenfuss

S09

Species diversity of amphibians and reptiles across vicariant barriers in the Asian deserts. THEODORE J. PAPENFUSS. *Museum of Vertebrate Zoology, University of California, Berkeley, CA 94720, United States of America.* A study on the biogeography, distribution, and systematics of the herpetofauna of desert regions of China, Mongolia, and the former USSR has been underway for the last seven years, with the collaboration of herpetologists from these countries. This research has enabled us to develop detailed distribution lists for the various deserts within this region. Areas studied range from lowland sandy and gravel deserts such as the Karakum of Turkmenistan and the Taklamakan of China, to high elevation deserts on the Tibet-Qinghai Plateau. Complex tectonic events have effected this region. The overall arid region is divided into a number of isolated and semi-isolated basins, often containing endemic species. Total diversity decreases dramatically at high elevations and in the more northern deserts. The lizard genera *Phrynocephalus* and *Eremias* are the domi-

nant elements. In some regions the above two genera are the only lizards present. Few amphibian species occur in the region. In mesic areas ranids and *Bufo* are the only taxa present. Biochemical studies suggest that complex nomenclatural history of the genus *Phrynocephalus* in China is due to old descriptions based on a genus that shows great pattern and coloration variation throughout its range in China. [KEYWORDS: Amphibia, Reptilia, Asian deserts, biogeography, distribution].

Passmore & Jennions

S22

Multiple spawning, polyandry and testis size in the foam-nest frog, *Chiromantis xerampelina*. NEVILLE PASSMORE AND MICHAEL D. JENNIONS. *Dept of Zoology, University of Witwatersrand, Private Bag 3, Wits 2050, South Africa.* Breeding was observed in a natural population of the foam-nest frog, *Chiromantis xerampelina*. The population was characterised by a male-biased operational sex ratio and unpredictable female arrival. At more than 90% of nests, 1–7 unpaired males ('peripheral males') gathered around the amplexing pair during nest construction. Those closest to the pair competed with each other, and with the amplexing male, to position their cloacae against the female's cloaca during oviposition bouts. An additional experiment, in which the amplexing male was prevented from shedding sperm into the nest, showed that peripheral males are capable of fertilizing the clutch. We conclude that peripheral males are engaged in an alternative mating tactic involving sperm competition. Using comparative data from 18 African anurans and 19 Japanese anurans, we show that *C. xerampelina* has testes 14 times heavier than predicted on the basis of body mass. This is consistent with a trend seen in several taxa where testis size is related to the intensity of sperm competition. Over 80% of males in the study population were observed behaving as peripheral males, and 57% were observed both in amplexus and as peripheral males. Male mating success and participation at nests was unrelated to size. Presence at the breeding site was the best predictor of mating success, either as an amplexing or peripheral male. Nests were built in 2.4 sessions. Males dismounted between sessions and females descended to the water. On returning to the nest, many females were clasped by different males. Amplexus displacement was also observed. In all, more than half the females bred polyandrously, some mating with up to 3 males.

Paulissen *et al.*

C06– 123

Genetic diversity and diet breadth: diets of parthenogenetic and bisexual whiptail lizards. MARK A. PAULISSEN[1], JAMES M. WALKER[2] AND JAMES E. CORDES[3]. [1]*Dept of Biological & Environmental Sciences, McNeese State University, Lake Charles, Louisiana 70609, United States of America.* [2]*Dept of Biological Sciences, University of Arkansas, Fayetteville, Arkansas 72701, United States of America.* [3]*Div. of Sciences, LSU-Eunice, Eunice, Louisiana 70535, United States of America.* Parthenogenetic animals generally show little genetic diversity among individuals; theoretically the ecological variation between individuals is also low. However within-individual ecological breadth of parthenogens may be as high as in bisexual species. We compared the diets of: (1) the parthenogenetic whiptail lizard *Cnemidophorus laredoensis* and the bisexual whiptail lizard *C. gularis* at two sites of sympatry in Texas, (2) the parthenogenetic *C. tesselatus* and the bisexual *C. sexlineatus* at a site of sympatry in Colorado in two different seasons. Mean within-individual diet breadths of parthenogens and bisexuals did not differ in most samples. Mean between-individual diet overlaps showed that. contrary to theory, between-individual diet variance was the same, or greater in parthenogens than in bisexuals. [KEYWORDS: diet breadth, parthenogenesis, bisexual species, whiptail lizards, *Cnemidophorus*, USA].

Pearn *et al.*

S30

Snakebite in herpetologists. JOHN H. PEARN[1], JEANETTE COVACEVICH[2], NEIL T. CHARLES[3] AND PETER RICHARDSON[4]. [1]*Dept of Child Health (University of Queensland), Royal Children's Hospital, Brisbane, Qld 4029, Australia.* [2]*Senior Curator (Vertebrates), The Queensland Museum, PO Box 3300, South Brisbane, Qld 4101, Australia.* [3]*Quarantine Officer, Australian Quarantine Inspection Service (Brisbane International Airport), Locked Mail Bag 10, Hamilton Central PO, Brisbane, Qld 4007, Australia.* [4]*Curator, The Dreamtime Reptile Reserve, 85 Childers Road, Bundaberg, Qld 4670, Australia.* Previous studies by our group have documented that human snakebite can be classified into one of six defined syndromes, of which that involving herpetologists is one of the most defined in terms not only of risk, but of morbidity, bite pattern and post-accident action. We report here a clinical study of fifty sequential bites involving six experienced Queensland herpetologists. Bites were less common during the catching of specimens. Most bites sustained by this group of experienced herpetologists occurred during husbandry, and in particular, during case maintenance. The median number of bites sustained exceeded eight per person. Five of the six herpetologists required intensive care medical management for life-threatening envenomation. All the life-threatening envenomation cases involved (exclusively) Australian elapids. Bites occurred principally, but not exclusively, on the hand. In many instances, the speed of the strike was such that there was doubt whether or not a true bite had occurred, until the onset of clinical signs. Fatalities are known to occur amongst herpetologists, but none occurred in this case series. There was no long term morbidity. An analysis of these fifty cases is presented in the context of safety and preventive medicine. In general, first aid measures are exemplary in this group of snakebite victims. One case described in this series was the first time that the modern management of human snakebite (using a compressive bandage and immobilisation) was used in a human victim. [KEYWORDS: snakebite, herpetologists, conservation and captive care, clinical envenomation].

Pearson

S09

Fire-breeding dragons? Sympatric *Ctenophorus* and fire in the Great Victoria Desert. DAVID J. PEARSON. *Dept of Conservation and Land Management, P.O. Box 51, Wanneroo, WA 6065, Australia.* Dragons of the genus *Ctenophorus* are a prominent component of the lizard fauna of arid Australian hummock grasslands. In a study on the south-western edge of the Great Victoria Desert, experimental fires led to the phoenix-like appearance of two previously uncaptured species. A summer fire, which removed 96–100% of grass cover, resulted in the disappearance of one species reliant on hummocks for thermoregulatory shelter and protection from predators. Spring fires left greater cover and allowed the co-occurrence of all but one species. This species strongly favoured very open habitats. Diets were compared with available invertebrate resources in each fire treatment. They selected different prey and foraged at different times of the day. The distribution of all *Ctenophorus* spp. in the region seemed closely associated with gross substrate and vegetation differences. However, in fairly uniform hummock grasslands, post-fire age and fire intensity were important determinants of the species composition and diversity of the dragon fauna. [KEYWORDS: dragon, agamid, *Ctenophorus*, fire, diversity].

Pearson

C06–124

Distribution and status of pythons in Western Australia. DAVID J. PEARSON. *Dept of Conservation and Land Management, P.O. Box 51, Wanneroo, WA 6065, Australia.* Fifteen taxa of pythons are currently recognised on the Australian mainland; nine of these occur in WA. Two species (*Morelia carinata* and *M. perthensis*) and two subspecies (*M. spilota imbricata* and *Liasis olivaceus barroni*) are endemic to W.A. Information on their distribution is relatively poor due to their cryptic habits and sparse museum collections. Museum accessions, published records and sightings by conservation agency staff, amateur herpetologists and Aborigines were used to investigate the distribution and status of python taxa in WA. In addition, a sighting record scheme was developed and preliminary results are presented. Tropical, sub-tropical and arid zone species appear to have secure status, except *M. carinata*, which is known from just two specimens. *Aspidites ramsayi* and *M. s. imbricata* have declined markedly in the temperate south-west over the last 30 years. Habitat destruction and fragmentation were probably the major contributing factors in the Wheatbelt region, however, predation by feral animals, fire and changes in prey resources may be significant in other parts of their range. [KEYWORDS: pythons, distribution, status, Western Australia].

Peccinini Seale *et al.*

C06–125

Comparative cytogenetic and evolution on the Brazilian *Cnemidophorus occelifer* and *Lemniscatus* group (Sauria, Teiidae). DENISE M. PECCININI SEALE[1], CARLOS F. DA ROCHA[2], ALEXANDRE B. DE ARAUJO[3] AND TEREZINHA M.B. DE ALMEIDA[4]. [1]*Instituto de Biociências, Universidade de São Paulo, CP 11461, São Paulo, 05422- 970, Brazil.* [2]*S. Ecologia, Insituto de Biologia, UERJ, Rua São Francisco Xavier 524, Rio de Janeiro, 20550-011, Brazil.* [3]*Depto de Ecologia, Universidade de Brazilia, 70910, Aca Norto, Bracilia, Brazil.* [4]*S. Genetica, Instituto Butantan, São Paulo, Brazil.* Chromosomes and meiosis of *Cnemidophorus occelifer* from different Brazilian localities were studied. Karyotyping showed chromsomal geographic variation and a mechanism of chromosome sex determination of the type XX–XY. The karyotypes seem to be derived from cytotype D of *C. lemniscatus* through several pericentric inversions on the first and second pairs of chromosomes. The metaphase analysed showed diploid number of 46 and 48 chromosomes and a male heterogamety. The species which seems to be the nearest in the eastern limit of geographic distribution of *lemniscatus* group is *C. occelifer*. Cytological data from two new populations of *C. lemniscatus* presented unisexual cytotype C with 2n=50 chromosomes. The patterns of nucleolar organiser regions (NOR-banding) showed variation in the intensity in the number of active NORs in the chromosomes. (Supported in part by CNPq, FAPESP, Museo Emilio Goeldi, UERJ, UNB.). [KEYWORDS: sex chromosomes, *Cnemidophorus occelifer*, karyotypes, parthenogenetic, *Cnemidophorus lemniscatus*].

Peccinini Seale *et al.*

C01

Comparative cytogenetic studies of Amazonian reptiles. DENISE M. PECCININI SEALE[1], CARLOS F. DA ROCHA[2], MARLICE B. PEDROSO ROBLES[1] AND TEREZINHA M.B. DE ALMEIDA[3]. [1]*Instituto de Biociências, Universidade de São Paulo, CP 11461, São Paulo, 05422- 970, Brazil.* [2]*S. Ecologia, Insituto de Biologia, UERJ, Rua São Francisco Xavier 524, Rio de Janeiro, 20550-011, Brazil.* [3]*S. Genetica, Instituto Butantan, São Paulo, Brazil.* We describe the karyotypes and meiosis of the lizards and amphisbaenians collected by the Fauna Rescue Amazonas, Tucurui in Para, and Samuel in Rondonia. The samples received do not represent all of the lizard and amphisbaenian

fauna in the area; however, the preliminary data of analysed species show interesting results and certainly will be a contribution to the comparative Brazilian taxonomy, especially from the Amazon. Chromosomes were prepared from bone-marow, testis suspensions and intestinal epithelium. The karyotype description of fifteen species from four families of Sauria and two species of Amphisbaenia showed chromosomal variation (2n=30 to 2n=50) and mechanisms of chromosome sex determination. There are polymorphisms in the patterns of chromosomal nucleolar organiser (NOR banding) and in the patterns of constitutive heterochromatin (C-banding). (Supported in part by Eletronorte, FAPESP, CNPq, Museo Emilio Goeldi, Insituto Butantan). [KEYWORDS: Amazonian lizard karyotpye, amphisbaenian karyotype, sex chromosomes].

Pechmann

S14

Population regulation in complex life cycles: aquatic and terrestrial density-dependence in pond-breeding amphibians. JOSEPH H.K. PECHMANN. *Dept of Zoology, Duke University and Savannah River Ecology Laboratory, P.O. Drawer E, Aiken, SC 29802, United States of America.* Population regulation can potentially occur in any or all stages of a complex life cycle, but no experiments have manipulated densities in more than one stage. I raised larval *Ambystoma talpoideum* at replicated aquatic densities of 900 or 2700 per 315 m^2 pond. After metamorphosis, juveniles were placed in terrestrial pens at 28 or 84 per 100 m^2 pen in a replicated split-plot design. This resulted in 4 treatments: LA-LT (Low Aquatic density-Low Terrestrial density), LA-HT, HA-LT, and HA-HT, comprised of densities within estimated natural ranges. Salamanders from LA treatments were larger at 1 year of age, matured at a younger age, and had higher survival of males to maturity than those from HA treatments. Neither terrestrial density nor the interaction of aquatic and terrestrial density had any significant effects. In a similar experiment with *Gastrophryne carolinensis*, post-metamorphic effects of aquatic density again were significant; no juveniles from HA treatments survived. Toads from the LA-LT treatment matured earlier and at a larger size than those from the LA-HT treatment. Aquatic density exerted lifetime effects on traits important to population regulation in both species, and terrestrial density also had significant effects in *Gastrophryne*. [KEYWORDS : *Ambystoma*, *Gastrophryne*, density, aquatic, terrestrial].

Péfaur

C06–126

Value of local collections for the analysis of anuran population declines. JAIME E. PÉFAUR. *Ecología Animal, Facultad de Ciencias, Universidad de Los Andes, Mérida 5101, Venezuela.* There is a lack of statistical and field methods to analyse amphibian population declines. Herein it is proposed a procedure to analyse the local data of a museological collection (Vertebrate Collection, University of Los Andes, Mérida, Venezuela). The decade of the 80's was selected as the representative period, a time when a systematic collecting activity around the Venezuelan Andes was carried out. Four population parameters (sample sizes, percentages, proportion indexes of the most labile species, and a regression index), and one community parameter (a diversity index) were calculated to detect population/community trends among anurans. An integrated analysis of results showed a decline for the community, as well as for several *Atelopus*, *Colostethus* and *Centrolene* populations, that is in agreement with the hypothesis and bibliographic references. Uncertain status was shown by populations of most species of *Hyla* and *Leptodactylus* which have an irregular phenology. Popu-

lations of *Bufo* and some *Colostethus*, *Eleutherodactylus*, and other genera showed no strong modifications. The methodological procedure and its results seem to be satisfactory to evaluate numerical trends at the level of populations and communities, even though these results confirm some previous reports and consolidate the evidence of declination in some particular species, they also indicate that the numerical behavior of Andean anuran populations is not uniform. It is suggested that similar analysis should be carried out with local records of other important Latin American herpetological collections in order to obtain a better picture of the actual population status of the neotropical amphibians. [KEYWORDS: collections, Anuran population declines, methods, Andes, Venezuela].

Peterson *et al.*

S21

Some like it fast and some like it slow: contrasting antipredator behaviours in two coexisting tadpole species. ANDREW G. PETERSON[1], STEPHEN J. RICHARDS[2], AND C. MICHAEL BULL[3]. [1]*Ecosystem Dynamics Group, Research School of Biological Sciences, The Australian National University, GPO Box 475, Canberra, ACT 2601, Australia.* [2]*Dept of Zoology, James Cook University, Townsville, Qld 4810, Australia.* [3]*School of Biological Sciences, Flinders University, GPO Box 2100, Adelaide, SA 5001, Australia.* Larvae of *Ranidella signifera* and *Litoria ewingi* are common members of tadpole communities of temporary ponds in southeastern Australia, where odonate larvae are the major predators. Field surveys and laboratory observations showed that *R. signifera* preferred the substrate of water bodies, whereas *L. ewingi* utilised the water surface and water column more. In laboratory aquaria, both species demonstrated an increase in use of the substrate during the dark phase of a 12:12 photoperiod. Laboratory predation trials revealed that *L. ewingi* suffered heavier predation from the corduliid odonate *Hemicordulia tau*, a benthic predator, than did *R. signifera*. Predation on *L. ewingi*, but not on *R. signifera*, declined as water depth increased, implying that *L. ewingi* use the water column to escape benthic predators. The results of simulated predatory strikes in the laboratory suggest the relatively greater susceptibility of *L. ewingi* to predation in shallow water was due to this species having lower escape velocities and shorter sprint distances than *R. signifera*. The evidence available indicates that *R. signifera* occupies the same microhabitat as *H. tau*, and that it has evolved a cryptic lifestyle and fast escape speeds to minimise its predation risk while *L. ewingi* has evolved a more active lifestyle and uses the water column and water surface to avoid predation by *H. tau*.

Peterson & Arnold

S29

The ecology of maternal thermoregulation in garter snakes. CHARLES R. PETERSON[1] AND STEVAN J. ARNOLD[2]. [1]*Dept of Biological Sciences, Box 8007, Idaho State University, Pocatello, ID 83209, United States of America.* [2]*Dept of Ecology and Evolution, University of Chicago, Chicago, IL 60637, United States of America.* To determine the extent and developmental importance of variation in the body temperatures (T_b) of pregnant snakes, we conducted a combination of field and laboratory studies of western terrestrial garter snakes (*Thamnophis elegans*). We captured 8 adult female snakes in a mountain meadow in northeastern Califonia, implanted temperature sensitive-radiotransmitters in them, and then released them back into the field. Using an automated radiotelemetry system, we monitored their body temperatures at 10-minute intervals over the course of gestation; the mean number of days that snakes

were monitored was 26. These snakes typically exhibited triphasic T_b patterns with plateau phase temperatures of about 30°C. The overall mean T_b was 26°C (N = 10,876 readings). In the laboratory, we assigned 74 pregnant females to one of nine constant temperature treatments (ranging from 21 to 33°C) for the course of gestation. The range of temperatures over which pregnant snakes could produce living young was relatively narrow (23–32°C). The duration of the gestation period was shortened by about 5 days for every increase of 1°C. Developmental temperature did not affect some scale counts (e.g. postoculars) but did have a small, statistically significant effect on other scale counts (e.g. ventrals). These results suggest that the primary effect of T_b variation within the temperature range that supports pregnancy is on developmental rate and that meristic characters are relatively well buffered against T_b variation in this range. The peaks and troughs of the reaction norms and the minima for vertebral anomalies and scale asymmetries occurred at 27°C, which is closer to the mean field T_b (26.6°C) than the mean plateau phase T_b (about 30°C). This result raises the intriguing question of whether the thermal dependency of development is best correlated (and thus coadapted) to the snakes' thermal preference or to the actual distribution of temperatures experienced in the field. [KEYWORDS: body temperature, development, garter snake, pregnancy, *Thamnophis elegans*].

Peterson & Dorcas

C06– 129

An automated recording system for monitoring anuran vocalisation. CHARLES R. PETERSON AND MICHAEL E. DORCAS. *Dept of Biological Sciences, Box 8007, Idaho State University, Pocatello, ID 83209, United States of America.* Recent concerns over the conservation of amphibians have led to an increased need for surveys and monitoring programs. The detection of anuran vocalisations has been a valuable technique in these efforts. However, temporal, interspecific, and environmentally induced variation in calling may lead to failure to detect some species. Automated recording systems can increase the effectiveness of calling surveys as well as aid in studies of calling behaviour. Advantages of automated recording include (1) the ability to sample for extended periods of time, thus increasing the probablility of detecting a given species; (2) decreased disturbance of calling anurans, thus decreasing the probability of missing easily disturbed species; (3) the ability to sample multiple sites simultaneously; (4) consistent sampling without the need for experienced field personnel; and (5) a permanent sampling record. If combined with environmental measurements, data from automated recording systems can be used to optimise when, where and under what conditions to sample. Potential problems include (1) noise interference from wind, water and the calls of other species; (2) theft or vandalism; and (3) protection of equipment from the environment. Portable, automated, recording systems can now be assembled for less than $250 US. Components include a cassette-tape recorder, an omnidirectional microphone, a solid-state, recyling timer, a 12-volt power supply, a voltage converter, and a weather resistant case. The combination of portable automated recording systems with expert pattern recognition systems should expand and factilitate the usefulness of each system. So far, automated recording systems have been used to study temporal variation in the calling behaviour of western chorus frogs (*Pseudacris triseriata*), the effects of environmental variation on calling in southwestern toads (*Bufo microscaphus*), and to detect the presence of a breeding population of barking tree frogs (*Hyla gratiosa*) on the Merritt Island National Wildlife Refuge, Kennedy Space Center, Florida. For

the reasons described above, we believe the automated recording systems will prove helpful in developing standardised survey and monitoring programs for anuran species that call. [KEYWORDS: anuran, automated tape recording, calling, monitoring, surveying].

Phillips S28

Children of children's python. GAEL E. PHILLIPS. *Tissue Pathology, Institute of Medical and Veterinary Science, P.O. Box 14 Rundle Mall, Adelaide, SA 5000, Australia.* "Children's Pythons" are the living memorials of the Keeper of Zoology at the British Museum during the period 1823 to 1840. *Morelia childreni* (Gray, 1842) is named after John George Children, F.R.S., a Mineralogist who somewhat reluctantly became Keeper of Zoology under the patronage of Sir Humphry Davy and Sir Joseph Banks. J.G. Children, (1777–1852), came from a family long established in Kent, and he sought employment in the British Museum after the failure of the family's bank at Tonbridge. His father, George Children, who paid the debts of the bank from his own pocket, thereby being reduced to penury, was also a scientist. Their most famous achievement was the building in 1808 of the largest Voltaic battery ever built. Although John George Children contributed relatively little to the Zoological literature, his influence was important, and his contributions to Mineral Chemistry were outstanding. John Edward Gray, (1800–1875) gave the name of his former colleague at the British Museum to the Children's Python in 1842. The group has since undergone reclassification, but the species *Morelia childreni* commemorates a remarkable scientist. His other memorials are the mineral childrenite and a cowrie. It is fitting that a living herpetological memorial should commemorate an important early 19th century scientist. [KEYWORDS: John George Children, Children's Python, *Morelia childreni*, John Edward Gray, Childrenite].

Phillips & Alberts S17

Ecology of *Varanus albigularis*. JOHN A. PHILLIPS AND ALLISON C. ALBERTS. *Center for Reproduction of Endangered Species, Zoological Society of San Diego, P.O. Box 551, San Diego, CA 92112, United States of America.* A population of white-throated savanna monitor lizards (Varanus albigularis in Etosha National Park, Namibia, was studied for 17 months. A total of 238 lizards were marked, of which, thirty-five were radio-tagged for periods greater than 12 months. Wet season (December–March) home ranges determined from radio-telemetry data were large and differed significantly between adult males (18.3 ± 2.4 km^2) and females (6.1 ± 0.6 km^2). During the dry season (April–November) males and females utilised less than 10% of their wet season home range, except during the breeding season (July–August) when males moved extensively while locating estrus females. All reproductive events, including yolking, occurred during months when no food was available. When supplemental food was made available during the dry season individual lizards increased their daily movements over 30-fold, suggesting that food and not seasonal differences in average temperature limits home range utilisation. The largest adult lizards were males; however, there was no difference in wet season mass between males and females of similar snout-vent length. The apparent sex ratio varied dramatically by season, but this was a result of the different activity patterns between the sexes. Overall, the data suggest parity between the sexes. The biomas of *V. albigularis* at least rivaled that of all sympatric medium and large-sized mammalian carnivores in the park. (Supported by NSF BNS 90-00100). [KEYWORDS: home range, reproduction, *Varanus*].

Pianka S09

Currents in biogeographic thinking: their effects on studies of reptile zoogeography. ERIC R. PIANKA. *Dept of Zoology, University of Texas, Austin, Texas 78712-1064, United States of America.* Various approaches that have been taken in biogeographic studies are briefly reviewed, with particular reference being given to how they affect studies of reptile zoogeography. Examples are given from the literature, with particular emphasis upon the zoogeography of Australian desert lizards. [KEYWORDS: classical biogeography, ecological biogeography, experimental biogeography, island biogeography, vicariance biogeography, panbiogeography].

Pianka S06

Comparative ecology of *Varanus* in the Great Victoria Desert. ERIC R. PIANKA. *Dept of Zoology, University of Texas, Austin, Texas 78712-1064, United States of America.* The ecologies of seven desert species of monitor lizards (*Varanus*), which are very variable in size, are described and compared. Data are reported on abundance, anatomy, behaviour, body temperature relationships, daily activity patterns, diet, habitat and microhabitat, prey size, reproduction, seasonal patterns of activity, growth, sexual dimorphisms, and tracks. As many as six of the seven species occur together in sympatry at one study site. A food web of 40 species of desert lizards is presented. Hutchinsonian ratios of head lengths (larger/smaller) are significantly greater in two observed assemblages of sympatric varanids than in a null model consisting of all possible pairs of species of all Australian varanids. Evolution of body size and the adaptive radiation of *Varanus* in Australia are discussed. [KEYWORDS: *Varanus*, foodweb, monitor lizards, Hutchinsonian ratios, comparative ecology, body size].

Pisanets C06–130

Hybridisation and some isolation mechanisms peculiar to Paleartic toads (Anura : Bufonidae). EUGENY M. PISANETS. *Herpetological Laboratory, Melitopol Teacher's Training College, Melitopol 332315, Ukraine.* Our investigation of the relationships of Palearctic toads included 113 crosses and were made by using *Bufo viridis viridis*, *B. v. turanensis*, tetraploid toads *B. danatensis* and common toads (*B. bufo*-complex) from Europe, the Caucasus region and the Far East. All crosses progeny developed under the same laboratory conditions. The results are : 1. In some control crosses (the amplexus and spawning took place!) the hatching of embryos were absent (3 out of the 24 crosses); 2. Percent of hatched embryos and feeding tadpoles in some hybrid crosses were larger than in the controls (12 out of the 57 crosses); 3. Some crosses which are characterised by the lower percent of hatched embryos (about 5–30%) had a higher level (70–100%) of metamorphosed toads. These data show that probably isolating mechanisms and viability hybrids at the different stages of development are not connected only with specific related interrelations. [KEYWORDS: toads, crosses, hybridisation].

Pisanets & Grushko C06– 131

Initial parental origin of the tetraploids *Bufo danatensis* species (Anura : Bufonidae). EUGENY M. PISANETS AND TATJANA A. GRUSHKO. *Herpetological Laboratory, Melitopol Teacher's Training College Melitopol 332315, Ukraine.* The materials of electrophoretic analysis indicated to hybrid origin of Asiatic tetraploid toads *Bufo danatensis* Pisanets, 1978. For clarification of the question on parental inital species 24 crosses of *B. viridis viridis* from the southern Ukraine (control) and *B. v. turanensis* from the southern Turcmenia (hybrid combination) were carried out

during the spring, 1993. Only in two hybrid crosses the number of fertilised eggs and the hatched of larvae was larger than in the control. The comparison of the oral disk system structure of 75 larvae in one control crosses and in two hybrid ones did not show principal differences. The number of chromosomes of the tadpoles in the control crosses were 22; in two hybrid combinations it was found that one cell had 19 chromosomes and another - 21; all the rest analysed cells had 22 chromosomes each (34 larvae were studied). The preliminary materials show that hybridisation of these two forms hardly caused the formation of 44 chromosome *B. danatensis*. [KEYWORDS: toads, tadpoles, chromosomes, oral disk, crosses].

Platz

S19

***Rana subaquavocalis*: underwater vocalisations and mating strategy of a new species of ranid frog from Arizona.** JAMES E. PLATZ. *Dept of Biology, Creighton University, 2500 California Plaza, Omaha, NE 68178, United States of America.* A remarkable new species of large ranid frog occurs in isolated populations in the Huachuca Mountains of Cochise County, Arizona, United States of America. Field observations were carried out at the Ramsey Canyon location, a square concrete tank 14 m on a side and averaging 1.3 m in depth with sharply sloping walls. Tape recorded vocalsations made over four breeding seasons revealed that males call while totally submerged, rendering vocalisations inaudible in the air. The vocal repertoire consists of a minimum of 5 different call types propagated from a depth of 1.3 metres. The breeding season is prolonged, lasting from late March to early July. Adults are large by leopard frog standards. Age estimates based on skeletochronological studies of phalanges indicate that males may reach age 10 while females have been documented as old as 13 years post metamorphosis, or about three or four times the average life span reported in published skeletochronology studies for *Rana pipiens*. Several factors including longevity, prolonged breeding season and constraints imposed by underwater acoustics favor the evolution of lek behavior. A constellation of observations support this contention: Males are known to be aggressive. Call sequences are complex. Only a small number of males (three or four, and often two) call at one time from central locations while substantial numbers (10 to 15) adult non-calling males remain visible around the periphery of the tank. [KEYWORDS: Amphibia, bioacoustics, lek, Ranidae, skeletochronology].

Plotkin *et al.*

S18

Ecology of the olive ridley sea turtle *Lepidochelys olivacea* in the eastern Pacific Ocean. PAMELA T. PLOTKIN[1], RICHARD A. BYLES[2], AND DAVID W. OWENS[1]. [1]*Dept of Biology, Texas A&M University, College Station, Texas, 77843, United States of America.* [2]*U.S. Fish and Wildlife Service, Albuquerque, New Mexico, 87103, United States of America.* At sea sightings of *Lepidochelys olivacea* in the eastern tropical Pacific Ocean (ETP) and mark-recapture data from tagging programs have revealed that *L. olivacea* regularly occurs in oceanic waters. The importance of this oceanic habitat in the life cycle of *L. olivacea* is unknown and consequently the ecology of this threatened marine vertebrate is poorly understood. Since 1990, we have used satellites to monitor the migrations of radio-tagged *L. olivacea* from their breeding/nesting area near Nancite Beach, Costa Rica to (1) document migration routes (2) identify foraging areas and (3) determine if the turtles migrate in socially structured groups. After the last clutch of the season has been oviposited, female *L. olivacea* leave

the nesting beach individually. Their post-nesting migration routes traverse thousands of km of deep oceanic waters (> 1,000 m deep) and are geographically distributed over a very broad range from Mexico to Peru. *L. olivacea* do not migrate to one specific foraging area. They swim nomadically and occupy a series of feeding areas within their oceanic habitat, feeding predominantly on pelagic tunicates, coelenterates, and crustaceans. We believe *L. olivacea's* nomadic migratory behavior, a tactic thus far unique to this sea turtle, evolved in response to the temporal and spatial variability of resources in the ETP. Our research on male *L. olivacea* has just begun and preliminary results suggest that males also occupy oceanic habitats. Some males undertake brief journeys towards nesting areas where females may be intercepted *en route* to their nesting beach; other males become temporary residents (June through September) in nearshore areas of the nesting beach, where they actively pursue females. [KEYWORDS: olive ridley sea turtle, migration, telemetry, oceanic habitat].

Pokriefka *et al.*

S26

Achievable serum concentrations and half-life of the fluoroquinolone ciprofloxacin through various administration routes in *Pseudemys scripta elegans*. RICHARD POKRIEFKA[1], CRAIG WEATHERBY[2], TOM NELSON[3], FRANK PAUL[4], RICHARD AMENTA[4] AND ANTHONY OGNJAN[4]. [1]*Detroit-Riverview Hospital, 7733 E. Jefferson, Detroit, MI 48214, United States of America.* [2]*Biology Dept, 110 S. Madison, Adrian College, Adrian, MI 49221, United States of America.* [3]*Great Lakes Zoological Supply, Inc., 22841 Van Dyke Ave., Warren, MI 48089, United States of America.* [4]*Mt Clemens General Hospital, 1000 Harrington, Mt Clemens, MI 48043, United States of America.* Thirty specimens of the red-eared slider turtle, *Pseudemys scripta elegans*, were obtained from a reptile wholesale house for this study. Turtle body weight ranged from 212 to 524 g with an average weight of 378 g. Gender was evenly distributed (13 females and 17 males). Turtles were randomised to three separate treatment groups for antibiotic trials. Group 1 received intramuscular ciprofloxacin (Cipro) at a dosage of 20 mg/kg total body weight (TBW). Group 2 received Cipro through emersion in antibiotic treated water at a dosage of 5 g/l of tap water. Group 3 received Cipro by 24 h continuous emersion (prior to serum sampling) in antibiotic treated water at a dosage of 5 g/l of tap water. All animals were housed at a constant temperature of 22°C under standard laboratory conditions. Serum samples were drawn on each specimen via cervical vein at the following times 2, 4, 8, 12, 24, and 48 hours. Serum samples were frozen at -40°C then promptly sent to a reference laboratory and analysed by microbiologic assay for serum Cipro levels. Serum drug level data was then utilised to develop a pharmacokinetic model and serum half-life trends were analysed to formulate reliable dosing regimes. Analysis of the data revealed several significant trends varying by individual dosing routes. All routes achieved sufficient serum levels to exceed the MIC (minimum inhibitory concentration) for all susceptible bacterial pathogens most frequently encountered in herpetological medicine. This study answers several important questions regardling pharmacokinetics and medical application of fluoroquinolone antibiotics in Chelonia. [KEYWORDS: disease, drug therapy, medicine, health, turtle].

Pokriefka *et al.*

C31

A prospective survey of indigenous oral and cloacal bacterial flora in wild caught healthy North American rattlesnakes. RICHARD POKRIEFKA[1], CRAIG WEATHERBY[2], JERRY JOHNSON[3], CHRISTOPHER PODLASKOWSKI[4], FRANK PAUL[4]

AND ANTHONY OGNJAN[4]. [1]*Detroit-Riverview Hospital, 7733 E. Jefferson, Detroit, MI 48214, United States of America.* [2]*Biology Dept, 110 S. Madison, Adrian College, Adrian, MI 49221, United States of America.* [3]*Biology Dept, El Paso Community College, 919 Hunter, El Paso, TX 79915, United States of America.* [4]*Mt Clemens General Hospital, 1000 Harrington, Mt Clemens, MI 48043, United States of America.* A review of the available literature reveals a paucity of data on the prevalence of indigenous bacteria flora from reptiles in native environs. Differences occurring in bacteria colonisation between captive and native reptile specimens may contribute to variations in incidence and pathogenesis of infections. To expand our knowledge of indigenous bacterial species, bacterial flora were sampled from 25 healthy North American (USA) rattlesnake species: 3 *Crotalus atrox*, 3 *C. molosus*, 4 *C. lepidus*, 5 *Sistrurus catenatus*, and 10 *S. milliarius*. Culture specimens were obtained from the oropharynx and cloacae of each animal and transferred within 24 hours to a microbiology laboratory. Cultures were plated on differential media to support growth of Gram positive and Gram negative aerobic bacterial and incubated under standard conditions. Less than 40% of oral isolates and greater than 90% of cloacal isolates were enteric Gram negative bacilli. Potential pathogens such as *Pseudomonas* spp. and *Enterobacter* spp. accounted for less than 25% of oral and greater than 90% of cloacal isolates. Overall prevalence of oropharyngeal Gram negative isolates were less than 45%, while that of cloacal isolates were 100%. In studies on certain captive specimens, Gram negative bacillary colonisation of the oropharynx is often reported at 100%. Our data reflect the vast differences in bacterial flora which can occur between native and captive reptiles. [KEYWORDS: bacteria, disease, health, medicine, rattlesnake].

Polynova C06–133

Functional role of hierarchic system of interrelations in lizard populations. G.V. POLYNOVA. *Russian Research Institute of Nature Conservation and Reserves, Moscow, Russia.* The regularity in the appearance of hierarchic interrelations in lizard populations has been considered. Field researchers in natural populations of *Phrynocephalus interscapularis* and *Eremias intermedia* and experiments in enclosure with *Agama sanguinolenta*, *Phr. mystaceus*, *Phr. helioscopus*, *E. grammica* and *E. velox* demonstrated that hierarchic system of interrelations is one of the mechanisms of population self-regulation that appears and works only during the reproductive season. Analysis of the author's and published data reveals the existence of species-specific differences in the hierarchic system in Sauria at the level of families.

Polynova C06–132

Spacing patterns and the main factors forming their specificity. G.V. POLYNOVA. *Russian Research Institute of Nature Conservation and Reserves, Moscow, Russia.* Spacing patterns in populations of six lizards have been considered. Analysis of the author's and published data reveals the existence of four separate types in lizard spacing patterns and their systematic character that appears at the level of families. The main factors that form species-specific and population differences in lizard spacing patterns are: the size of reproductive effort, preferred way of foraging and predator escape, the main way of communication (defined by the most developed sense organ) and current level of population density. The final corrections are formed by means of the concrete ecological circumstances: the level of habitat visibility, constancy and abundance of the main resources.

Polzonetti-Magni et al. C06–134

Opioid peptides and reproduction in amphibians and reptiles. A.M. POLZONETTI-MAGNI, O. CARNEVALI AND G. MOSCONI. *Dipartimento di Biologia MCA, Università di Camerino, Via Camerini 2, 62032 Camerino, Italy.* In mammals, propriomelanocortin-related peptides are involved in reproductive processes both at the hypothalamo-pituitary and ovarian levels. Using immunocytochemical, biochemical and physiological "in vitro" studies, we provided evidence for a diffuse POMC-related opioid system in the frog, *Rana esculenta* and in the lizard, *Podarcis s. sicula* Raf. Ovarian β-endorphin (β-EP) is expressed in steroidogenetic tissue, and changes during the reproductive cycle. Seasonal changes in the ovary are different to those in the brain or in the pituitary. During both the reproductive spring period and the summer post-reproductive phase, pMol amounts of β-EP stimulate steroidogenesis "in vitro" in a naloxone-reversible way. In either period, an inhibition of sex steroid secretion, possibly mediated via other factors is the result of opioid action. Moreover, the "in vivo" experiments have demonstrated the involvement of opioids in the stress response. The acute stress paradigm, here applied, is consistent with the measurement of plasma androgen levels in female frogs after short-captivity confinement. The sharp decrease of plasma androgens in the captive frogs is reversed by naltrexone, a long acting opioid antagonist. Taken together, these findings support a physiological role for POMC-derived peptides in the ovarian seasonality and in the stress-induced inhibition of gonadal steroids. [KEYWORDS: ovary, sex steroids, stress response, opioid antagonist].

Polzonetti-Magni et al. C13

Divergent sex steroid pattern in two sympatric, morphologically cryptic species of the genus *Leptodactylus* from subtropical South America. A.M. POLZONETTI-MAGNI[1], J.M. CEI[1], N. IBANEZ[2], AND B.B. ALVAREZ[3]. [1]*Dipartimento Biologia MCA, Università di Camerino, Italy.* [2]*Universidad Nacional de Rio Cuarto (Dip. Ciencias Naturales y Fac. Veterinaria) Rio Cuarto, Cordoba, Argentina.* [3]*Universidad Nacional del Nordeste (Fac. Ciencias Exactas, Naturales y Agrim.), Corrientes, Argentina.* The genus *Leptodactylus* is widespread in mesic and xeric environments of subtropical and tropical southern South America: its remarkable evolutionary differentiation is pointed out by the several species groups throughout the whole area of its neotropical distribution. A general report on the different physiological threshold to the high temperatures of the specific sensitivity of the pituitary and of the germinal epithelia in *Leptodactylus ocellatus* and *Leptodactylus chaquensis* from northern and northeastern Argentina was given and discussed several years ago (Cei 1980). The physiological peculiarities of the reproductive cycle have been the first kind of evidence leading to the biological comparative screening of the "sibling" species of the *Leptodactylus* complex of the "*pachypus*" group. The Linnean taxon *L. ocellatus* which is sympatric with *L. chaquensis* in Paraguay and on the banks of the Parana River, does not present evident gametogenetic discontinuity or cyclical variation of secondary sex characters if compared with the striking and well-defined seasonal rhythm, found in *L. chaquensis*. In order to have a better understanding of the internal mechanisms of the seasonal hormonal regulation of the reproductive cycle in both species, particularly in their sympatric area, plasma sex steroids, androgens (A), estradiol- 17β (E), and progesterone (P), have been evaluated by RIA method. In the male *L. chaquensis*, plasma androgen and estradiol-17β levels reached peak values in November, well related to the gonadal increasing values and spermiation. In the female, the androgen trend

was parallel to that of the male; in addition the plasma androgen levels in females have been found higher than in males. Regarding estradiol-17β changes, it seems of interest to stress the presence of two peak values: the first one in August–September probably regulating ovarian growth by activation of liver vitellogenin synthesis; the second one concomitant with the androgen peak, occurring at the mating period (November). Conversely, in both male and female *L. ocellatus* little variation of plasma sex steroids has been found because of their irregular and continuous gametogenetic activity. In conclusion, the Linnean taxon *L. ocellatus*, which is sympatric with *L. chaquensis* in Paraguay and in Parana area, does not present evident cyclical variations not only in the gametogenetic activity and secondary sex characters, but also in the sex steroid plasma levels; whereas, high seasonality in reproductive trend has been found in *L. chaquensis*.

Poran

S12

Some morphological adaptations of the head region of sea snakes. NAOMIE S. PORAN. *North Carolina State University, United States of America.* The osmotic challenges and diffusion rates of the marine environment suggests that the chemosensory system of sea snakes may include some unique specialisations. Light microscopy of a series of snake heads including Australian terrestrial elapids and hydrophiids revealed that marine snakes have retained the terrestrial anatomical characteristics of the vomeronasal organ with thick neuroepithelium and large mushroom body. Moreover, the relative size of the vomeronasal organs was often greater in the marine species. However, the typical columnar organisation of the neural epithelium found in many other snakes was significantly reduced in both elapids and sea snakes. Marine snakes showed among other cranial features, differential melanin distribution, reduced glandular masses and significantly smaller nasal cavities relative to terrestrial elapids. *Laticauda*, which is the least aquatic of the sea snakes, exhibits intermediate cranial characteristics. Possible functional aspects of these differences will be discussed.

Porter *et al.*

S29

Climate variation, habitat fragmentation and body size effects on lizard and turtle life histories. WARREN P. PORTER[1], STEVE ADOLPH[2], CHARLES CURTIN[1] AND KENT HATCH[1]. [1]*Dept of Zoology, University of Wisconsin, 117 W. Johnson St., Madison, WI, 53706, United States of America.* [2]*Dept of Biology, Harvey Mudd College, 301 E. Twelfth St., Claremont, CA, 91711, United States of America.* A model incorporating a combination of theory, physiological measurements, and common garden experiments with populations of ornate box turtles, *Terrapene ornata*, six-lined racerunners, *Cnemidophorus sexlineatus*, and eastern fence lizards, *Sceloporus undulatus*, explains much of how habitat, climate variation in time and space, and body size affect life history characters and response times to climate change. We find that lengths of activity season and daily activity periods are key variables. They can be computed from climate data, a microclimate model, and specific physical, physiological and behavioural properties of an animal. A life history model based on biophysical, physiological and behavioural properties of individuals computes lengths of activity season and daily activity periods and it can explain a large part of observed survivorship, egg mass, and size and age at maturity. The model also predicts different optimal behaviours for different sizes of lizards in ontogeny. Two notable exceptions to predictions suggest possible genetic selection effects associated with a specific climate regime. Habitat fragmentation alters microclimates available to animals, physiological

responses due to temperature changes, and results in different life history patterns and response times to climate change, depending on life span of the species. [KEYWORDS: climate, habitat, body size, lizard, turtle, life history].

Powell & Knesel

C06– 135

Haematology and blood chemistry of *Macroclemys temmincki*. SANDRA C. POWELL[1] AND JOHN A. KNESEL[2]. [1]*Dept of Medical Technology, Northeast Louisiana University, Monroe, Louisiana 71209, United States of America.* [2]*Dept of Biology, Northeast Louisiana University, Monroe, Louisiana 71209, United States of America.* Haematological and blood chemistry profiles were investigated in 21 alligator snapping turtles (*Macroclemys temmincki* Troost). Blood smears stained with Sudan Black B, Myeloperoxidase, Alpha Naphthyl Acetate Esterase, Naphthol AS-D Chloroacetate Esterase, Leukocyte Alkaline Phosphatase, or Hemacolor were examined by light microscopy for specific leukocytes. Acidophils, the primary leukocyte found, stained positive for all cytochemical stains except Alpha Naphthyl Acetate Esterase. Monocytes stained positive for Alpha Naphthyl Acetate Esterase only. Lymphocytes stained negative for all stains. Erythrocytes contained an intracellular body in close proximity to the nucleus, and many of the erythrocytes contained intracorpuscular parasites (possibly *Haemogregarina*). Haemoglobins (7.32 gr/dL) were determined by a cyanomethemoglobin colorimetric procedure, packed cell volumes (24.7%) from spun hematocrit tubes, and leukocyte (1074 mm^3) and erythrocyte (419,000 mm^3) counts with a Neubauer hemocytometer. Blood chemistry values (mg/dL) included Glucose (38.6), BUN (37.6), Ca (9.9), Phos. (4.2), Mg (3.4), Cholesterol (115), Albumin (0.5 g/dL), and Total Protein (5.2 g/dL) as determined by a Paramax (Baxter) Autoanalyzer. [KEYWORDS: *Macroclemys*, haematology, blood, chemistry].

Poynton

S07

Regional patterns of amphibian distribution: Africa exclusive of Mediterranean Region, and including Madagascar and Seychelles. J.C. POYNTON. *Dept of Zoology, Natural History Museum, London SW7 5BD, United Kingdom.* Geographical sampling and taxonomic analysis of African amphibians is less than adequate, although better in Madagascar and Seychelles. The faunas of Africa, Madagascar and Seychelles each show a high level of endemism and differ markedly from each other. Twelve regions are distinguished in subsaharan Africa. High-ranking regions in respect of species diversity are West Equatorial (160 spp), Tropical Highlands (144 spp), East African Lowland (55 spp). Percentage endemicity ranks as West Equatorial (46%), South Temperate (41%), Tropical Highlands (34%). The Tropical Highlands and South Temperate regions together carry an Afro-temperate fauna, a third of the total number of subsaharan species and in need of special conservation. Gondwanaland-derived elements are evident in this fauna. Gondwanaland elements are indicated in the faunas of Madagascar and Seychelles. Correlations of distributional patterns with temperature and rainfall are evident, but particular environmental factors involved in causal relationships have on the whole not been identified. [KEYWORDS: zoogeography, Amphibia, Africa, Madagascar, Seychelles, diversity, endemism].

Poynton

S07

Investigating regional patterns: small steps between the obvious and the obscure. J.C. POYNTON. *Dept of Zoology, Natural History Museum, London SW7 5BD, United Kingdom.* Biogeography has a narrow boundary between the obvious and

the obscure. Obvious: biogeography rests on the availability of reliable and adequate locality data. But these words conceal conceptual and practical complexities, often scale-dependent. Obvious: taxon ranges need to be grouped and compared, providing biogeographical classifications. But concepts regarding classification have many obscurities. Obvious: Plant and animal distribution patterns are causally affected by patterns in the environment. But investigation is problematic. Correlation does not imply causation. Current distribution patterns may reflect past variation in environmental tracking rather than present environmental effects. The concept of dependent and independent variables tends not to be useful in holistic systems analysis. Mathematical procedures assuming linear causation and data symmetry can be misleading. Obvious: Analysis should produce area cladograms and reconstructions of faunal history. But cladograms are notoriously non-congruent, and fossils and palaeoclimatic data are usually sparse. Not too obscure: Unless we keep an eye on such obscurities, this symposium may not have much long-term usefulness. [KEYWORDS: biogeographical analysis].

Praschag S25

Captive care of turtles in a private greenhouse. REINER PRASCHAG. *Am Katzelbach 98, A-8054 Graz, Austria.* Eighty one species of freshwater turtles and tortoises are maintained in a private greenhouse of about 150 m^2. The tropical and sub-tropical species live mostly in large aquaria, each holding more than 100,000 l of water. Several outdoor ponds were adapted for turtle species from colder climates, and these have proved to be the more sensitive and difficult to keep. Natural behaviour is promoted by natural climatic regimes and the social behaviours of groups of turtles are studied in large tanks. The behaviour, growth, fertility and reproduction observed in captivity are compared with those found in nature. The author's special interests are small, cold climate turtles and unusual forms, including the genera *Macroclemys*, *Claudius*, *Kachuga*, *Graptemys*, *Platysternon*, *Carettochelys* and snake-necked species. About 30 species are breeding in these conditions, but the fertility is lower than in nature, due to dietary factors. A future aim is to determine those species adapting better to captivity. [KEYWORDS: freshwater turtles, architecture, acclimation, behaviour, breeding].

Praschag C34

A critical study of reptile houses in Zoos. REINER PRASCHAG. *Am Katzelbach 98, A-8054, Graz, Austria.* I visited more than 100 Zoos in the world, mostly USA and in Europe. I found good, interesting and nice aquarium houses, but very seldom a good reptile house. Reptiles like sunlight, but surprisingly they are often kept in dark houses and enclosures. The best results in the captive care of reptiles I must see when they keep them behind the scene under rather sterile conditions. It seems we are not able to show the natural life of reptiles to the public. But special this is the main aim of the reptile house in the zoo!

Preece S07

Diversity and abundance of lizards in three vegetation formations in central Australia. NOEL D. PREECE. *Ecoz, G.P.O Box 381, Darwin, NT 0801, Australia.* A four year study of lizard diversity and abundance in I, a mulga *Acacia aneura* formation: II, a spinifex *Plectrachne schinzii* formation and III, a riverine woodland *Eucalyptus terminalis* formation, was undertaken to test the hypothesis that lizard diversity and

abundance should be less in the mulga and riverine formations. The results showed that there was no significant difference in diversity between the three formations, while there was a significant difference in abundance ($P < 0.01$). There were significant differences between formations when the taxa were separated into functional (terrestrial/arboreal; diurnal/nocturnal) and taxonomic groups (geckoes/skinks). The functional/taxonomic separation may be artifactual as most geckoes are also nocturnal while most skinks are terrestrial and diurnal. Species composition varied noticeably. The mulga formation holds almost identical species to the riverine woodland (a subset of the riverine), although there are fewer species present, while the suite of species present in spinifex is largely different with some overlap with the other two formations. Four species of diplodactyline geckoes and one Gekkonidae, *Gehyra variegata*, and one skink, *Monetia greyii* are found in all three communities. Some species are common to any two pairs of vegetation formation. [KEYWORDS: mulga, riverine woodland, spinifex, taxonomic groupings].

Propper et al. S10

Endocrine regulation of water absorption behaviour in desert anurans. CATHERINE R. PROPPER, WILLIAM E. JOHNSON, AND LOREÉ A. HARVEY. *Dept Biol. Sciences, Northern Arizona University, Flagstaff, AZ 86011, United States of America.* Because of their permeable skins, amphibians are particularly susceptible to dehydration. In anuran amphibians, rehydration usually is not accomplished by oral drinking, but rather is achieved by a specific behaviour that includes placement of the highly permeable ventral pelvic skin against moist surfaces (water absorption behaviour). Two hormones, angiotensin II (AII) and arginine vasotocin (AVT), are known to influence permeability of the skin; in other vertebrate groups, AII is known to induce drinking behaviour. Studies on the effects of these hormones on dehydration-related behaviours may provide a strong model for investigation of the endocrine coordination of peripheral and behavioural events. Recent studies in toads suggest that exogenous AII influences water absorption behaviour (Hoff and Hillyard, 1991). Our lab has demonstrated that AII but not AVT induces water absorption behaviour in *Bufo cognatus* and *Scaphiopus couchii*. In order to test the hypothesis that endogenous AII released during dehydration induces water absorption behaviour, we treated dehydrated animals with either saralasin or losartan (both AII receptor blockers) or captopril (AII synthesis inhibitor). Saralasin significantly enhanced water absorption behavior in *S. couchii*; no other treatment significantly enhanced or inhibited water absorption behaviour in either species. These results indicate that, as with mammals, the endocrine events regulating dehydration-related behaviours are complex. Future studies in this system may provide insights into both how some anuran amphibians survive in relatively desiccating environments, and how rainfall acts as an environmental cue for emergence and reproduction. Hoff, K.S. and Hillyard, S.D. 1991. *Physiol. Zool.* 64:1165-1172. [This research was supported by NSF grant BNS-9110045 to CRP]. [KEYWORDS: Anura, frog, dehydration, angiotensin II, arginine, vasotocin].

Puky C06–137

Effect of different threats on the amphibian community along the River Ipoly at Parassapuszta, Hungary. MIKLÓS PUKY. *Hungarian Danube Research Station, 2131 Göd, Jávorka S. u. 14., Hungary.* The amphibian community at Parassapuszta has been investigated since 1987. The study was started to investigate the effect

of the international road leading between the breeding site, the floodplain of the River Ipoly, and the winter habitat, the heavily forested foothills of the Borzsony Mountains. Three breeding seasons later a ditch was dug through the floodplain, which lowered the water table and gradually changed the breeding site providing an opportunity to compare the effects of these human impacts at the same site. The traffic (approximately 1,000 cars daily) did not kill off the amphibian community (eleven species) in the area, which might be due to the decrease of intraspecific competition. Traffic of this intensity may also select for faster crossing and an alteration of the migration pattern. On the other hand it could certainly change the sex ratio and the size distribution of the populations. The lowering of the water table has had a dramatic effect. The community seemed to collapse, three species disappeared within four years and the total number of amphibians decreased by an order of magnitude. *Rana dalmatina*, a species with an opportunistic breeding strategy could survive the best in spite of size distribution changes and a moderate decrease in the individual number. [KEYWORDS: amphibians, decline, migration, road effects, habitat destruction].

Puky & Oertel

C06– 138

Heavy metal accumulation in the populations of three European amphibians. MIKLÓS PUKY AND NÁNDOR OERTEL. *Hungarian Danube Research Station, 2131 Göd, Jvorka S. u. 14., Hungary.* The Ag, Cd, Cu, Fe, Hg, Pb and Zn accumulation of *Rana esculenta*, *Bufo bufo* and *Bombina bombina* in different developmental stages, tissues, organs and seasons were investigated at two sites along the Danube, in a seminatural pond and in a fish hatchery. Heavy metal determination was made by atomic absorption analysis. Considerable difference was found between the sites in the relative and absolute quantities of the metals. Some of the differences can be explained through direct or indirect connections with the Danube. The concentration of six metals exceeded the appropriate sustainable concentrations for freshwater life. A striking result of our work is that the average concentration of Ag and Cd increased significantly i.e. at Cd from 0.12 μg/g to 0.96 μg/g in three years, which was detectable in amphibians as well. Significant differences were found between the different tissue concentrations. Maternal organism plays a protective role against heavy metals, the concentrations in the ovary was usually higher (except Zn) i.e. in *Bombina bombina* it was 0.075 μg/g Hg while only 0.002 μg/g Hg in the eggs. The metal concentrations of *Rana esculenta* crural muscle, which people consume, was relatively low. Concentration factors were usually between 100 and 10,000. Kidney accumulated Ag, Cd, Fe, Hg, Zn, liver Cu the most. *Rana esculenta* usually had the highest, *Bufo bufo* the lowest values. Differences in the concentration factors emphasizes the importance of different heavy metal uptakes. [KEYWORDS: amphibians, heavy metals, accumulation, Danube].

Pyles

S05

Developmental patterns and life history strategies in desmognathine salamanders. REBECCA A. PYLES. *Dept of Biological Sciences, East Tennessee State University, Box 70703, Johnson City, TN 37614, United States of America.* The alteration of developmental pathways has been proposed as both a mechanism and a constraint responsible for differences in body size and for the origin of anatomical novelties in amphibians. Heterochrony has been suggested as the underlying and unifying phenomenon associated with the diversity of size, morphology, and life history strategies in salamanders of the family Plethodontidae. This study was designed to test

whether consistent developmental patterns are correlated with trends in adult size, life history, and/or morphological characteristics within members of the subfamily Desmognathinae. The development of the chondro- and osteocranium was compared among ontogenetic series of five species of *Desmognathus*, representing a broad range of adult body size (30 mm – 100 mm) length of larval period (0.5 – 4 yrs), and habitat (aquatic – terrrestrial). Ontogenetic series of two species of *Eurycea* were used for outgroup comparison, No single developmental pattern (e.g. paedomorphosis or peramophosis) could be associated with the observed morphological differences in timing or rate of appearance of cranial elements. In contrast with the larger aquatic species, the smaller, more terrestrial *Desmognathus* with shorter larval periods exhibit early elaboration of nasal cartilages, compacted or rapid ossification of the auditory region and certain palatal elements, but delayed or late development of the suspensorium. The comparatively early ossification of the skull roof and palate and lack of nasal capsule development may represent adaptation for the aquatic feeding mode and/or diet during the lengthy larval period in larger aquatic *Desmognathus*. Cranial characteristics of adults are similar, except that more terrestrial forms appear to have general reduction in ossification overall as compared with more aquatic forms. Data from this study support the interpretation that compacted, rapid early development coupled with later development truncation may be associated with reduced larval period and small body size that accompanies a more terrestrial life history mode in this groups of salamanders. [KEYWORDS: cranium, cartilage, bone, development, salamanders, size, life history].

Qualls

S15

The evolution of viviparity in an Australian skink. CARL P. QUALLS. *School of Biological Sciences A08, University of Sydney, NSW 2006, Australia.* What selective forces have been responsible for the evolution of reptilian viviparity? Comparative evidence suggests that cold climates have been important in this respect, perhaps because gravid females can maintain a warmer incubation temperature for the developing embryos by behaviourally thermoregulating. This warmer incubation temperature would allow the embryos to complete development more rapidly than if they were exposed to the cooler temperatures of a nest in a cold environment. The Australian skink *Lerista bougainvillii* is one of only a few species of squamate to include both egg laying and live bearing populations. This situation allows oviparous and viviparous lizards to be compared experimentally, with minimum bias due to phylogenetic differences, making this species ideal for testing hypotheses on the evolution of viviparity. Gravid females (both oviparous and viviparous) were transplanted into field enclosures in both hot and cold climates. Their subsequent reproductive success (number of offspring) was then compared between climates and reproductive modes. In addition, eggs were collected from gravid oviparous females and experimentally incubated under different thermal conditions. These incubation treatments simulated a cold nest, a thermoregulating viviparous female, and an intermediate stage of egg retention. Viviparous embryos were subjected to the same incubation temperatures by placing gravid females into the incubators. Incubation temperature affected the incubation period, size, shape, growth, and thermoregulatory behaviour of the hatchlings. [KEYWORDS: viviparity, oviparity, reptile, incubation, temperature, evolution].

Raja Sekhar & Subba Rao

C06– 139

Nesting olive ridleys *Lepidochelys olivacea* (Eschscholtz) and their present

status along the northern Andhra Pradesh coastline, India. P.S. RAJA SEKHAR AND M.V. SUBBA RAO. *Dept of Environ. Sciences, Andhra University, Visakhapatnam 530 003, A.P., India.* Olive (Pacific) ridley sea turtles, *Lepidochelys olivacea* (Eschscholtz) are valuable resources to many people of the Indian ocean, having contributed to the nutritional, economic and cultural fabric of the region. However, despite long standing value of this resource, its future is in jeopardy and many turtle populations have declined to the point where they are no longer significant resources. This is mainly due to indiscriminate exploitation largely of breeding stages (Frazier, 1980). As part of the conservation of the olive ridleys the present studies were conducted along the Northern Andhra Pradesh coastline during 1990 to 1991 for their status and breeding ecology. The coastline is an important nesting habitat, in winter months large number of olive ridleys sporadically nesting on the shoreline, while they are in migration towards Gahirmatha island for mass nesting known as Arribada. During migration large number of olive ridleys were exploited and indiscriminately killed for their eggs, meat, shell and calipee for small monitory benefits. The nesting ridleys were accidentally trapped and drowned in the trawler nets causes instant mortality due to suffocation, after they washed ashore. Some of the turtles brought lively while they are in courtship activity at sea or nesting on shore. The status is also evident from the disturbances to the nests and nesting habitats. During the period 925 freshly laid nests identified of which 805 nests were disturbed either by human or subject to predation i.e. Jackals, Foxes and Dogs. Hence, the status of the olive ridleys reveals their future is alarming in this region. [KEYWORDS: olive ridleys, sea turtles, nesting, resources, exploitation, disturbances].

Rao & Sharma

C06– 140

Status and conservation of monitor lizards in India. R.J. RAO AND BRIJ. B. SHARMA. *School of Studies in Zoology, Jiwaja University, Gwalior, M.P. 474 011, India.* Of the four speices or monitor lizards which occur in India, the yellow monitor *Varanus flavescens* and water monitor *V. salvator* are highly utilised ones. The *V. bengalensis*, the bengal monitor is widely distributed throughout India and *V. griseus*, the desert monitor inhabit the desert, arid and semi-arid zones in the Western part of the country. The monitor lizards have traditionally been exploited by rural lowland residents for meat. There is a trade in *Varanus* products for medicinal purposes from poaching. In addition large number of development projects in India have altered the existing monitor lizard habitats. There is a lack of basic knowledge on the status of different species of monitor lizards. This paper highlights the research programme initiated on the conservation status of monitor lizards in India. Country-wide surveys have been carried out to identify the populations of monitor lizards and their commercial utilisation. At the end of the study we will assess the future management options for conservation of monitor lizards in India.

Rasmussen

C06–142

Maxillary tooth number in the tree-snakes genus *Dipsadoboa*. JENS B. RASMUSSEN. *Zoological Museum, Universitetsparken 15, 2100 Copenhagen Ø, Denmark.* The relationship between the number of maxillary teeth and total body size is examined between the sexes in 12 of the 13 recognised taxa within the African Tree-Snakes, *Dipsadoboa*. The number of maxillary teeth is constant in all species. In one species (*D. unicolor*) there is a slight, but significant difference in number of maxillary teeth between the sexes. No significant geographical differences seem to exist between different populations of the same species. A possible relationship between number of maxillary teeth and of potential prey is discussed. It is concluded that number of maxillary teeth is a good taxonomic character. [KEYWORDS: *Dipsadoboa*, maxillary tooth, systematic character].

Ratnam

S17

Resource partitioning in a captive population of the water monitor lizard *Varanus salvator* : an approach to captive management and research. JAYASHREE RATNAM. *Madras Crocodile Bank Trust, Mammallapuram 603104, India.* In a semi-natural enclosure (14 m × 16 m) with several microhabitat options such as trees (of different heights), shrubs, grass and sandy ground areas, mounds, tree holes, bowers, rocks and a fairly large pond, a sample population of adult, sub-adult and juvenile *Varanus salvator* (total n=22) has been introduced. Daily observations are conducted to determine activity patterns, thermoregulatory rhythmns, microhabitat and time partitioning (spatial needs), and social interactions across the different size classes in this population. Resource partitioning occurs in the study population in two ways. (1) There is a clear partition along the microhabitat gradient across the different size classes. Certain "prime" microhabitats like the burrows and shrubs are exclusively used by the adults, while small crevices and sapling trees are used only by juveniles and are essentially inaccessible to the adults due to their larger sizes. On large trees, thin branches are generally avoided by the adults and utilised by the juveniles. The ground and water areas are more often used by the adults. In general, juveniles are significantly more arboreal than adults. (2) The time dimension is partitioned with the juveniles being active in the morning while the adults and sub adults are much more active in the late afternoon. In general, juveniles bask and become active earlier in the day than adults. The above natural history traits may be applied to a captive management program as follows: it is possible to maintain varanids of all size classes in a single enclosure, without undue aggression or cannibalism. This is possible; by providing a range of microhabitats, particularly in the vertical dimension as varanids are both good climbers and burrowers. These micro-habitats must range in different sizes such that larger individuals are excluded from some areas like small crevices or thin branches, and these become "safety areas" for smaller individuals. Further, it may be possible to optimise health of the population by feeding the different size classes when they are most active. From the standpoint of research on captive animals, it is felt that such enclosure designs represent an optimum approach to studying the behavioural ecology of the species: under the simulated natural conditions, a wide range of behaviours, particularly that of juveniles and their responses to adults (difficult to observe in the wild) is witnessed.

Rebêlo *et al.*

C06–143

Growth, sex ration, population structure, and mortality due to hunting in *Caiman crocodilus yacare*. GEORGE H. REBÊLO[1], GUILHERME A.N. BORGES[2], CARLOS YAMASHITA[3] AND ANACLETO G. ARRUDA F[o2*]. [1]*INPA, Ecologia, C.P. 478, 69.083-970 Manaus AM, Brazil.* [2]*FEMA-MT, Dept Estudos de Conservação, C.P. 268, 78.000 Cuiab´ MT, Brazil.* [3]*IBAMA, Alameda Tietê, 637, Cerqueira César, 01417 São Paulo SP, Brazil.* **Present address: Tecnocaiman, V´rzea Grande MT, Brazil.* A mark and recapture study was carried out in the Pantanal of Poconé, Brazil. The

linear growth rate decreased with size. Females reach sexual maturity at about 5 to 6 years old. Males reach sexual maturity at more than 7 years of age. Growth is fast until maturity but slow and relatively constant in the largest size classes. Variations in growth rates could not be related to habitat or season. The sex ratio varied within size/age classes, but is close to 1:1 over all in habitats and seasons. The number of males was higher than females only in permanent habitats, during the dry season. The population structure differs according to habitats and seasons. Hatchlings account for the majority of caimans caught in temporary habitats and permanent habitats. Hunting in the region is selective for caimans larger than 1.2 m in total length. Comparison of the hunted population with the population captured indicates that 60% of hunted caimans are adult males and that hunting probably reduced the proportion of adults in two of the three study sites. [KEYWORDS: Crocodilia, Pantanal, growth, population structure, hunting, sex ratio].

Reed & Sites

S03

Chromosomal dynamics and selected estimates of fitness and fecundity in a hybrid zone between chromosome races of the *Sceloporus grammicus* complex (Phrynosomatidae) in Central Mexico. KENT M. REED[1] AND JACK W. SITES, JR[2]. [1]*Dept of Biology, University of Rochester, Rochester, NY 14627, United States of America.* [2]*Dept of Zoology, Brigham Young University, Provo, UT 84602, United States of America.* The F5 (2n = 34) and FM2 (2n = 46) races of the *S. grammicus* complex, which hybridise in the Tulancingo transect, differ by fission and/or inversion rearrangements at chromosomes 1, 3, 4, and 6 (1 and 6 are diagnostic on the basis of size and morphology), and by a complex rearrangement of chromosome 2, which also carries the nucleolus organiser region (NOR). Meiosis was examined in males heterozygous for simple fissions and pericentric inversions, and also for the complex rearrangements at chromosome 2. Analysis of synaptonemal complexes (SCs) and chromosomal configurations at diakinesis showed normal trivalent formation in simple fission heterozygotes, and heterosynapsis (lack of reverse loop formation) in pericentric inversion heterozygotes. Metaphase II configurations showed balanced segregation of gametes and uniformly low levels of nondisjunction. Similar analyses of chromosome 2 heterozygotes revealed meiotic pairing difficulties for some arrangements, increased levels of nondisjunction, and production of nonparental chromosomal morphologies through recombination. The levels of nondisjunction in some males may be high enough (near 50%) to influence reproductive performance in this zone. Reproductive parameters of females were examined in the form of clutch size (adjusted for SVL, = fecundity), and showed that female hybrids manifested increased levels of primary infertility (germ cell death reflected as smaller clutches) and secondary infertility (evident as inviable embryos). Females collected from within the zone showed a strong bias towards preferential matings with "F5-like" males. Some of the hybrid female fecundity reduction could be attributed to the presence of chromosome 2, but the genetic background of the sire is likely also to be an important factor influencing female reproductive success. [KEYWORDS: *Sceloporus grammicus*, parapatric hybridisation, chromosomal rearrangements, meiosis, synaptonemal complex, clutch size, female fecundity].

Reeder & Wiens,

C01

Phylogeny of *Sceloporus* (Squamata: Phrynosomatiidae): evidence from molecules and morphology. TOD W. REEDER[1] AND JOHN J. WIENS[2]. [1]*Dept of Herpetology, American Museum of Natural History, New York, NY 10024, United States of America.* [2]*Dept of Zoology, University of Texas at Austin, Austin, TX 78712, United States of America.* Molecular and morphological data were utilised to infer the phylogenetic relationships within the North American lizard genus *Sceloporus*. More than 70 species were coded for some or all of 85+ morphological characters, derived from osteology, squamation, karyology and life history. The molecular data were based on ≈900 bp of sequence information from the mitochondrial 12S and 16S ribosomal RNA genes for ≈30 species, yielding 185+ informative characters. The two data sets were combined and subjected to cladistic analysis using PAUP. The combined data set contained numerous taxa (=pseudofossils) that were scored for the morphological data but not for the sequence data. Traditionally, *Sceloporus* has been divided into two lineages. These are the small-scaled and large-scaled radiations, with the genus *Sator* postulated to be nested within the small-scaled radiation. In our analysis, *Sator* was included in the ingroup to test the monophyly of *Sceloporus*. Our results suggest: 1) *Sator* is the sister taxon to *Sceloporus*, thus corroborating the monophyly of *Sceloporus*, 2) most of the small-scaled species groups (e.g. *siniferus*, *pyrocephalus*, *jalapae*, *scalaris*) are monophyletic, 3) the monophyly of most of the large-scaled species groups is not supported, 4) the small-scaled radiation is not monophyletic, but instead forms a graded series of lineages leading to a clade composed primarily of large-scaled species, and 5) the large-scaled radiation is monophyletic if the *scalaris* species group is included. Based on our analysis, a new classification is proposed that is consistent with phylogeny. [KEYWORDS: Squamata, Phrynosomatidae, *Sceloporus*, phylogeny, morphology, rDNA, classification].

Rehák

C06–144

Notes to the snake fauna of west Ethiopia. IVAN REHÁK. *ZOO Prague, Scientific Dept - Herpetology, Troja, 17100 Prague 7, Czech Republic.* In 1992 and 1993, the two Czech herpetological expeditions worked in Ethiopia, especially in Bedele area, Ilubabor Province. The material of snakes accumulated at Bedele consists of 9–10 species, including 5 Ethiopian endemics, some of them very poorly known and now available for the first time as living specimens for further herpetological research: *Bitis parviocula* Böhme, 1977 — Ethiopian endemic, the third known specimen was collected; *Crotaphopeltis hotamboeia* Laurentus, 1768; *Dasypeltis atra* Sternfeld, 1912 — the northernmost distribution recorded; *Dasypeltis* sp.; *Lamprophis erlangeri* Sternfeld, 1908 — Ethiopian endemic, now rediscovered species; *Philothamnus* sp.; *Pseudoboodon boehmei* Rasmussen et Largen, 1992 — Ethiopian endemic, previously known of 5 preserved specimens; *Pseudoboodon lemniscatus* Duméril et Bibron, 1854 — Ethiopian endemic; *Rhinotyphlops somalicus* Boulenger, 1895 — Ethiopian endemic, the largest known specimen (67 cm) was collected. Moreover, the exuvia of the viper *Bitus arietans* Merrem, 1820 was collected at altitude 2,200 m a.s.l., unusual for the species. The detailed studies are in preparation.

Rehorek *et al.*

C05

A comparative morphological analysis of the Harderian glands of three species of *Lerista* (Scincidae). SUSAN J. REHOREK[1], BRUCE T. FIRTH[1] AND MARK N. HUTCHINSON[2]. [1]*Dept of Anatomy and Histology, The University of Adelaide, SA 5005, Australia.* [2]*Herpetology Section, South Australia Museum, North Terrace, Adelaide 5000, Australia.* The Harderian gland is found in the antero-medial

region of the orbit in most terrestrial vertebrates. It has been found in all reptiles thus far examined, but its association with other morphological orbital features is diverse. The function of the reptilian Harderian gland is unknown, but orbital lubrication, chemoreception and a role in preliminary digestion have been suggested for different reptile groups. We hypothesised that if the Harderian gland has a role in orbital lubrication, the gross morphology of the gland must be influenced by the orbital environment. Three skink species of the genus *Lerista* were chosen for their high degree of orbital variation. Two main variables were examined a) the effects on the gross morphology of the Harderian gland due to the presence of a clear scale which completely covers the eye (*L. muelleri*) and b) the level of miniaturisation of the skull in fossorial skinks (*L. edwardsae*).*L. bougainvilli,* which possesses an unmodified orbit, was used as the control species. The shape of the Harderian gland differed in all three species. The size of the Harderian gland in *L. edwardsae* was found to be statistically different from those of the other two species. This, however, could be a feature of skull miniaturisation. Thus, it appears that the availability of space in the orbit, not the functional anatomy of the orbital environment, results in the variations in size and shape of the scincid Harderian gland. The supposition that the Harderian gland may have a lubricatory role in the orbit of scincid lizards therefore seems unlikely. This is further supported by the presence of a postero-dorsally located mucous-secreting lacrimal gland in all three species. Hence, the Harderian gland in Australian scincid lizards may have a role in either chemoreception or preliminary digestion. [KEYWORDS: Harderian gland, skinks, spectacle, skull, miniaturisation, lacrimal gland].

Reid & Rakotobearison

C06– 146

Captive breeding of the critically endangered tortoise *Geochelone yniphora* in Madagascar. DON REID[1] AND GERMAIN RAKOTOBEARISON[2]. [1]*Field Conservation Officer (Madagascar), Jersey Wildlife Preservation Trust, B.P. 738, Antananarivo 101, Madagascar.* [2]*Chef d'Elevage des Tortues, Eaux et Forets, Station Forestiere d'Ampijoroa, Andranofasika, Ambato-Boeni, Mahajanga 403, Madagascar.* The captive breeding of a critically endangered tortoise, the angonoka *Geochelone yniphora* at Ampijoroa Forestry Station in north-west Madagascar is described, with particular reference to incubation techniques, incubation periods, hatching times, and techniques to improve survival chances of hatchlings. Since the program began in 1987 hatch success and survival rate have markedly improved over successive years. By December 1992, 70 juvenile angonoka survive. Incubation periods vary from 148 days to 297 days, and incubation temperatures are also extremely variable. The intention to release young animals on a legally protected reserve to be established by the Malagasy Government within their natural range following the findings of an ongoing field study program is also discussed. [KEYWORDS: tortoise, *Geochelone yniphora*, angonoka, Madagascar].

Rhodin *et al.*

C06– 148

Electron microscopical analysis of cartilage canals and vascular growth in the humerus of leatherback turtle hatchlings, *Dermochelys coriacea*. JOHANNES A.G. RHODIN[1], ANDERS G.J. RHODIN[2] AND JAMES R. SPOTILA[3]. [1]*Dept of Anatomy, College of Medicine, University of South Florida, Tampa, Florida 33612, United States of America.* [2]*Chelonian Research Foundation Lunenburg, Massachusetts 01462 and Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts 02138, United States of America.* [3]*Dept of Bioscience and Biotechnology,*

College of Science, Drexel University, Philadelphia, Pennsylvania 19104, United States of America. In a comprehensive description and discussion of the comparative chondro-osseous development and growth of marine turtles, the unique pattern of vascular ingrowth and the formation of cartilage canals in the leatherback turtle (*Dermochelys coriacea*) were previously analysed by light microscopy [A.G.J. Rhodin, 1985, *Copeia* 1985(3):752-771]. In an attempt to further elucidate the ultrastructural characteristics of these processes, humeri from leatherback turtle hatchlings were examined by transmission electron microscopy. The transparency of the plastic resins used as embedding media allowed us to first identify the vascular ingrowths by light microscopy, and then to select specific growth cones and cartilage canals for electron microscopy. These were serially sectioned, either parallel to the long axis of the growth cone or across, beginning near the leading tip of the cartilage canal. Thick sections for light microscopy were alternated with thin sections for electron microscopy, thus allowing us to view the vascular growth cone and its cellular contents, and to reveal the nature of the cells associated with the vasculature and the cartilage canals. Preliminary results demonstrate that the chondrocytes in a narrow zone surrounding the leading tip of the vascular cone undergo a process of cell death, indicated by their highly pyknotic nuclei and breakdown of cytoplasmic organelles. However, chondrocytes located more peripherally and below the leading growth tip show the process typical for stages preceding bone formation: proliferation, hypertrophy, and degeneration, concomitant with calcification of the cartilaginous matrix. The blood vessels of the vascular growth cone are mainly large capillaries consisting of endothelial cells and peripheral pericytic cells of mesenchymal nature. There are also multinucleated giant cells present near the vascular growth tip. These cells show an ultrastructure reminiscent of mammalian osteoclasts, although they lack the typical microvilli of this cell type. We believe that these cells represent chondroclasts engaged in a process of matrix breakdown and that they are, perhaps, responsible for the demise of the chondrocytes around the top of the cartilage canal. The cartilage canals are lined by primitive mesenchymal cells, and there are also numerous additional cell types such as macrophages, monocytes, leukocytes and occasional erythrocytes. The topographical arrangement of the blood vessels in the cartilage canals is not yet completely understood, but we are attempting a three-dimensional reconstruction. Preliminary results indicate that these vessels are arranged in a cascade-like formation with a feeder arteriole giving rise to several capillary sprouts, which in turn form venous capillaries that return the blond to venules and veins. [KEYWORDS: cartilage canals, microvascular circulation, capillary buds, *Dermochelys coriacea*].

Richards *et al.*

C06–150

Declines in populations of Australia's endemic tropical rainforest frogs. STEPHEN J. RICHARDS[1], KEITH R. MCDONALD[2] AND ROSS A. ALFORD[1]. [1]*Zoology Dept, James Cook University, Townsville, Qld 4811, Australia.* [2]*Conservation Strategy Branch, Queensland Dept of Environment and Heritage, Atherton, Qld 4883, Australia.* Repeated, quantitative sampling of stream dwelling frogs over the past four years has shown that populations of six frog species endemic to the tropical rainforests of northern Queensland have declined. Declines have occurred at high altitudes in the southern portions of the tropical rainforest. An extensive survey conducted during 1991- 1993 did not locate any individuals of two upland species, *Litoria nyakalensis* and *Taudactylus*

rheophilus. Another upland species, *T. acutirostris*, which formerly was widely distributed, appears to have declined in rainforests south of the Daintree River. Three species (*Litoria nannotis*, *L. rheocola* and *Nyctimystes dayi)* were absent from most upland sites south of the Daintree River, but were common at lowland sites and at all sites north of the Daintree River. Declines appear to be unrelated to aspects of water chemistry, the history of forestry or mining at sites, or to lack of wet season rain. Once declines have occurred, fragmentation of rainforest habitats may prevent recolonisation from adjacent sites. [KEYWORDS: frogs, population declines, rainforest].

Richter & Krügel

C06–151

***Syncope antenori* — a nonfeeding tadpole of the Amazonian rain forest.** SUSANNE RICHTER[1] AND PETER KRÜGEL[2]. [1]*Dept of Zoology, University of Vienna, Althanstr. 14, 1090 Vienna, Austria.* [2]*Austrian Academy of Sciences, Kegelg. 27, 1030 Vienna, Austria.* Tiny water bodies, like bromeliads, require special adaptations in larval development. To avoid crowding between tadpoles anurans must 1) produce fewer eggs or 2) disperse their clutch to several aquatic sites. A limiting basic resource may also be the varying amount of food necessary for larval development. Feeding with nutritive, unfertilised eggs or investment in eggs with a large amount of yolk are obviously reactions to the limited food resource. Nonfeeding, free swimming tadpoles are known only in four microhylid genera (*Anodonthyla*, *Platypelis*, *Plethodontohyla*, *Kalophrynus*). The heavily yolk filled intestines which are very similar to those of *Platypelis grandis* and the complete absence of foodtraps strongly indicate that tadpoles of *S. antenori* do not feed during larval development. *Syncope* is the first anuran species with reproduction mode 6 (free swimming, nonfeeding larvae) for the Neotropics. In this study, the larval digestive system of the syntopically living Peruvian microphagous larvae of *Chiasmocleis bassleri* is compared with the digestive tract of the tadpoles of *S. antenori* and the nonfeeding Malagassian microhylid larvae of *Platypelis grandis*. In contrast to *Chiasmocleis bassleri*, *S. antenori* and *P. grandis* possess a rather similar buccopharyngeal cavity and a short digestive tract. Internal gills are lacking in both genera. *Chiasmocleis*, however, is characterised by internal gills, a typical microhylid oral cavity and a long, highly differentiated digestive tract. [KEYWORDS: nonfeeding tadpole, larval digestive tract, Amazon Basin].

Richter & Splechtna

C05

The pro- and opisthonephric problem — new aspects in anuran kidney development. SUSANNE RICHTER AND HEINZ SPLECHTNA. *Dept of Zoology, University of Vienna, Althanstr. 14, 1090 Vienna, Austria.* The development of the kidney in *Rana esculenta* can be described as a progressive event beginning with the formation of a pronephros at G stage 16, followed by an intermediate opisthonephric kidney at G stage 24 and a definitive opisthonephric kidney at G stage 28–32. The pronephros develops progressively more anteriorly as a response to the advantage of the earlier differentiation of the anterior body region whereas the opisthonephros arises in the posterior body cavity. Pronephros and, later on, the intermediate opisthonephric kidney are able to satisfy the excretory needs of larvae. Both are transient. Concerning the organisation and differentiation of the larval kidneys the pro- and intermediate opisthonephric kidney show similarities to the pro- and mesonephros of amniotes. On the other hand the definitive opisthonephric kidney specially adapted for adult life is similar to the metanephros. Both, pronephric and opisthonephric nephrons arise

from the intermediate plate; tubules are formed by evaginations of the somatopleura, Bowmans capsule and mesangial cells by the splanchnopleura. Glomular and glomerular vessels originate from outgrowths of the Aorta dorsalis and Vena cardinalis posterior. The renal corpuscles of the pro- and opisthonephros are characterised by a juxtaglomerular-like apparatus. In the pronephros it consists only of epitheloid cells, in the larval and adult opisthonephros it comprises granular cells, Lacis cells and a Macula densa. Though renal tubules of the pronephros, intermediate and definitive opisthonephros possess similar segments they have distinct different cellular structures. [KEYWORDS: excretory system, anuran larvae, *Rana esculenta*].

Roberts

C06–152

The thermal sensitivity and ecological relationships of endurance and sprint speed in Australian geckos. ALAN ROBERTS. *Dept of Zoology, University of Western Australia, Nedlands, WA 6009, Australia.* Levels of endurance (stamina) determined for 5 species of Australian gecko are evolutionary adapted to their ecology. In all species, endurance was maximal between 25°C and 28°C, which is well below the optimal temperatures for diurnal species. This reflects the low body temperatures (T_bs) experienced by nocturnal lizards during their activity time (about 25°C). In contrast, sprint speed was maximal at T_bs greater than 35°C, which is well above the likely nocturnal T_bs of these geckos. The difference in thermal optima between endurance and sprint speed suggests that these physiological functions have responded to different evolutionary pressures. Differences in maximum endurance times between species corresponded to ecological differences. Peak endurance was lowest for *Diplodactylus assimilus*, an arboreal sit-and-wait predator, and highest for *Rhynchoedura ornata* and *D. pulcher*, which are terrestrial and termite specialists. Maximum endurance times were intermediate for a semi-arboreal gecko, *D. granariensis*, and a terrestrial generalist gecko, *D. stenodactylus*. For an arboreal sit-and-wait predator like *D. assimilus*, foraging does not involved prolonged periods of movement. Termites however, constitute a clumped resource and it is highly likely that *R. ornata* and *D. pulcher* have to cover considerable distances in order to locate prey. The degree of movement undertaken during foraging by *D. granariensis* and *D. stenodactylus* are likely to be intermediate to these extremes. Levels of endurance therefore appear to reflect the amount of movement undertaken whilst foraging. The endurance of *D. pulcher* is closer to the ecologically similar *R. ornata* than to its congeners, suggesting that ecological factors may be more important than phylogenetic relationships in determining endurance times. Interspecific variation in maximum sprint speed did not follow the pattern observed for endurance, nor did it correspond to other known ecological relationships between these species. The high optimum temperature for sprint speed suggests that any adaptation has been in response to selective pressures experienced whilst animals are in their diurnal retreats. This may for instance indicate a greater risk of predation during the day than at night. Interspecific differences may result directly from different levels of selection or indirectly as a result of other physiological and/or morphological differences. [KEYWORDS: geckos, endurance, sprint speed, thermal sensitivity, ecology].

Roberts *et al.*

C17

The use of operative temperatures to interpret thermoregulation in the Australian agamid *Ctenophorus isolepis*. ALAN ROBERTS, DYLAN KORCZYNSKYJ AND PHILIP WITHERS. *Dept of Zoology, University of Western Australia, Nedlands,*

WA 6009, Australia. We use operative temperature (T_e) models to investigate thermoregulatory precision and the mechanisms by which it is achieved in the Australian Agamid *Ctenophorus isolepis citrinus*. *C. isolepis* was found to thermoregulate precisely, with only a slight, positive relationship (slope=0.23) between body temperature (T_b) and mean environmental temperature (MET). MET was calculated as the average T_e of the environment occupied by the lizards ($\bar{x}T_e$) and thus represents average ambient temperature that they experienced. Air temperature (T_a) was found to underestimate thermoregulatory precision by inadequately representing the diurnal range of environmental temperatures experienced (slope T_b vs. T_a =0.46). T_es (and therefore the $\bar{x}T_e$ experienced by an animal) are influenced by the physical characteristics of both the animal and its environment. The amount by which T_a underestimates thermoregulatory precision will therefore depend upon the species under investigation and the microhabitat it occupies. These relationships strongly argue for the use of a compound measure of ambient temperature relevant to the animal of interest, such as $\bar{x}T_e$, rather than the use of a single measure of ambient temperature, such as T_a or T_e, when comparing the thermoregulatory abilities of different species. *C. isolepis* uses 3 mechanisms to achieve its high level of thermoregulatory precision: 1) microhabitat use, 2) posture and 3) orientation to the sun. Microhabitat use exerted the greatest influence on T_b by determining the nanoclimate to which lizards were exposed. The range of T_es (and therefore potential T_bs) present within the environment varied from 10°C at the time of emergence (0700–0800) to > 30°C at 1400. The use of nanoclimate types by *C. isolepis* was non random throughout the day with lizards occupying those areas with T_es closest to their preferred body temperature (PBT). The diurnal pattern of posturing exhibited by *C. isolepis* was strongly time and temperature dependant. Posture had its greatest influence on T_b during the hottest part of the day when the difference between air and substrate temperature is highest. The influence of orientation on T_b varied temporally with solar elevation. In contrast to microhabitat use and posture, it was greatest when the sun was close to the horizon and orientation was most able to influence the angle of incidence between the lizards body and incoming radiation. [KEYWORDS: agamid, thermoregulation, T_b, T_a, T_e, nanoclimate, posture, orientation].

Roberts

C04

Call structures in overlap zones between *Pseudophryne guentheri* and *P. occidentalis* (Anura : Myobatrachidae) in Western Australia. J. DALE ROBERTS. *Dept of Zoology, University of Western Australia, Nedlands, W.A. 6009, Australia.* *Pseudophryne occidentalis* and *P. guentheri* overlap in the wheatbelt of Western Australia. Calls of these two species are distinct with *P. occidentalis* commonly making two distinct calls, a short and a long call, but *P. guentheri* making one. The short call of *P. occidentalis* is structurally similar to the advertisement call of *P. guentheri*. Electrophoretic analysis of variation at twenty loci revealed six fixed differences in comparisons of allopatric populations of the two species. In the overlap zone electrophoresis indicates no current F1 hybrids but a period of hybridisation in the past. This situation is one where reinforcement of call differences (i.e. reproductive character displacement) is likely. Calls were analysed from 333 *P. guentheri* from 12 allopatric and 10 sympatric sites and 278 *P. occidentalis* from 12 allopatric and 11 sympatric sites. This paper will report on geographic variation in calls of both species and determine whether either species shows evidence of reinforcement. Preliminary

analyses based on a partial data set indicate significant shifts in pulse repetition rate for *P. occidentalis* when comparisons are made between allopatric and sympatric populations but no shifts consistent with the occurrence of reinforcement for *P. guentheri*. [KEYWORDS: Anura, *Pseudophryne*, advertisement calls, reinforcement, hybridisation].

Calling behaviour in desert anurans: ecological and phylogenetic factors. J. DALE ROBERTS[1] AND BRIAN K. SULLIVAN[2]. [1]*Dept of Zoology, University of Western Australia, Nedlands, WA 6009, Australia.* [2]*Life Sciences Program, Arizona State University West, P.O. Box 37100, Phoenix, AZ 85069, United States of America.* We evaluated intra- and inter-specific variation in advertisement calls of anurans occurring in both mesic and xeric environments in Australia and North America. *Bufo cognatus* (2 mesic, 4 xeric samples) and *B. punctatus* (2 mesic, 3 xeric samples) showed little geographic variation in three call characters: pulse rate, call duration and dominant frequency. Principal Components Analysis also showed no detectable geographic variation. In *Neobatrachus kunapalari* (4 mesic, 1 xeric sample) one mesic population had a lower mean pulse number but there was no variation in pulse rate or dominant frequency. Principal Component Analysis also showed no significant geographic variation for *N. kunapalari*. The lack of differentiation occurs despite variation in abiotic (temperature, rainfall pattern and total annual rainfall) and biotic (number of sympatric congeners) factors. Comparisons of calls in five arid zone *Neobatrachus* (four tetraploid — *N. aquilonius*, *N. centralis*, *N. kunapalari*, *N. sudelli*, one diploid — *N. fulvus*) revealed a common call structure: low pulse numbers and low pulse rates. Congeneric species from more mesic sites have higher pulse numbers and pulse rates. The similarity in calls of xeric taxa may indicate common ancestry with the four tetraploids derived from *N. fulvus*, or it may indicate an ecological selection pressure related to the duration and availability of breeding opportunities in the arid zone. [KEYWORDS: deserts, Anura, *Bufo*, *Neobatrachus*, advertisement calls].

Roberts & Sullivan

S09

Frogs of the *Geocrinia rosea* complex: conservation issues in south-western Australia. J. DALE ROBERTS[1], GRANT WARDELL-JOHNSON[2] AND DON DRISCOLL[1,2]. [1]*Dept of Zoology, University of Western Australia, Nedlands, W.A. 6009, Australia.* [2]*Dept of Conservation and Land Management of Western Australia, Research Section, Brain Street, Maajimup, WA, 6258, Australia.* The *Geocrinia rosea* complex contains four frog species found across the far south-west corner of Western Australia: *G. lutea* around Walpole; *G. rosea* from the drainages of the Shannon to Donnelly Rivers; *G. vitellina* in Spearwood Creek and four unnamed seepages close to Spearwood Creek; and *G. alba* between Witchcliffe and Karridale, west of the Blackwood River. All are spring-surnmer breeders with direct development of the eggs. *G. vitellina* has approximately 0.2 km^2 of suitable breeding habitat and disturbance, e.g. foraging by feral pigs, at any of the five known breeding sites could cause local extinction. Captive breeding or, introduction to sites outside the natural range coupled with reintroduction programs may be warranted to replace unnatural loss of *G. vitellina* populations. *G. alba* has lost about 70% of suitable breeding sites to clearing within a total range of 101 km^2. Local extinctions have occurred at ten sites within the last eight years, caused by clearing or associated with intense fires. Reintroduction of *G. alba* to sites where vegetation has been rehabilitated may be warranted as a long-term conservation

Roberts *et al.*

C06–153

measure. [KEYWORDS: *Geocrinia*, Anura, conservation, reintroduction, restricted distributions].

Roberts

S21

Embryo survival in two species of tropical Hylidae with leaf-laid eggs. WENDY E. ROBERTS. *Museum of Vertebrate Zoology, University of California, Berkeley, CA 94720, United States of America.* While intense predation of aquatic eggs may have influenced the evolution of diverse reproductive modes in tropical frogs, few studies have measured survival in either aquatic or non-aquatic eggs. From 1990 to 1992 I quantified embryo survival from egg laying until tadpole hatching in two species of Hylidae laying eggs on leaves above a swamp at La Selva, Costa Rica. Although predation by snakes and insects was observed on embryos of both *Agalychnis callidryas* and *Hyla ebraccata*, it caused little mortality. Eggs of *H. ebraccata* experienced more desiccation but still had higher survival rates than those of *A. callidryas*, which were sometimes swept into the water before development was completed. Parental behaviour during egg laying differed between the two species, and influenced the outcome of survival until tadpole hatching. Survival of embryos of both these species was higher than that of aquatic eggs laid by other hylids in the same swamp. [KEYWORDS: Anura, embryo survival, reproductive mode, tropics, Costa Rica].

Robertson

S21

Selection for communal egg-laying in scincid lizards. PETER ROBERTSON. *Wildlife Research Section, Dept of Conservation and Natural Resources, P.O. Box 137, Heidelberg, Vic 3084, Australia.* Communal egg-laying has been recorded for a number of small scincid lizards in south- eastern Australia, and elsewhere for gekkonid lizards and elapid snakes. Clutches may contain up to 250 eggs, representing the efforts of up to 80 females The simplest explanation of this phenomenon is a shortage of sites suitable for egg deposition and incubation. Other hypotheses suggest that the temperature or hydric environment of the site may be influenced by larger numbers of eggs, that exchange of moisture or gases between the developing embryo and the environment may be affected, or that predation rates on different size clutches may vary. To test these, a number of communal clutches, of different sizes, of the McCoy's Skink *Nannoscincus maccoyi* were monitored during the incubation period. Egg deposition sites did not appear to be limiting, and the physical environments of large clutches were not significantly different from small clutches. No instances of predation by vertebrates were recorded, however many eggs were destroyed by invertebrates (beetle larvae and ants), with predation rate significantly lower in larger clutches. It is suggested that communal egg-laying behaviour in this species may have evolved as a predator avoidance mechanism. [KEYWORDS: communal egg-laying, parental care, predation, Scincidae].

Roček

S02

Taxonomy and distribution of Tertiary discoglossids (Anura) of the genus *Latonia* v.Meyer, 1843. ZBYNĚK ROČEK. *Dept of Paleontology, Geological Institute, Academy of Sciences, Rozvojov ' 135,165 00 Prague 6 — Suchdol, Czech Republic.* Definition of the genus *Latonia* v.Meyer, 1843 (Anura, Discoglossidae) and description of all its known skeletal elements are given. Taxonomic revision based on both articulated skeletons and disarticulated bones from tbe Late Oligocene to Pliocene deposits of various European localities revealed that *"Prodiscoglossus" vertaizoni* Friant, 1944 is in fact the earliest known *Latonia* identical with that from the French locality, Coderet,

both of the Late Oligocene age. The Miocene representatives of the genus, namely *Latonia seyfriedi* v.Meyer, 1843, *L. gigantea* (Lartet, 1851), *L. ragei* Hossini, 1993 and *Latonia* sp. have been widely spread in western, central, and eastern Europe. General evolutionary trends that can be recognised in the Miocene and Pliocene material are appearance of the secondary dermal sculpture on the maxillae of some species, and gigantism. Summary of evolution within the genus *Latonia* and a revised description of the holotype of *L. seyfriedi* and hitherto unknown specimen from the type locality Öhningen are given. It was confirmed that *Discoglossus giganteus* Wettstein-Westersheimb, 1955 and *Pelobates robustus* Bolkay, 1913 are synonyms of *Latonia*, and the same holds (besides mentioned *Prodiscoglossus vertaizoni)* also for *Diplopelturus ruscinensis* Depéret, 1890. *Latonia fejfari* (Špinar, 1975) and *L. kolebabi* Špinar, 1976 are synonyms of *L. gigantea*. Since *L. gigantea* and *L. ragei* were described on the basis of disarticulated bones (the principal diagnostic character being presence/absence of sculpture on the maxilla), whereas *L. seyfriedi* was based on articulated skeletons embedded by their dorsal side in matrix, the taxonomic relations between the three forms remain unsolved until further preparation of the latter holotype will be possible. Available data about the geographic and stratigraphic distribution are summarized and discussed on the background of the palaeogeographic and palaeoclimatic situation in Europe during the Neogene. [KEYWORDS: Discoglossidae, *Latonia*, Tertiary, Europe, evolution, paleozoogeography].

Roček & Lamaud

C06– 154

Leptodactylid frogs in Europe. ZBYNĚK ROČEK[1] AND PIERRE LAMAUD[2]. [1]*Dept of Paleontology, Geological Institute, Academy of Sciences, Rozvojov ' 135, 165 00 Praha 6 — Suchdol, Czech Republic.* [2]*Grande rue, 39380 Chissey sur Loue, France.* In 1903, De Stefano erected the new genus *Thaumastosaurus* for a supposed saurian reptile found in the phosphorites of Quercy (Eocene of SW France). Nopcsa (1908) considered the similar name *Thaumattosaurus* v.Meyer 1841 as a homonym, and therefore he proposed the new name *Enigmatosaurus*. Hoffstetter (1945) correctly recognised that this animal is in fact an anuran, and Rage (1981) placed it in Ceratophryinae (Leptodactylidae). Recently, a new material was discovered (sphenethmoids, prooticooccipitals, nasals, maxillae, squamosals, etc.) at the site La Bouffie (Lower Ludian, Quercy) which made it possible to give full description of all available skeletal elements, definition of the genus, revision of its taxonomic position, and since the holotype of *Thaumaslosaurus* was lost, designation of the neotype. It turned out that Rage's original taxonomic assignment was correct and that this anuran is morphologically very close to *Eophractus* Schaeffer, 1949 from the Lower Eocene of Patagonia and to contemporary *Caudiverbera* Laurenti, 1768. In accordance with the International Code of Zoological Nomenclature (1985) the original name *Thaumastosaurus* should be retained, so the full name of this anuran is *T. botti* De Stefano, 1903. Its presence in Europe in the late Eocene suggests some connection between Gondwana and Laurasia in the late Mesozoic and/or early Tertiary, and its absence in the Neogene of Europe confirms profound faunal changes at the Eocene/Oligocene border ("Grande Coupure"). [KEYWORDS: Leptodactylidae, Tertiary, Europe].

Rocha

C06–155

Plant food preference and ontogenetic shift in diet in the lizard *Liolaemus lutzae* of southeastern Brazil. CARLOS FREDERICO D. ROCHA. *Setor de Ecologia,*

Inst. Biologia, Universidade do Estado do Rio de Janeiro, Maracanã, Rio de Janeiro, RJ, 20550, Brazil. I studied the diet of the tropidurid lizard *Liolaemus lutzae* in an area of "restinga" (sand dune habitats) — Barra de Maric´ — of Southeastern Brazil. The stomach contents of 180 (79 males, 101 females) lizards were analysed in terms of number and volume of each category of prey. The data showed that *L. lutzae* has a generalised diet that includes both arthropods and plant material (leaves and flowers). Only four (*Alternanthera maritima*, *Phylloxerus portulacoides*, *Ipomoea litorallis* and *I. pes-caprae*) of the 19 plant species of the beach habitat were consumed by the lizards. These plants were those with the highest level of water and nitrogen contents, but had the lowest level of cellulose contents. Male and female *L. lutzae* shift ontogenetically in diet. Hatchlings up to 39.0 mm SVL are exclusively carnivorous, including successively higher proportions of plant material with the increase in size (r^2=0.52; p=0.02). Males and females differed significantly in the proportion of plant material consumed (ANCOVA, $F_{2,167}$= 92.90; $p < 0.05$), although the plant consumption increase at similar rate in the sexes (t = 0.31; N =180; p = 0.754). Adults of *L. lutzae* are omnivorous, primarily herbivorous. I conclude that *L. lutzae* shifts ontogenetically in diet and that it selects some of the plants of the beach habitat apparently due to their qualitative properties. [KEYWORDS: Lizard, *Liolaemus lutzae*, diet, ontogenetic shift, plant consumption].

Rodda & Chiszar

S21

Are cotton swab presentations a sufficient model for ophidian prey recognition? GORDON H. RODDA[1] AND DAVID CHISZAR[2]. [1]*US Fish and Wildlife service, 4512 McMurry Ave., Fort Collins, Colorado 80525, United States of America.* [2]*Dept of Psychology, University of Colorado, Boulder, Colorado 80309, United States of America.* A large number of studies of prey recognition in snakes has involved the presentation of prey extracts or other chemical cues on cotton swabs. When given the opportunity, snakes often attack and attempt to ingest the swab, confirming the realism of the laboratory model. Work by Chiszar and others has shown a consistent strong response of Brown Tree Snakes, *Boiga irregularis*, to a variety of chemical cues, especially those of vertebrate blood. The relative efficacies of chemical cues for attracting Brown Tree Snakes was tested in the field. Each of 100 randomised traps had one of five bait types: live mice, blood, another inanimate bait that elicited a strong laboratory response (a catfish bait), a commercial snake lure (which failed to elicit a strong response in the laboratory), and a control. The total captures using these baits were: 507 (mice), 29 (blood), 25 (catfish bait), 19 (snake lure), and 10 (control). Under field conditions, the chemical cues had about 1/20 of the effectiveness of a natural prey item, and the relative differences in efficacies of the inanimate attractants were not demonstrable. Among the factors that may be responsible for the lack of correspondence between our laboratory and field results are: 1) modes of prey recognition may differ with distance from the prey (only short distances used in lab), 2) chemical cues may not be stable over time (only short durations studied in lab), and 3) multiple sensory channels, including non-olfactory channels (not studied in lab), may be important in prey recognition. [KEYWORDS: prey recognition, cotton swabs, odour extracts, Serpentes, *Boiga irregularis*, blood, tongue flicks].

Rodda & Fritts

Perturbations of insular herpetofaunas: perspectives from study of the

S08

brown tree snake in the western Pacific. GORDON H. RODDA[1] AND THOMAS H. FRITTS[2]. [1]*US Fish and Wildlife Service, 4512 McMurry Ave., Fort Collins, Colorado 80525, United States of America.* [2]*US Fish and Wildlife Service, National Museum of Natural History, Washington, DC 20560, United States of America.* The native fauna of the western Pacific island of Guam has been decimated by the introduction of the Brown Tree Snake, *Boiga irregularis*. Most of the island's native bird, mammal, and lizard species have been lost. We will summarise seven years of population and dietary samples of the snake and its native and introduced prey species. Introduced birds, mammals, and lizards have declined in abundance, apparently in response to historically unprecedented populations of the introduced snake, but none of the introduced prey species has been extirpated. Unlike Guam's native species, the introduced prey originated in areas of sympatry with snakes. In most areas of Guam, the introduced species now constitute the bulk of prey for the snake. These facts suggest that coevolution of predator and prey are important for the persistence of both. Furthermore, dietary dependence of the snake on introduced prey suggests that the snake would not have attained the high population densities that it has, nor would it have had such a dramatic impact on native wildlife, if introduced prey had not been abundant. Based on this scenario, we predict that any new introductions of snakes to oceanic islands will have maximal impact on native wildlife on those islands lacking native snakes and possessing abundant introduced prey. For example, within Micronesia, Saipan is likely to be more vulnerable than are the Palau Islands. [KEYWORDS: introduced species, Brown Tree Snake, *Boiga irregularis*, Guam, predator-prey interactions, extinction].

Rodda & Rondeau

C09

Population regulation of the brown tree snake in Guam and Melanesia: is predation release the key to the success of extralimital populations? GORDON H. RODDA[1] AND RENÉE J. RONDEAU[2]. [1]*US Fish and Wildlife Service, 4512 McMurry Ave., Fort Collins, Colorado 80525, United States of America.* [2]*The Nature Conservancy, 1244 Pine St., Boulder, CO 80302, United States of America.* The Brown Tree Snake, *Boiga irregularis*, has thrived as an introduced species on the island of Guam. Peak densities of the snake have exceeded 50/ha and densities in excess of 30/ha appear stable in some areas. Are these high densities attributable to the absence of snake predators from the island of Guam, or are there other causal factors which differ between this extralimital population and the snake's native range? We studied the abundance of the snake, potential predators, and major prey types at six sites within the snake's native range: two sites on New Guinea, two sites on islands north of New Guinea, and two sites in the eastern Solomon Islands. At all six sites, snake and prey densities were lower than on Guam, but the presence of potential predators was variable. At sites in the eastern Solomons there were no native species that would prey on the snake, and the introduced predators are similar to those on Guam. In contrast, prey densities, especially of the lizards which constitute the primary prey for young snakes, were much lower in all native range sites. A multiple regression model incorporating the relative densities of competing snakes, frog prey, skink prey, and gecko prey at ten sites (four Guam, six native range) suggested that lizard prey abundances were key correlates of snake abundances. Frog density did not make a significant contribution to the model, and the abundances of snakes were correlated, possibly reflecting overlap in diet. We conclude that Brown Tree Snake populations are affected more strongly

by prey availability than by predation pressure. [KEYWORDS: population regulation, Guam, *Boiga irregularis*, Papua New Guinea, Solomon Islands, predation, prey, extralimital populations].

Rodrigues

C06–156

Lizards, snakes and amphisbaenians of the palaeoquaternary sand dunes of the middle São Francisco River: Bahia, Brazil. MIGUEL TREFAUT RODRIGUES. *Universidade de São Paulo, Instituto de Biociências, Departamento de Zoologia, Caixa Postal 20520, 01498-970 São Paulo, SP, Brazil.* A palaeoquaternary desert was discovered in the morphoclimatic domain of the semiarid Brazilian Caatinga. This site of high continental dunes is located at the environs of the banks of the middle São Francisco River, State of Bahia, Brazil. A preliminary herpetological survey indicates that the area harbors a very peculiar fauna showing striking adaptations to psammophily, with a species richness and endemism unparalleled in South America. This area, equivalent to 5000 km^2, presents 35 species of lizards and amphisbaenians and 26 species of snakes totalling 20 new endemic reptiles including several new genera and species. This fauna is also characterised by the abundance and high diversity of fossorial and nocturnal forms differing strongly in composition from Caatinga and the previously studied North American, Kalahari and Australian desert faunas. These differences are thought to be the result of an association of an ecogeographic mechanism of speciation initially synchronic and latter replaced by a classic allopatric mode of speciation actuating in an ancestral caatinga fauna. The last event of speciation occurred when the river attained full exorreism dividing formally continuous sands and isolating ancestral psammophilic populations on opposite banks. At present four closely related species pairs isolated by the river support this model. Possibly the period of species multiplication corresponded to the end of Würm-Wisconsin glacial. [KEYWORDS: lizards, snakes, Amphisbaenians, deserts, diversity, speciation].

Rodriguez

C12

Eight years of populations studies through male calling activity in anurans of Amazonian Peru. LILY O. RODRIGUEZ. *Depto Herpetologia, Museo de Historia Natural, UNMSM. Aptdo 14-0434 Lima 14, Peru.* Audio strip transects were used to characterise diel and seasonal patterns of calling activity in male frogs. The sample included five diurnal and five nocturnal species (Dendrobatidae and Leptodactylidae) from Manu, S.E. Peru. Diurnal frogs have restricted activity while nocturnal frogs also call during day time. Only *Eleutherodactylus toftae* exhibits both diurnal and nocturnal activity. Diel and seasonal activities appear to be species-specific and not restricted by modes of reproduction although weather conditions may influence males calling activity, time of day is more important. These data, collected over 8 years of field work, serve also to illustrate between years population fluctuations, probably related to annual rainfall variation. On the whole, no evidence of populations decline was found. [KEYWORDS: calling activity, weather conditions, diel patterns, seasonal patterns, population fluctuations].

Rohr

C21

Life history variation in a lowland and highland population of the southern water skink, *Eulamprus tympanum*. DETLEF ROHR. *Dept of Zoology, La Trobe University, Bundoora 3084, Australia.* Aspects of the life history of lowland and highland populations of the Southern Water Skink, *Eulamprus tympanum*, were compared. Current life history theory predicts that the populations should differ in certain life history traits as a result of adaptive responses to local environmental conditions. Because females from high altitude have relatively short activity seasons due to local climatological conditions, they should grow slower, mature later, and have a lower age-specific reproductive effort. However, the longer life span of females at high altitude may allow them to achieve a similar total lifetime production of offspring as females from the lowland population. Measurements taken include a range of parameters commonly used in life history studies such as size of females pre- and post-parturition, as well as litter and offspring size. In addition, the age of adult females was determined by skeletochronology to obtain estimates of age-specific fecundity and age at maturity. Quantitative analysis of lipid content in the tail of females post-parturition was used to examine the influences of tail autotomy on clutch size and/or mass. These results will be discussed in the context of current life history theory. [KEYWORDS: reproduction, life history, age-specific fecundity, Reptilia, Scincidae, *Eulamprus tympanum*].

Roithmair

S22

Mate choice and mating patterns in Peruvian dart-poison frogs. MARGARETE E. ROITHMAIR. *Institut für Zoologie, Universität Wien, Althanstrasse 14, A-1090 Wien, Austria.* The reproductive and social behaviour of two syntopic Dendrobatic species, *Epipedobates femoralis* and *Epipedobates trivittatus*, were studied in Amazonian Peru. Males of both species were territorial. Advertisement calls were used for spacing and marking of territories, and for mate attraction. Pair-formation, courtship, and mating took place in the territory of the male. The reproductive behaviour of the two species differed in length and pattern of courtship, oviposition behaviour and male brood-care behaviour. In both species, successful males called on more days and defended larger territories than unsuccessful males. Male body size and mating success were not correlated. Females were not territorial and were never attacked when approaching calling males. Females rejected males during courtship by leaving males or refusing nest sites. Females demonstrated active mate choice by sampling males and preferring particular males over others. In *E. femoralis*, all females visited other territories prior to pairing, finally choosing as mate the resident of the largest territory of all visited potential mates. In *E. trivattatus*, 35% of paired females sampled residents before mating and also preferred owners of large territories for mating. The unrestricted mobility of females may enable them to assess the ranges of various territories. Since territory size is dependent on calling activity, which involves high energetic costs, territory size may reveal male quality. [KEYWORDS: female choice, male mating success, territoriality, mating behaviour, dart-poison frogs].

Romero-Schmidt *et al.*

C06–157

Management practices effects on a lizard community of Baja California, Mexico. HEIDI ROMERO-SCHMIDT, ALFREDO ORTEGA-RUBIO AND CERAFINA ARGUELLES-MÉNDEZ. *Centro de Investigaciones Biológicas de Baja California Sur. A.P. 128, La Paz, 23000, B.C.S. Mexico.* The effects of different managing practices, especially extensive livestock, on a lizard community of Baja California Sur, Mexico were studied using a 10,000 m^2 8 years exclosure. During three consecutive days of a week of every month of 1992, the lizard's abundance were compared between grazed and ungrazed arid tropical scrub at the lower parts of La Sierra de La Laguna, Baja California Sur, Mexico. We censused two transect systems established inside and outside

the exclosure, in the search of active lizards. Also, the substrate availability and vegetation cover were estimated at both transects. The lizard community is composed of 8 species, but only three are abundant: *Urosaurus nigricaudus*, *Uta stansburiana* and *Cnemidophorus hyperythrus*. The statistical analysis of the lizard abundance indicates that there exist significant differences, inside and outside the exclosure, in only two species: *U. nigricaudus* and *U. stansburiana*. The differences found among population's responses to management practices on such few studied endemic species and subspecies of Mexico are analysed and discussed. [KEYWORDS: lizard community, management practices, Baja California, Mexico].

Ross

S25

Ultrasonographic assessment of the follicular maturation cycle, ovulation, and pregnancy in boid snakes. RICHARD ROSS. *Institute for Herpetological Research, P.O. Box 2227, Stanford, CA 94309, United States of America.* The follicular maturation and reproduction cycle in boid snakes is incompletely known. Much, however, can be inferred from captive breeding experiences and extrapolation from other reptile taxa. Ultrasonography is a technique used for visualisation of human embryos, and is being adapted for assessment of follicular development, ovulation, and embryogenesis in snakes. This technique allows visualisation of the very early stages of follicular maturation through ovulation, and also permits early identification of embryos. It is therefore, an excellent tool for reproductive husbandry, allowing the herpetologist to more completely understand follicular maturation and ovulation, and to assess the effect of varying conditions and situations on the development of the ovarian follicles, and also allows the determination of success or failure of mating trials with a high degree of accuracy. Routine ultrasonography permits the herpetologist to make accurate decisions regarding disposition of specimens during seasonal breeding trials: separations, reintroductions, feeding and temperature changes can all be performed based on accurate information rather than guesswork and intuition. A review of the follicular maturation cycle, and slide and video demonstrations of ultrasonography will be presented. [KEYWORDS: ultrasonography, boids, reproductive cycle].

Rowe *et al.*

S19

Exploitation of an aposematic signal: information "leakage" in rattlesnake rattling. MATTHEW P. ROWE[1], DONALD H. OWINGS[2] AND RONALD R. SWAISGOOD[2]. [1]*Dept of Biology, Appalachian State University, Boone, NC 28608, United States of America.* [2]*Dept of Psychology and Graduate Group in Animal Behavior, University of California at Davis, Davis, CA 95616, United States of America.* Although ethologists often treat signals as having been designed to "provide" information, it has been argued that at least some of this information is a product of broader functional and structural aspects of which the signal is a part. In the former view, rattling is assumed to be simply a ritualised signal used by rattlesnakes to inform enemies of their venomousness. In the latter view, rattling might be expected to contain more information than a simple warning about dangerousness. Physiological and morphological constraints on rattling, for example, may allow enemies to extract additional information about their risk of interacting with the rattlesnake. The interactions between northern Pacific rattlesnakes (*Crotalus viridis oreganus*) and California ground squirrels (*Spermophilus beecheyi*) provide an excellent system for such analyses. Although rattlesnakes are major predators on ground squirrel pups, adult squirrels will approach, harass, and even

attack the snake in defense of their young. In many of these encounters, rattlesnakes respond defensively by rattling and by striking. We recorded the rattling sounds and defensive strikes (using high-speed video) of rattlesnakes at 4 different body temperatures: 10, 18, 27, and 35°C. Results indicate that risks posed to a ground squirrel during an encounter with a rattlesnake vary as a function of both snake size and body temperature; cold snakes have slower and less accurate strikes than warm snakes, while large snakes have faster and longer strikes and inject more venom during bites than small snakes. Because of physiological and morphological constraints, however, rattling also varies with snake size and T_b; large snakes have louder rattling with lower dominant frequencies than small snakes, while warm snakes have louder rattling with faster "click rates" than cold snakes. Lab and field experiments demonstrate that California ground squirrels pay attention to this "unintended" information; e.g. by responding more cautiously when they hear rattling from warmer, faster, and more accurately striking rattlesnakes. [KEYWORDS: acoustic communication, aposematic, rattlesnake, warning signal].

Roytberg

C06–158

On some intrinsic trends in patterns of scalation variability in lizards of the genus *Lacerta*. EVGENY S. ROYTBERG. *Dept of Biology, Daghestan Science Centre, Academy of Sciences, Makhachkala 367025, Russia.* Pholidosis of Lacertidae, forming a well defined pattern, is an excellent model for studying general trends in variation and evolution of morphological structures. Studying variation of pholidotic traits in *Lacerta*, I have revealed a number of regularities which can hardly be explained in adaptationistic terms and seem to reflect the action of intrinsic factors. 1) In the individual variability of head scutes pattern, variants with supernumerary shields are much more frequent, as compared to those having fewer elements than in the typical pattern; degree of the variability as well as its diversity is strictly limited These properties are supposed to be determined by developmental constraints (Alberch, 1980), formed in the course of evolution of head scutellation in the direction of oligomerisation and formation of a regular and stable pattern. 2) Another evidence involves the overall positive covariation among many of scalation meristics which exists in individual variability and seems to weakly constrain patterns of population differentiation in morphospace of meristic scale characters. [KEYWORDS: morphological variation, pholidosis, Lacertidae].

Russell

S04

The aponeuroses of the lacertilian ankle and their relation to sprawling locomotion. ANTHONY P. RUSSELL. *Dept of Biological Sciences, University of Calgary, 2500 University Drive NW, Calgary, AB T2N 1N4, Canada.* Despite pioneering and detailed work by McMurrich in the first decade of this century, the structure of the "plantar aponeurosis" of the lacertilian pes has remained poorly understood. In recent years a better understanding of the lacertilian mesotarsal joint and its role in the mechanics of sprawling locomotion has been gained. These developments have made possible a reassessment of the structure and potential function of the "plantar aponeurosis". This anatomical "component" in actuality consists of a stratified series of aponeurotic sheets that traverse the ankle joint, dividing the ventral surface of the foot into a series of compartments. This arrangement is considered in the context of the mechanics of lacertilian-type sprawling locomotion and in terms of the evolutionary transition to the lacertilian-type of pedal design. [KEYWORDS: lizard, locomotion,

aponeuroses, mechanics].

Ryan P5

Why we need more not less biology when studying behavioural adaptations. MICHAEL J. RYAN. *Dept of Zoology, University of Texas, Austin, TX 78712, United States of America.* Tinbergen posed a series of proximate and ultimate questions in ethology — questions that subsequently came to define different and exclusive research areas in animal behaviour. With the popularity of sociobiology, questions about the current fitness effects of behaviour eclipsed Tinbergen's other questions, and behavioural ecology almost became synonymous with animal behaviour. Recently, however, there has been increased interest in a more multi-disciplinary approach that embraces many of the fundamental questions posed by Tinbergen, resulting in studies combining mechanistic aspects of behaviour and evolution. I review several studies of amphibians and reptiles that have utilised such an approach, and discuss recent criticisms suggesting that such knowledge of mechanisms and phylogeny are not relevant to studies of adaptation!

Sachsse S26

Reptilian preventive medicine. WALTER SACHSSE. *Institute für Genetik, Johannes Gutenberg-Universität, Mainz, SB II - 3. St / Postf. 20, Germany.* Since the medical sciences are well established for warm-blooded i.e. endothermic animals, by this contribution shall be given only the — often unexpected — differences seen in reptiles. The time relapse between the origin of a disease and its first recognisable symptoms is by orders of magnitude longer than in members of other vertebrate classes. This has many consequences. Next, there is a far greater resistance against extreme physical conditions, maybe in conjunction with an astonishing range of variation in basic laboratory values. In most instances for prevention only, living conditions have to optimized, but with regard to reptilian characteristics as stronger dependence on external factors, or inborn behaviour. There are also quite a few favourable aspects for a medical approach.

Sachsse S25

Possibilities, contributions and dangers on the way for captive breeding by private persons. WALTER SACHSSE. *Institute für Genetik, Johannes Gutenberg-Universität, Mainz, SB II - 3. St / Postf. 20, Germany.* Aspects to be considered: geographic and climatic position of the worker, facilities, cooperation, choice of animal species, dilemma between aquarium for observation and enclosure of quasi natural habitat, scientific recording, selection of specimens between inbreeding and hybridisation, legal aspects including the need for recognition, continuity, publication of results, whereabouts of the offspring, educational effects.

Sarre *et al.* C18

Metapopulation structure and regional persistence of *Oedura reticulata* and *Gehyra variegata* (Gekkonidae) in remnant habitat. STEPHEN SARRE[1], GRAEME T. SMITH[2] AND JACQUI A. MEYERS[3]. [1]*Molecular Evolution and Systematics, Australian National University, PO Box 475, Canberra, ACT 2601, Australia.* [2]*CSIRO Division of Wildlife and Ecology, LMB 4, PO Midland, WA 6056, Australia.* [3]*CSIRO Division of Wildlife and Ecology, P.O. Box 84, Lyneham, ACT 2602, Australia.* The concept of a metapopulation (a series of interacting sub-populations) has been used to model regional extinction processes. It is based on the idea that the regional extinction of a species is not only a function of processes at the population level, but also of the interaction between populations. To date, most studies of metapopulation dynamics have concentrated on metapopulations that are in equilibrium (i.e. colonisation and extinction rates are approximately equal) probably because systems with rapid turnover are relatively amenable to study. However, it is quite likely that many species will be restricted to habitat remnants and, for those with poor dispersal ability, the probability of extinction will be determined by the characteristics of individual populations and their habitat remnant rather than the interaction between populations. Identifying the characteristics that make a species vulnerable to extinction following habitat fragmentation is one of the most pressing problems in conservation biology. One suggestion is that habitat specialists are less able to cope with rapid changes to their habitat or to form metapopulations than habitat generalists and so will be more vulnerable to extinction. To test this proposition, we examined the distribution of two species of gecko (*Oedura reticulata* and *Gehyra variegata*) in a recently fragmented region of the Western Australian wheatbelt. *O. reticulata* has been classified as a habitat specialist (based on the frequency of use of perch sites) in comparison to *G. variegata* and thus was expected to be more vulnerable to extinction pressures. A survey of 32 remnants consisting of habitat suitable for both species supports this expectation because *G. variegata* was present in all but one remnant, whereas *O. reticulata* was present in only 72% of the remnants. Logistic regression modelling of the presence or absence of *O. reticulata* revealed a positive correlation between an index of habitat size and the presence of *O. reticulata* suggesting that extinction is operating at a local or population level rather than on a regional basis in this species. An examination of variation in mitochondrial DNA among several populations of *O. reticulata* has revealed a high degree of genetic structure between sub- populations commensurate with little or no maternal gene flow. This finding suggests that *O. reticulata* has not formed an equilibrium metapopulation. It is likely that the distribution of the species within the region will continue to decline. [KEYWORDS: metapopulation, extinction, mitochondrial DNA].

Savitzky S12

Adaptations of the crab-eating snake, *Fordonia leucobalia* (Homalopsinae), to estuarine life. ALAN H. SAVITZKY. *Dept of Biological Sciences, Old Dominion University, Norfolk, VA 23529-0266, United States of America.* The homalopsine colubrid snake *Fordonia leucobalia* occupies coastal habitats from southeastern Asia to northern Australia. Its diet consists largely of hard-shelled crustaceans, including both thalassinid shrimp and brachyuran crabs. The morphology of *Fordonia* exhibits derived features believed to be specialisations for such a diet. However, data bearing on prey handling behaviour are equivocal and may reflect regional differences in preferred prey. The morphological specialisations of *Fordonia* include primary mechanical features associated with prey handling and processing, as well as secondary attributes reflecting foraging behavior and habitat. Primary adaptations include blunt teeth, secondary buttressing of dentigerous bones, and changes in the leverages of the major mandibular adductor muscles. Significantly, the muscles themselves are not hypertrophied. Secondary features include a deeply countersunk lower jaw, a robust prokinetic articulation, hypertrophied stomach musculature, and an enlarged premaxillary gland (believed to serve as a salt gland in homalopsines). Although individually modest, the presumed trophic adaptations of *Fordonia* in aggregate contrast markedly with the morphology of piscivorous homalopsines. [KEYWORDS: Colubridae, Homalopsi-

nae, morphology, feeding, estuarine].

Savitzky *et al.*

C06–160

Movement patterns of the canebrake rattlesnake, *Crotalus horridus* (Viperidae: Crotalinae), in southeastern Virginia, USA. ALAN H. SAVITZKY[1], BARBARA A. SAVITZKY[2] AND CHRISTOPHER E. PETERSEN[1]. [1]*Dept of Biological Sciences, Old Dominion University, Norfolk, VA 23529-0266, United States of America* [2]*Dept of Biology, Chemistry, and Environmental Science, Christopher Newport University, Newport News, VA 23606-2998, United States of America* The canebrake rattlesnake consists of a phenotypically distinct series of populations of *Crotalus horridus* located on the southeastern coastal plain of the North America. The northeasternmost populations are located in Virginia, where they are considered endangered due to habitat alteration. The movements of several *C. horridus* were monitored for periods ranging from several months to more than one year by means of radiotelemetry. Snakes hibernated singly or in small groups in tunnels formed from the decomposition of roots, often at the edge of wetlands. Fall movements were directed toward areas rich in such tunnels. Snakes entered several tunnels, some tunnels several times, before selecting a hibernaculum. Snakes were not active above ground during the Winter but did move underground within the tunnels. Spring emergence was followed by a period in which snakes often rested under leaf litter. Summer movements varied widely among individuals, but snakes often returned to areas previously visited. Although most movements occurred in hardwood forest, several individuals spent extended periods in swamps, where the reduced canopy may have afforded an advantage in thermoregulation. A few individuals crossed open water several meters wide. The observed movement patterns suggest that conservation of the canebrake rattlesnake will require protection of land on a landscape scale, rather than simply protection of a single habitat. [KEYWORDS: Viperidae, Crotalinae, rattlesnake, ecology, movements].

Scanlon

S02

The phylogenetic position of the Madtsoiidae (Serpentes). JOHN D. SCANLON. *School of Biological Sciences, University of New South Wales, P.O. Box 1, Kensington, NSW 2033, Australia.* Jaws and braincase elements of Tertiary and Quaternary madtsoiid snakes from Australia show characters allowing the phylogenetic position of the family to be inferred. The Vidian canal and abducens nerve (VI) open extracranially on the anterior face of the basipterygoid process as in lizards; the same condition is interpreted to be present in the Cretaceous snake *Dinilysia patagonica*, but in no extant Alethinophidian snakes. There is a common foramen for the maxillary and mandibular branches of the trigeminal nerve (V_2 and V_3), as in *Dinilysia* but unlike Alethinophidia. The ear region shows a condition believed to be intermediate between lizards and boid snakes, less specialised than *Dinilysia* or anilioids: the crista circumfenestralis is tubelike, not tending to close laterally around the stapes, and there are separate, but connected, openings of the fenestra pseudorotunda and apertura lateralis recessus scalae tympani. The jaws are elongated (thought to be a specialisation of Australian madtsoiids) but otherwise similar to those of primitive Alethinophidians, with palatopterygoid tooth rows enlarged relative to lizards and *Dinilysia*. The pterygoid lateral process is larger than in *Dinilysia* or extant snakes. It is concluded that the Madtsoiidae is the sister group to all other Alethinophidia, originating after the separation of a lineage leading to *Dinilysia* but before the origin of anilioid,

boid and other Alethinophidian lineages. [KEYWORDS: *Yurlunggur* Scanlon, *Wonambi naracoortensis* Smith, basicranium, ear region, jaws, Serpentes, Alethinophidia, Madtsoiidae, Miocene, Pleistocene].

Schabetsberger

S20

Daily food consumption and gastric evacuation rates of alpine newts (*Triturus alpestris*). ROBERT SCHABETSBERGER. *Dept of Zoology, University of Salzburg, Hellbrunnerstasse 34, 5020 Salzburg, Austria.* Gastric evacuation rates of larval and adult alpine newts (*Triturus alpestris*) were estimated under laboratory and field conditions at different temperatures. Four different mathematical models were fitted to the data. Time for total gastric emptying was longer than in teleost fishes and was within the range reported for some Elasmobranchs. Daily food consumption was estimated with the ELLIOT & PERSSON model, which was developed for fish but proved to be applicable to estimate food consumption in adult and larval alpine newts. Daily rations were low compared to teleost fishes with similar body weight. [KEYWORDS: daily food consumption, gastric evacuation rates].

Schildger *et al.*

S26

Comparative diagnostic imaging — radiology, endoscopy, sonography — in reptiles of the families Varanidae and Iguanidae. B-J. SCHILDGER, M. KRAMER, M. GERWING, B. GEYER, H. SPÖRLE, H. TENHU AND R. WICKER. *Zoologischer Garten Frankfurt, Alfred Brehm Platz 16, 60316 Frankfurt 1., Chirurgische Veterinärklinik, Justus Liebig Universität, Frankfurter Straße 108, 35392 Gießen, Germany.* Radiological examination, ultrasonography and endoscopic examination of reptiles of the families Varanidae and Iguanidae were used to obtain information on the heart, lungs, liver and gonads. Radiology is effective in differentiating the heart in the Varanidae (but not Iguanidae), the lungs (in both families) and in differentiating the liver lobes from the heart (cranial) and lung (dorsal) but not the intestinal tract (caudal). Neither ovaries nor testes could be differentiated. Ultrasonography was not useful for examination of the lungs, but allows investigation of both lobes of the liver, including the inner structure, and the gall bladder. Follicles larger than 1.5 mm in diameter could be detected but not testes or juvenile gonads. Endoscopic examination is useful for judging the heart, heart action and the pericardium, the serosal surface of a single lung, the colour and surface of a single liver lobe and the gonads of any sex or age.

Schmid & Macgregor

S01

C-band heterochromatin and karyotype evolution in amphibians. MICHAEL SCHMID[1] AND HERBERT MACGREGOR[2]. [1]*Dept of Human Genetics, University of Wurzburg, Germany.* [2]*Dept of Zoology, University of Leicester, United Kingdom.* The karyoptyes of amphibians show some remarkable features that may represent clues to mechanisms and trends in karyotype and chromosomal evolution. The genus *Plethodon* shows variable genome sizes but identical karyotypes suggesting some means of accomplishing balanced genome growth. An integrative analysis of phylogenetic relationships within the genus *Triturus*, based on biochemical genetics, reproductive interactions and cytogenetics has provided clear evidence that changes in genome size during the course of speciation have resulted almost entirely from loss or accumulation of DNA sequences that are localised in C-band heterochromatin. The actual DNA sequences in C-band heterochromatin and the karyotypic locations of C-bands suggest a mechanism in which

non-coding DNA sequences become highly repeated in the centromere regions of chromosomes, forming large centromeric C-bands, and are then dispersed outwards into the chromosome arms to pericentric and later to interstitual regions. Data from more than 300 species of anurans and urodeles have shown that short chromosome arms tend to have telomeric C-bands whereas longer chromosome arms have intercalary C-bands. Moreover, heterochromatic bands with similar fluorochrome affinities or restriction enzyme sites in relation to non-homologous chromosomes tend to occupy similar sites in relation to centromeres. The positions of interstitial C-bands within karyotype are related to arm lengths of the chromosomes in the karyotype. We propose that regularities of this kind may signify a process of heterochromatin transfer to equilocal sites in chromosome arms. We shall discuss possible nucleotypic circumstances that might facilitate or bring about changes of these kinds.

Schneider S03

Bioacoustics and taxonomy of water frogs in Europe and Northern Africa. H. SCHNEIDER. *Zoologisches Institut, Universität Bonn, D-5300 Bonn 1, Germany.* The mating call of male anurans is a very characteristic feature with specific biological functions. Because of its high specificity it also is very useful for solving taxonomic problems. The distribution and the composition of the water frogs (genus *Rana)* in the Mediterranean region seemed to be very simple. The lake frog, *Rana ridibunda,* was supposed to occupy a very large area extending from western Europe to Asia and also to the Nile delta and the Arabian peninsula. Based on the analyses of mating calls this picture changed decisively. In western Greece and southern Albania a new species has been found, *Rana epeirotica* (Epeirus frog) which occurs in the low lands and prefers still or low flowing waters with abundant but low vegetation. A comparative bioacoustic study of lake frogs in southeastern regions (western Turkey, Israel, Nile delta) revealed marked differences compared with those in Greece. After the study of the typical lake frog *Rana ridibunda* Pallas, 1771 in the terra typica restricta near Guryev at the northern end of the Caspian Sea it was obvious that neither the southeastern water frogs nor those in the main part of Greece represent the typical *Rana ridibunda*, but two separate species which have been established in the mean time: *Rana levantina* (Levant frog) in Israel and the adjacent regions and *Rana balcanica* (Balkan frog) in Greece and Albania. Furthermore, discriminant analyses also demonstrated that *Rana ridibunda* and *Rana balcanica* are sibling species, whereas *Rana levantina* is part of another line of evolution. This line extends through northern Africa, for *Rana levantina* and *Rana perezi* are sibling species as well. *Rana perezi* inhabits the Iberian peninsula. By means of the bioacoustical method its occurrence in Tunisia has recently been demonstrated beyond doubt. This suggests that *Rana perezi* is a species native to Africa and not related to *Rana ridibunda* as previously assumed. Its occurrence on the Iberian peninsula is the northern extension of its range of distribution.

Schwartz S19

Dynamics of communication in anuran choruses: a neotropical treefrog's solutions to a male's problems. JOSHUA J. SCHWARTZ. *Division of Biological Sciences, University of Missouri, Columbia, MO 65212, United States of America.* Anuran choruses are acoustically complex assemblages of calling males, and within choruses vocal competition among males for females is typically intense. High call rates of chorus members have two obvious consequences for males: (1) background

noise can make communication difficult and (2) energetic costs of advertisement can be considerable and so place limits on male vocal activity. Males of the neotropical treefrog *Hyla microcephala* have adopted solutions that involve structuring the timing of their calls on both a fine and coarse temporal scale. On a fine time scale, males increase the spacing between the notes of their calls when interrupted by the call of another frog. Responses of this kind are strongest to the loudest neighbour, and some males may ignore interruptions by all but a single close male. Chorusing males also call in distinct bouts punctuated by periods of silence. This coarse-scale call timing is known as unison bout singing. Data on calling behaviour and biochemical assays demonstrated that unless chorusing is punctuated by pauses, most males would be unable to sustain high rates of calling for an entire evening without exhausting glycogen reserves in their trunk muscles. [KEYWORDS: anuran, communication, energetics, noise].

Schwartzkopf et al. S16

Movement and dispersal in adult cane toads: comparing northern Australia, Brazil and Venezuela. LIN SCHWARTZKOPF[1], PETER BAYLISS[2], MARGARITA LAMPO[3] AND ROSS ALFORD[4]. [1]*Dept of Zoology, University of British Columbia, Vancouver BC V6T 1Z4, Canada.* [2]*Depto. de Ecologia, INPA, CP-478, 69011 Manaus AM, Brazil.* [3]*Centro de Ecologia, IVIC, Aptdo. 21827, Caracas 1020-A, Venezuela.* [4]*Dept of Zoology, James Cook University, Townsville, Qld 4811, Australia.* Cane toads (*Bufo marinus*) have spread rapidly throughout northern and eastern parts of Australia since they were introduced in 1935. Population models for use in biological control require information on the factors influencing mortality and movement of adults. We compare the movements of cane toads in northern Australia to their movements in Brazil and Venezuela, where *B. marinus* is a native species. Data from Australia and Brazil suggest that toad movements are often extensive (over 800 m per night) and are extremely variable among individuals. In Australia, there was a strong influence of both body size and season on movement patterns. Small toads are active more frequently than large toads, and all toads move about more in the wet season. Preliminary data from Venezuela also suggest that toads may move farther during wet periods. In both Australia and Brazil, toads seemed to fall into two groups: those individuals that remain within a home range or activity area, and individuals that suddenly disperse over long distances. In Australia, dispersal events were most common during wet seasons, or during and after heavy rainfall in dry seasons. Factors influencing movement in all three countries appear to be similar, but mortality due to predation may be more common in Brazil than in Australia. [KEYWORDS: movement, dispersal, *Bufo marinus*, ecology, conservation].

Seabrook C22

Terrestrial habitat use of the cane toad (*Bufo marinus*) in Australia. WENDY SEABROOK. *Queensland National Parks and Wildlife Service, P.O. Box 155, Albert St., Brisbane, 4002, Australia.* Cane toads have been reported to occupy a wide variety of habitats in both their introduced and natural ranges. Recent studies undertaken in Australia have shown, however, that cane toads have clear habitat preferences which stem from the negative relationship between the abundance of toads and the density of ground and canopy vegetation. A review of the terrestrial habitat use of the cane toad will be presented, and the implications of these findings for the design of control strategies discussed. [KEYWORDS: *Bufo marinus*, habitat use, vegetational cover].

Secor & Diamond C16

Adaptive response of the snake's digestive system. STEPHEN M. SECOR AND JARED M. DIAMOND. *Dept of Physiology, University of California, Los Angeles, California, United States of America.* Endotherms exhibit modest post-feeding responses of their digestive tract which result from a relatively high frequency of feeding and almost continuous processes of digestion. Because sit-and-wait foraging snakes feed on relatively large food items (> 50% of body mass) at long intervals, we hypothesised that they would possess much larger digestive responses. From sit-and-wait foraging sidewinders *(Crotalus cerastes,* Family Viperidae) and Burmese pythons *(Python molurus,* Family Boidae), we measured remarkable increases in metabolism (7-fold), nutrient uptake ability (4 to 16-fold), and intestinal mass (> 2-fold) 24 hours after snakes fed. After the completion of digestion, both species down-regulated intestinal function and reduced the mass of their small intestine. We interpret those responses as a selected benefit to reduce the energetic cost of maintaining a fully functional digestive tract during the frequent non-digesting periods. Rapid up-regulation of nutrient transporters together with intestinal hypertrophy, which occur at a substantial energetic cost, are necessary for these snakes to digest a recently consumed meal. Not all snakes exhibit these dramatic post-feeding responses. Active foraging coachwhips *(Masticophis flagellum,* Family Colubridae), which feed more frequently in the wild and would commonly be undergoing digestion, exhibit only modest post-feeding responses (< 3-fold). *Masticophis flagellum* do not down-regulate intestinal function and have adapted the strategy of constantly maintaining a fully functional digestive system. [KEYWORDS: digestive physiology, metabolism, nutrient transport, morphology].

Secor & Nagy S11

Physiological correlates of foraging mode for the snakes *Crotalus cerastes* and *Masticophis flagellum*. STEPHEN M. SECOR[1] AND KENNETH A. NAGY[2]. [1]*Dept of Physiology, University of California, Los Angeles, California, United States of America.* [2]*Dept of Biology, University of California, Los Angeles, California, United States of America.* Foraging mode, known to be correlated with physiological characteristics of lizards, may possess overriding influences on the physiology of snakes. We addressed this hypothesis by examining the physiology of the sit-and-wait foraging viperid *Crotalus cerastes* and the active foraging colubrid *Masticophis flagellum* using both field and laboratory measurements. The diurnally active *M. flagellum* attains higher body temperatures (T_b) and moves greater distances per day than the nocturnal *C. cerastes.* Field metabolic rates, determined by doubly-labelled water methods, of *M. flagellum* were significantly greater (2–2.5 times) than those of *C. cerastes* throughout the year. This is attributed to the former species higher field standard metabolic rate (SMR), a product of their greater SMR (40% greater than *C. cerastes)* and field T_b, and activity cost. The daily energetic cost of movement by *M. flagellum* is projected to be 8-times that of *C. cerastes,* due to the greater distances that they travel and the higher energetic cost of their mode of locomotion. The greater energetic cost of active foraging experienced by *M. flagellum* is balanced by their greater rate of energy intake (twice that of *C. cerastes)* as determined by water influx rates. Both species maintained positive energy and water balance for the majority of their activity season. The lower rate of prey capture by *C. cerastes* resulted in the selection of digestive adaptations that involve down-regulating their digestive tract during non-digestive periods and its rapid revitalisation after a meal has been consumed. The magnitude of such responses

are diminished for the frequently feeding, active-foraging, *M. flagellum.* [KEYWORDS: field metabolic rates, standard metabolic rates, feeding rates, digestive physiology].

Semenov C06–161

Two years mark-recapture research in Uzbekistan desert lizards: densities, movement patterns, survival. DIMITIJ V. SEMENOV. *Institute of Evolutionary Animal Morphology and Ecology, Leninsky 33, 117071 Moscow, Russia.* The population ecology of desert lizads was studied in 6 habitats in Uzbekistan during two spring seasons. All active lizards of 10 specimens were marked and released on 22 study areas (100 × 100m). 839 specimens were marked, 276 recapture were recorded, 71 lizards were recaptured after hibernation. Mean movement distances by all species are similar, about 24–32 m. Males of all species have larger movement distances than females. Shortest mean movement distances are recorded in two *Phrynocephalus* species: *reticulatus* and *helioscopus.* Proportion of marked specimens found after hibernation is larger in *Phrynocephalus* (4 species) than in other species (maximum 31.3% in *Ph. helioscopus).* The largest recorded home range belonged to a *Trapelus sanguinolentus* male: 2655 m^2. Population densities in research seasons were rather constant for the same habitat but in different habitats the density of the same species may vary drastically. The highest density (as many as 70 specimens per ha) was found in *Ph. interscapularis.* The information on miccrohabitats, activity, demography of the 10 species and also 4 less abundant and nocturnal species is pooled. [KEYWORDS: lizard, *Phrynocephalus,* ecology, movement distance, density].

Sever C13

Sperm storage in female salamanders. DAVID M. SEVER. *Dept of Biology, Saint Mary's College, Notre Dame, Indiana 46556, United States of America.* Spermathecae occur in seven families of salamanders that constitute the suborder Salamandroidea. In all these families except the Plethodontidae, the spermathecae consists of numerous simple alveolar glands opening individually into the roof of the cloaca and are termed "simple spermathecae". Although the distal ends of simple spermathecae are alveolar, no cytological differences have been reported between proximal and distal regions. All regions produce a glycoprotein for export into the lumen to bathe stored sperm. Plethodontids possess "complex spermathecae" composed of compound alveolar glands in which distal bulbs connect by narrow neck tubules to a common tube that opens into the roof of the cloaca. The common tube and neck tubules secrete a glycoprotein into the lumen, but the distal bulbs lack this secretory product and are actively spermiophagic as long as sperm are present. Phagocytosis of stored sperm by the spermathecal epithelium also occurs in simple spermathecae but not to the degree that it occurs in plethodontids. Spermiophagy may be energetically a more advantageous way for disposal of residual sperm in complex spermathecae. Selective pressures for sperm storage could have resulted in glands for this purpose arising independently in different lineages. Differences in development and cytology provide evidence for independent origin of simple and complex spermathecae, and simple spermathecae may be polyphyletic as well. [KEYWORDS: salamanders, spermathecae, sperm storage, phylogeny].

Seymour P3

Respiratory constraints on amphibian reproductive mode. ROGER S. SEYMOUR. *Dept of Zoology, The University of Adelaide, SA 5005, Australia.* Amphibian eggs are surrounded by jelly capsules which impede the diffusion of oxygen to the em-

bryos. Although sometimes thin, a capsule can cause significant limitation of oxygen uptake, and retard embryonic development. Paradoxically, however, jelly capsules are essential for adequate oxygenation of the embryos, because they separate the eggs in an egg mass and limit local competition between embryos for available oxygen. The size and metabolic intensity of an egg mass are limited by (1) the size and development rate of embryos, (2) the changing geometry of individual capsules, (3) the shape and surface area of the egg mass, (4) the composition of the interstitial spaces between eggs, and (5) the site of oviposition, including temperature, oxygen tension, and natural convective currents. Adaptations within these constraints are investigated quantitatively in selected species with diverse reproductive modes. Terrestrial egg masses tend to collapse and stick to the substrate because of gravity and surface tension, thus eliminating airspaces between the eggs and forcing oxygen to diffuse through the jelly from only one direction. Thus terrestrial egg masses must be small or thinly spread, unless the eggs have rigid capsules that create air-spaces between them, or they are laid in foam which facilitates oxygen diffusion and also supplies oxygen directly from the bubbles. Aquatic egg masses can be large because they are supported in water where gravity and surface tension do not deform the mass. Oxygen can invade the mass from all surfaces, and convection of free water in channels between the eggs can be driven by solar heating of the egg mass or by other mechanisms. Foam nesting in aquatic breeders is a means to support the egg mass in better oxygenated water near the surface. [KEYWORDS: amphibian, eggs, egg masses, respiration, jelly, foam, oxygen].

Shaffer S01

Phylogenetic relationships of the salamander family Ambystomatidae: a molecular perspective. H. BRADLEY SHAFFER. *Section of Evolution and Ecology, University of California, Davis, CA 95616, United States of America.* The salamander family Ambystomatidae consists of two "groups" which together account for 29 bisexual species. Across the U.S. are 14 taxa characterised by deep divergences and relatively little intraspecific variation. Although the relationships of these species is still not completely resolved, a fundamental conflict between morphological and molecular (allozyme and mitochondrial DNA sequence) data exists over the monophyly of the subgenus *Linguaelapsus* (*mabeei*, *texanum*, *barbouri*, *annulatum*, *cingulatum*). The remainder of the family is included in the 15 species of the *tigrinum* group, a closely related, monophyletic set of species that is widely distributed over the U.S. and central Mexico. Detailed, population-level allozyme and mitochondrial DNA sequence results for these salamanders confirm that this is a recent, "explosive" radiation, resulting in the rapid evolution of morphological and life-history characteristics, including the multiple origins of metamorphic failure and paedomorphic adults. Our currently available data indicate that both 14 North American species and the *tigrinum* group involved rapid, nearly synchronous diversifications of lineages; the first occurring in the distant past, while the *tigrinum* radiation is a relatively recent event. Thus, the *tigrinum* group serves as an excellent model for recent, rapid speciation and divergence, while the other bisexual species may be better suited to examine long-term trends in morphology and ecological adaptation. [KEYWORDS: Ambystomatidae, phylogeny, allozymes, mtDNA sequences, salamander].

Shaffer *et al.* S24

The genetics of decline: a case study of the California tiger salamander, *Ambystoma californiense*. H. BRADLEY SHAFFER, SCOTT STANLEY, AND ROBERT F. FISHER. *Section of Evolution and Ecology, University of California, Davis, CA 95616, United States of America* *Ambystoma californiense* is a declining member of the tiger salamander complex that is confined to the grassland/vernal pool habitat of central California. For the past three years we have collected ecological, genetic, and historical information on the reasons for decline of this previously abundant pond-breeding amphibian. Our allozyme results, based on 84 populations and over 1,000 individuals, document extremely low levels of genetic variation, but deep genetic substructure and high Fst values among those populations that are variable. Our mitochondrial DNA sequence data also demonstrate high levels of population substructure, including great divergence among populations that are identical at 26 allozyme loci. One explanation for these conflicting molecular results is that migration is relatively rare, but that when it does occur, it is primarily male-biased. Our ecological field data confirm that introduced fishes (including the mosquito control vector *Gambusia*) and bullfrogs (*Rana catesbeiana*) exclude *Ambystoma* from lowelevation breeding sites. Since the salamanders also face a natural ecological barrier at high elevations, the entire vernal pool community is becoming restricted to a fragmented, linear strip of grassland with no opportunity for migration or local recolonization to occur. The combination of natural philopatry, sex-biased dispersal, and anthropogenic habitat destruction demands that several grassland reserves are required to maintain the genetic diversity found in *A. californiense*. [KEYWORDS: *Ambystoma californiense*, declining amphibians, metapopulations, allozymes, mtDNA sequences].

Sharrad C06–162

The herpetofauna of Danggali Conservation Park. ROBERT D. SHARRAD. *University of South Australia, Smith Rd, Salisbury East, SA 5109 Australia.* Danggali is a large South Australian park (250,000 ha) on the NSW border between Renmark and Broken Hill. Although sheep once grazed this semi-arid region, the vegetation is sufficiently intact for the park to be classified as a World Biosphere Reserve. For the last seven years staff and students of the Conservation and Park Management course of Uni SA have spent two weeks each autumn surveying the flora and fauna of Danggali. These and earlier studies reveal a satisfying variety of reptiles (55 spp) and two frogs. These species are listed and aspects of their natural histories illustrated.

Shchupak C06–164

The industrial frog rearing: technological and technical basis of culture. E.L. SHCHUPAK. *Institute Ecology of Plant and Animal, Ural Dep., Russia Acad., Ekaterinburg, Russia.* The culture of green frog compels investigators attention because of the quantity of frog in nature is reduced, furthermore capture frog for scientific and commercial needs results in disturbance of ecological balance. System of industrial frog rearing is elaborated by the group of population ecology of Amphibia. Organisation of large experimental frog's farms on the basis of fish hatcheries is the step for the solution of the problem. Resource saving technology is basis of frog farm, since in course of exploitation there are no damage to structure and productivity of natural communities and this technology promote to complex use of the territory. In fish hatchery there exist favourable conditions for high rate of revolution or frog population; growth rate of tadpoles and froglets exceeds the analogical indices in nature. Organisation's structure of frog farms vouches for its stable exploitation. The wide-scale, many-year observations

of dynamic generations of lake frog make possible the assigning their share in the productivity of population, that insures the realisation of population aproach to the exploitation of biological resouces.

Shea S25

Amateur contributions to herpetofaunal field studies: an Australian perspective. GLENN M. SHEA. *Dept of Veterinary Anatomy, University of Sydney, NSW 2006, Australia.* Contributions by amateurs to knowledge of Australian reptiles and amphibians in the field began prior to the establishment of Australian museum collections and universities. With a reptile and amphibian fauna consisting of 984 species, but with fewer than 150 professional herpetologists (including students), there is a continuing need for amateurs to contribute to Australian herpetological knowledge. Among the major amateur contributions to field herpetology have been the discovery of many new species, some with very restricted distributions (e.g. *Notaden weigeli*, *Litoria subglandulosa*, *Rheodytes*, *Diplodactylus wilsoni*, *Ctenophorus vinnietharra*, *Egernia hosmeri*, *Furina dunmalli*), the rediscovery of very rare species (e.g. *Pseudemydura umbrina*, *Tiliqua adelaidensis*) and serendipitous observations of uncommon behavioural characteristics and ecological features (e.g. male combat, mating, egg deposition, predation). In some cases, amateur contributions constitute the majority of known data on a species. Vital to the historical development of such contributions have been two factors. Firstly, the availability of publications for the dissemination of serendipitous observations, particularly *Herpetofauna*, but also the various State *Naturalist* journals. Secondly, encouragement of amateur observations and research and collaboration with amateurs by biologically-trained herpetologists. [KEYWORDS: herpetology, amateurs, field studies, history].

Sherbrooke S21

Predator specificity of antipredator displays in horned lizards, *Phrynosoma* spp. WADE C. SHERBROOKE. *Southwestern Research Station, American Museum of Natural History, Portal, Arizona 85632, United States of America.* Horned lizards employ a diverse repertoire of antipredator displays, some of which are associated with their unusual morphological traits. These behaviours vary between species, especially in relation to size, and are utilised in (1) avoiding detection, (2) escape, (3) resisting attack when apprehended. In controlled trials, prey responses to predators of diverse attack and prey handling capacities were characterised. Predators included species that swallow prey whole, greater roadrunners (*Geococcyx californianus*), western diamondback rattlesnakes (*Crotalus atrox*), and long-nosed leopard lizards (*Gambelia wislizenii*) as well as species that dismember their prey for ingestion, southern grasshopper mice (*Onychomys torridus*) and kit foxes (*Vulpes macrotis*). Some antipredator displays, such as "dorsal shield", are utilised against a broad spectrum of predators whereas other displays, such as "blood-squirting", are only utilised against a restricted group of potential predators. Size (ontogenetic and interspecific) is a factor influencing the efficacy of many antipredator behaviours. The significance of differences in antipredator displays in response to the diverse challenges of various predators will be discussed. [KEYWORDS: horned lizards, *Phrynosoma*, behaviour, antipredator, defensive behaviour].

Shine P4

Reptile ecology in the land of OZ. RICHARD SHINE. *School of Biological Sciences, University of Sydney, NSW 2006, Australia.* The physical, biological and cultural

attributes of a country can profoundly influence the kinds of science that are done by its inhabitants. More specifically, I argue that the unique features of Australia — its landforms, its climate, its herpetofauna, its scientific traditions — have had a major effect on Australian herpetology. Australia's notable features include its diversity of climates and habitat types, the consistently low and variable productivity of many areas, its "unusual" herpetofaunal lineages, and a long tradition of sceptical disbelief in elegant theoretical explanations (be they theological or ecological) among Australian academics. This scepticism, allied to the enormous climatic fluctuations common over most of the country, has discouraged belief in precise local adaptation and complex "equilibrial" models. Instead, Australian workers have tended to emphasise stochastic events and long time scales. My own research provides several examples of the ways in which being Australian, and working in Australia, have influenced the kinds of questions asked, the kinds of animals used to investigate those questions, and the kinds of answers that have emerged.

Shrestha C33

Impact of habitat alteration and climatic changes in the Himalayan newt in Nepal. TEJ KUMAR SHRESTHA. *Departmant of Zoology, Tribhuvan University, Kirtipur Campus, Kathmandu, Nepal.* The endangered species of the Himalayan newt *Tylototriton verrucosus* has an intrinsic scientific value because its population is declining rapidly in size and number. The Mahabharat and Siwalik hills of eastern Nepal claimed to include last remaining habitat of the newt. The survival of the newt in the eastern Nepal is due to suitable habitat in from crystal clear ephemeral rain pools and snowfed lakes and creeks rapids with teeming abundance of varied aquatic plants. Ecological studies of newt habitat was carried out in different stretches of Arun, Tamur and Mai river. Impact of deforestation, land use, road building, draining rock pools, erratic rainfall and climatic changes on the newts life activity and behaviour are discussed. For the need and opportunity for the creation of newt rock-pool sanctuary is highlighted. Prescription for relisting aforesaid objectives are given and future research areas are identified and discussed.

Shrestha C06–165

Conservation and management of herpetological diversity in the Himalayan foothills of Nepal. TEJ KUMAR SHRESTHA. *Departmant of Zoology, Tribhuvan University, Kirtipur Campus, Kathmandu, Nepal.* Nepal's herpetofauna, consisting of approximately 150 species, have colonised in the Himalayan foothills. During recent years environmental changes affecting major watershed and wetlands of Nepal are posing threats to amphibian and reptiles. The hydrological changes in wetlands and watersheds are also critical to the survivial of pristine amphibian such as Himalayan newt *Tylototriton verrucosus*, Himalayan toad *Bufo himalayanus*, Tree frog *Rhacophorus maximus* and pelobatid frog *Scutiger nipalensis*. Habitat alteration and climatic changes associated with clearing of tropical and temperate forest, cultivation of the land and impoundments associated with hydropower development are having a tremendous impact on herpetofauna of major riverine watersheds of Nepal (Gandaki, Koshi, Karnali and Mahakali). These activities seriously affected life activity of Himalayan pit viper *Agkistrodon himalayanus*, coral snake *Calliophis maccellandi*, python *Python molurus*, sand boa *Eryx conicus*, egg-eating snake *Elachistodon westermanni*, running lizard *Ophisops jerdoni*, agamid liazrd *Japalura major*, yellow monitor *Varanus flavescens*,

Himalayan skink *Sphenomorphus indicum*, yellow Asian tortoise *Indotestudo elongata* and soft shelled turtle *Chitra indica* etc. While conservation efforts are to be made at least to preserve isolated relict elements of Nepal's very diverse herpetofauna, future direction must be changed if conservationists are to be able to conserve the biodiversity of Himalayan herpetofauna into the next century. This paper also presents the strategy developed for intensifying and recommending measures for the protection of last remaining habitat pockets of high herpetological diversity in different altitudinal gradients. The special problem of conservation of rare herpetofauna conservation with reference to climatic changes is reviewed and conservation solutions are discussed in the paper.

Šinervo & DeNardo

S15

Costs of reproduction in the wild: an experimental test. BARRY SINERVO[1] AND DALE DENARDO[2]. [1]*Department of Biology, Indiana University, Bloomington, IN, 47405, United States of America.* [2]*Department of Integrative Biology, University of California, Berkeley, CA 94720, United States of America.* We measured indices of reproductive effort in field active side-blotched lizards and correlated these indices of effort with subsequent survival and reproductive success. Reproductive success was indexed by measuring the number of clutches produced by a female during the reproductive season as well as by the subsequent survival of the offspring to maturity. Natural selection on all measures of reproductive effort was optimising. Females that produced the largest and the smallest total clutch mass had lower survival and reproductive success than females that produced an intermediate total clutch mass. We tested these correlational patterns by surgically reducing clutch size during early reproduction and concomitantly reducing total clutch mass. We enhanced the survival and reproductive success of field active females by experimentally decreasing reproductive effort. Thus, the causes of the correlation patterns in which females producing the largest total mass had the lowest survival and subsequent reproductive success is due to costs of reproduction.

Sinervo *et al.*

C06–166

Sexual selelection, costs of reproduction, and colour morphs of side-blotched lizards (*Uta stansburiana*). B.S. SINERVO[1], D. MILES[2], D. DENARDO[3], W.A. FRANKINO[1] AND K. ZAMUDIO[4]. [1]*Biology Dept, Indiana University, Bloomington, IN 47405, United States of America.* [2]*Dept of Zoology, Ohio University, Athens, OH 45701, United States of America.* [3]*Dept of Integrative Biology, University of California, Berkeley, CA 94702, United States of America.* [4]*Dept of Zoology, University of Washington, Seattle, WA 98195, United States of America.* We studied the seasonal changes in territory use by three colour morphs of male side-blotched lizards on a study site located near Los Banos Grandes, CA. Males with blue throats tended to be monogamous in the first year, but were more polygynous with age. Blue-throated morphs also tended to mate guard individual females on their territories during a female's receptive cycle. A newly described orange morph is very active, tends to maintain much larger territories and does not appear to mate guard as carefully as blue-throated morphs. Orange morphs control territories with more females. The third morph appears to be a 'sneaker'. Sneakers resemble females in throat colour. These sneakers are less active during the early part of the reproductive season, but become more prominent later in the season as they acquire territory vacated when territory holding males die. Sneakers

also tend to be smaller in size because they hatch late in the previous breeding season relative to the other two morphs. Measurements of territory use were facilitated by a software package developed for the Macintosh. [KEYWORDS: sexual selection, costs of reproduction, *Uta stansburgiana*].

Sinsch

S14

The dynamics of a natterjack (*Bufo calamita*) metapopulation. ULRICH SINSCH. *Institut für Biologie der Universität, Rheinau 3-4, D-5400 Koblenz, Germany.* The migratory and reproductive behaviour of *Bufo calamita* was studied from 1986 to 1993 at four neighbouring sites using radio telemetry and microchip tagging techniques. Emphasis lay on the estimates of (1) the exchange of reproductive individuals between neighbouring sites and (2) the reproductive success at each site. Most reproductive males showed a lifelong site fidelity to the site of first breeding, whereas females did not prefer breeding sites. Consequently, the genetic distance (calculated from allozyme frequencies) between local populations was low, but increased with geographical distance. Besides simultaneously breeding toads at different localities there were up to three distinct temporal breeding assemblages at the same locality within one year. Genetic distances between the temporal populations at the same site were considerably greater than those between local ones. Thus, natterjack metapopulations consist of interacting local and temporal populations. The reproductive success varied considerably among the populations. The persistence of the populations with no or little reproductive success depended entirely on the recruitment of juveniles from the only self-sustaining local population. [KEYWORDS: *Bufo calamita*, metapopulation, local and temporal populations].

Sinsch

S03

Allozyme variation corroborates the distinction of *Rana levantina* and *R. balcanica* from *R. ridibunda*. ULRICH SINSCH. *Institut für Biologie der Universität, Rheinau 3-4, D-5400 Koblenz, Germany.* The allozyme variation among water frogs of the species *R. balcanica*, *R. levantina* and *R. ridibunda*, all formerly considered as one species (*R. ridibunda* Pallas, 1771), was studied using horizontal starch gel electrophoresis. Blood samples (N = 63) of frogs were collected from five populations in Greece and Israel. Samples (N= 9) of the hybrid frog *R. esculenta* collected from a locality in Germany were used as an outgroup for phylogenetic analyses. 15 enzymes controlled by twenty presumptive loci were identified. Genetic differentiation among species was considerably greater than among populations of the same species. Even at Nestos River where *R. ridibunda* and *R. balcanica* occur in the same habitats, individuals could be assigned to either species due to characteristic differences of genotypes, indicating reproductive isolation. The phylogenetic analysis indicates that *R. ridibunda* and *R. balcanica* are sibling species pertaining to an Eurasian lineage, whereas *R. levantina* and *R. perezi* represent an independent Afroasian lineage. [KEYWORDS: European waterfrogs, *Rana ridibunda*, speciation, allozymes].

Sinsch *et al.*

C02

Morphometric and allozyme studies on the Andean genera *Batrachophrynus* and *Telmatobius* (Leptodactylidae). ULRICH SINSCH, NORBERT JURASKE AND VERONICA CANALES. *Institut für Biologie der Universität, Rheinau 3-4, D-5400 Koblenz, Germany.* The endemic central-Peruvian genus *Batrachophrynus* is closely related to the widely distributed genus *Telmatobius*. Since the main difference between

the two *Batrachophrynus* species from *Telmatobius* species mainly bases on the absence of teeth, we studied 1) the morphometric differentiation of 10 Andean *Telmatobius* species and *B. macrostomus* and *B. brachydactylus* on the other side (total N = 403 individuals); and 2) the allozyme variation between three *Telmatobius* species and the two *Batrachophrynus* species (total N = 107 individuals). Morphological differentiation was tested for by discriminant analyses. There was a significant morphometric variation between species, but also frequently between different populations of the same species. Most of the subspecific taxa proposed by Vellard are not considered valid. However, the genetic differentiation between the genera was extremely low, so that the validity of the genus *Batrachophrynus* remains doubtful. [KEYWORDS: Andean Leptodactylidae, *Batrachophrynus, Telmatobius,* taxonomy].

Sites
S01

Chromosomal and molecular evolution in *Sceloporus* (Sauria, Phrynosomatidae). JACK W. SITES, JR. *Dept of Zoology, Brigham Young University, Provo, UT 84602, United States of America.* Species of *Sceloporus* have figured prominently in studies of population, community, and physiological ecology, social behaviour, disease transmission, and biogeography, and offer additional potential in relatively unexplored areas such as mate choice/sexual selection, regional gene duplication, the origin of sex chromosome heteromorphisms, hybrid zone dynamics, and coevolution of host-parasite systems. Using the chromosomally-based phylogeny of Hall, I show that duplication of the G3PDH locus has likely occurred independently at least three times in the genus, once each in the *graciosus*, *grammicus*, and *scalaris* groups. The same phylogenetic hypothesis suggests independent origins for at least five distinct sex chromosome heteromorphisms (the entire radiation of "crevice users", *S. clarki*, *S. lundelli*, *S. maculosus*, and *S. rufidorsum*), and four for the evolution of viviparity (the entire "crevice-user" group minus the *megalepidurus* clade, the entire *formosus* clade; and twice in the *scalaris* clade-verified with an independent molecular [= isozyme] data set. A large mtDNA sequence data base (2479 bp) has been used to phylogenetically evaluate patterns of chromosomal evolution within the chromosomally extremely polymorphic *S. grammicus* complex (2n = 32–46), and revealed that the history of autosomal rearrangement in this group has been more complex than previously hypothesised. Several rearrangements (Robertsonian fissions) have evolved independently on two or more occasions, and at least once in the history of this group, acrocentric fission products fused to secondarily reestablish the biarmed chromosomal morphology. The most parsimonious mtDNA cladograms were also informative with respect to the evolution of NORs on chromosome 2, and the origin of several zones of parapatric hybridisation between different combinations of chromosome races. [KEYWORDS: *Sceloporus*, chromosomes, mtDNA, comparative biology].

Sites *et al.*
S03

Chromosome clines and the genetic structure of a hybrid zone between chromosome races of the *Sceloporus grammicus* complex (Phrynosomatidae) in Central Mexico. JACK W. SITES, JR.[1], NICK H. BARTON[2] AND KENT M. REED[3]. [1]*Dept of Zoology, Brigham Young University, Provo, UT 84602, United States of America.* [2]*Institute of Cell, Animal, & Population Biology, Univ. of Edinburgh, United Kingdom.* [3]*Dept of Biology, University of Rochester, Rochester, NY 14627, United States of America.* The *Sceloporus grammicus* complex consists of at least 8

distinct chromosome races in central Mexico (2n=32–46) that form 7 distinct zones of parapatric hybridisation between different combinations of 2n races. One of these, the "Tulancingo" transect, has been studied in detail because of its accessibility, abundance of lizards, magnitude of the chromosomal differences between the hybridising races (2n=34×46), and the presence of abrupt, concordant clinal shifts from one race to the other for 3 diagnostic markers (chromosomes 1, 2, and 6). Extensive collections of lizards were made across this transect in June–July of 1989, and again in February of 1991, and all capture points plotted on mapped grids with surveying equipment (n = 505 lizards total). Hybrid index scores were plotted for each quad in the region of admixture and showed that some level of hybridisation and/or backcrossing is evident at the majority of sampling localities. Samples were tested for heterozygote deficits (Fis) and linkage disequilibrium (R) for different combinations of the diagnostic markers by pooling lizards into samples covering spatial scales of 0.2 to 3.0 km. Markers 6 and 1 show no heterozygote deficits in samples pooled over small scales, but deficits become significant over a scale of 100–200 m for chromosome 6, and for chromosome 1 as the grouping scale approaches 600 m. Chromosomes 2 shows a significant deficit even when samples are grouped over extremely small distances (40–50 m). Likelihood estimates of R showed extremely high disequilibrium over all scales of pooling for chromosome 2 in combination with other markers, and a similar pattern for C2/C6 over a distance of 50 m. Remaining gametic combinations show stable R values out to 600 m. The zone is strongly subdivided into a mosaic of local patches, and characterised by independent fluctuations across markers over small scales. This would give a heterozygote deficit but no consistent disequilibrium. As one pools over larger scales, fluctuations at different loci become concordant. These indirect estimates suggest more intense selection on chromosome 2 relative to other markers. [KEYWORDS: *Sceloporus grammicus*, parapatric hybridisation, chromosomal cline, heterozygote deficit, linkage disequilibrium, maximum likelihood].

Sites *et al.*
C01

Mitochondrial DNA sequence divergence and phylogenetic relationships of the genera of large iguanas (Sauria, Iguanidae). JACK W. SITES, JR.[1], SCOTT K. DAVIS[2], JOHN B. IVERSON[3] AND HOWARD L. SNELL[4]. [1]*Dept of Zoology, Brigham Young University, Provo, UT 84602, United States of America.* [2]*Dept of Animal Science, Texas A&M University, College Station, IX 77843, United States of America.* [3]*Dept of Biology, Earlham College, Richmond, IN 47374, United States of America.* [4]*Dept of Biology, University of New Mexico, Albuquerque, NM 87131, United States of America.* The family Iguanidae (*sensu* Frost and Etheridge, 1989) includes 8 extant general of large herbivorous lizards commonly known as iguanas. This includes the widely distributed (= North & South America) nominate genus *Iguana*, the North American genera *Ctenosaura* (+ *Enyaliosaurus*), *Dipsosaurus*, and *Sauromalus*, the Caribbean endemic *Cyclura*, the Galapagos endemics *Amblyrhynchus* and *Conolophus*, and the Fijian-Tongan endemic *Brachylophus*. Monophyly of the family and each of the basal taxa is in little doubt (with the possible exception of *Cyclura*) but intrafamilial relationships are uncertain. Several lines of evidence (morphological and immunological) suggest that the two Galapagos genera are sister taxa, and one hypothesis holds that *Brachylophus* is the sister group of the *Amblyrhynchus* + *Conolophus* clade. The genera *Ctenosaura* and *Cyclura* have also been proposed to be closely related, although

both have also been proposed to be nearest relatives to *Iguana*. Recent morphologically based cladistic studies have provided partial (de Queiroz, 1987) or complete resolution (Norell and de Queiroz, 1991). The latter study described the fossil genus *Armandisaurus* and its inclusion in the data matrix of de Queiroz (1987) resolved a single most parsimonious cladogram with the following topology: ((*Dipsosaurus* + *Armandisaurus*) + (*Brachylophus* + (((*Conolophus* + *Amblyrhynchus*) + *Sauromalus*) + ((*Iguana* + *Cyclura*) + *Ctenosaura*)))). We present an alternative hypothesis based on a parsimony analysis of 957 bases of mtDNA sequence, with two alternative topologies: ((((*Ctenosaura* + (*Amblyrhynchus* + *Conolophus*)) + (*Iguana* + *Sauromalus*)) + *Cyclura*) + *Brachylophus*) + *Dipsosaurus*), and ((((*Ctenosaura* + *Ctenosaura* + (*Amblyrhynchus* + *Conolophus*)) + ((*Iguana* + *Sauromalus*) + *Cyclura*))) + *Brachylophus*) + *Dipsosaurus*). The latter tree is one of two obtained when *Sceloporus* is the outgroup, while the first tree is the second alternative and the only topology resolved when rooted to *Oplurus*. Biogeographic implications are considered, as well as regions of congruence and discordance between morphological and molecular data sets. [KEYWORDS: Iguanas, mtDNA, molecular phylogeny, zoogeography].

Sjögren S24

Metapopulation dynamics and extinction in pristine habitats: a demographic explanation. PER SJÖGREN. *Center for Conservation Biology, Dept of Genetics, Uppsala University, Box 7003, S-750 07 Uppsala, Sweden.* Individual survival of more than 2400 marked pool frogs (*Rana lessonae*) was studied during 1984–88 at a central (representative) pond of a metapopulation system, using hand-net captures and a surrounding drift fence. In 1985–87, extensive captures were also carried out at 6 other pool frog ponds at 230–2300 m distance from this focal pond for emigration measurements. Combined with the life-time fecundity data of 327 frogs (Sjögren, *Evol. Ecol.* 5, 248–271), these data permitted a life table analysis under two separate conditions: A) all emigrants were considered to be lost from the system (dead), and B) the emigrants survived equally well at the recipient ponds as in their source habitat and were thus retrieved within a metapopulation system. While r was negative in the A-case, each local population increased with about 10% per year in the B-case (with emigration fully compensated by immigration). This result emphasises the role of local emigration propensity, and the importance of emigrant survival, for persistence of subdivided populations. It also hints that extinction may become inevitable under circumstances where individual "patch" habitats remain unaltered. [KEYWORDS: extinction, metapopulation, life table analysis, emigration, connectivity].

Sjögren C06– 167

Applying metapopulation theory to amphibian conservation. PER SJÖGREN. *Center for Conservation Biology, Dept of Genetics, Uppsala University, Box 7003, S-750 07 Uppsala, Sweden.* Amphibian species living and reproducing in ponds exhibit features of a metapopulation, i.e. a system of conspecific local populations linked through dispersal. Metapopulation theory predicts that local extinction and colonisation events occur in such a system, but that a regional equilibrium may exist in which local extinction is balanced by (re)colonisation. Thus, even a locally 'unstable' system may be regionally stable with an equilibrium fraction of the habitat patches occupied from a long-term perspective. This is relevant to conservation biology, in which the risk of population extinction due to demographic environmental and genetic uncertainties

has been emphasised (e.g. Goodman, *Conserv. Biol.* 1, 59–62). But still, the application of metapopulation theory to practical conservation has been questioned. With this theory in mind, I analysed data from four inventories of the regional distribution of Swedish pool frogs (*Rana lessonae*)in the 1950s, 1983, 1987 and 1990. I found that local extinctions and (re)colonisations occur, and that two important aspects/'dimensions' of these dynamics need to be carefully considered (Sjögren, *Biol. J. Linn. Soc.* 42, 135–147 & unpublished). First, habitat quality must be reliably defined (i.e. What is a habitat patch?), and second, spatial dynamics must be examined (i.e. effects of degree of isolation on local demography and environmental independence of patches). I present ways of practically dealing with these questions for conservation purposes. [KEYWORDS: metapopulation, conservation, spatial dynamics, extinction, inventory data].

Morphology and evolution of the species of the *nanuzae* group of the genus *Tropidurus* (Iguania : Tropiduridae). GABRIEL SKUK. *Universidade de São Paulo, Instituto de Biociências, Departamento de Zoologia, Caixa Postal 20520, 01498-970, São Paulo, SP, Brazil.* The *nanuzae* group of the genus *Tropidurus* was originally proposed based on the loss of the sternal fenestra and by having a derived karyotype. Morphological studies on whole exemplars and of osteological preparations of the three species in the group and related species (other Tropidurini lizards) sustain the hypothesis of the *nanuzae* group being the sister group of the remaining species in *Tropidurus*, although more evidence of monophyly is lacking. Each species in the group has accumulated derived features which make difficult to solve their phylogenetic relationships with each other, but the two strictly psammophilous species *T. amathites* and *T. divaricatus* seem to be sister species. These two species are ecologically very similar and geographically very near Since the *nanuzae* group must represent an early radiation in the history of *Tropidurus*, it is believed that the three species in the group probably have a relictual distribution, living in areas climatically and geologically very much differentiated within the greater morphoclimatic domains in which they are enclosed. The montane species, *T. nanuzae* was found to have differentiation in habitat preference, with northern populations being psammophilous. It is proposed that psammophily could be related in some way to the origin of the group and of the remaining *Tropidurus*, having seen that the other psammophilous species in the genus have been basally situated in their phylogeny. [KEYWORDS: *Tropidurus*, morphology, phylogeny, biogeography, ecology].

Skuk C06–168

Studies on an intracellular blood parasite of the skink, *Tiliqua rugosa*. CATHERINE J. SMALLRIDGE AND C. MICHAEL BULL. *School of Biological Sciences, Flinders University of South Australia, GPO Box 2100, Adelaide, SA 5001, Australia.* A survey was undertaken of a population of *Tilqua rugosa* near Mt Mary, South Australia, to screen for the presence of blood parasites. The population is host to two species of Ixodid tick, *Aponomma hydrosauri* and *Amblyomma limbatum* which are potential vectors of blood-borne diseases. Six percent of the lizards were found to have inclusions in their red blood cells at rates ranging up to 2% parasitaemia. Preliminary examination of the inclusion has shown it to be haemogregarine-like in appearance. Laboratory studies were undertaken to identify methods of transmission of the infection between lizards. These showed that lizards may develop the infection following

Smallridge & Bull C06-170

consumption of engorged *A. hydrosauri* recently detached from infected lizards. Resultant progression of infections in the blood were followed in individual lizards in the laboratory where infection rates up to 30% parasitaemia were observed. [KEYWORDS: Scincidae, blood parasites, transmission, Ixodidae].

Smith *et al.*

C05

Developmental and evolutionary linkage of placodal ectoderm and neural crest. STEVEN C. SMITH, ANN C. GRAVESON AND BRIAN K. HALL. *Dept of Biology, Dalhousie University, Halifax, N.S., Canada.* Ectodermal placodes and neural crest cells are both vertebrate innovations. Based on their common characteristics, it has been proposed that neural crest and placodes arose from a common precursor tissue. However, the developmental interactions necessary for the formation of these tissues are only poorly understood. We have examined the effect of the *premature death* (*p*) mutation of *Ambystoma mexicanum* (which affects the ability of ectoderm to produce normal neural crest cells) on the development of a primitive placodal derivative — the mechanoreceptive lateral-line system. Migration of lateral-line primordia and differentiation of mechanoreceptive neuromast organs are both disrupted in *p/p* embryos. These effects cannot be explained by the presence of surrounding mutant tissues. Rather, the *p* gene appears to directly interfere with the development of both neural crest and placodal ectoderm, suggesting that these tissues arise as the result of the same developmental interactions. These results may signify a closer evolutionary connection between neural crest and placodal ectoderm than previously suspected. [KEYWORDS: neural crest, *p* mutation, placodes, axolotl, lateral-line system, *Ambystoma mexicanum*].

Smits *et al.*

S13

The composition and function of surfactant in caecilian lungs. ALLAN W. SMITS[1], CHRISTOPHER B. DANIELS[2] AND SANDRA ORGEIG[2]. [1]*Dept of Biology, Box 19498 University of Texas, Arlington, TX 76019-0498, United States of America.* [2]*Dept of Human Physiology, School of Medicine, Flinders University, Bedford Pk., SA 5042, Australia.* Caecilians (Amphibia : Gymnophiona) possess long, saccular lungs that extend nearly the length of the body, ventilated by positive pressure exerted from an anatomically small buccal region. At low lung volumes (following exhalation) and/or under compression forces of water depth in aquatic species, their lungs may be prone to collapse, causing adherence of apposing epithelial lung surfaces. Pulmonary surfactant, a surface tension-reducing agent found in lungs of other vertebrates, would seem an essential adaptation in caecilians lungs. The composition and quantity of surfactant was examined from lung washings of aquatic (*Typhlonectes natans*) and terrestrial (*Schistometopum thomense*) caecilians, and the functional role of surfactant was tested by measuring lung opening and filling pressures prior to and following lung lavage. *Typhlonectes* surfactant contained significantly larger fractions of disaturated phospholipids (DSP) and cholesterol (CHOL) than *Schistometopum*, but both species had similar CHOL/DSP ratios. Incorporation of higher amounts of DSP and CHOL in *Typhlonectes* pulmonary surfactant may be correlated to functions of the more complex lung (greater septation) in an aquatic environment (hydrostatic compression). Pressures required to open the lung were greatly elevated with removal of surfactant in both species, as were pressures required to fill the lung following opening, indicating that surfactant plays important "anti-glue" and compliance-reduction roles. (Supported by the National Institutes of Health (HL46428; AWS) and Australian Research Council (CBD)).

[KEYWORDS: surfactant, lung, phospholipid, compliance, amphibian, Gymnophiona].

Snyder

S04

Functional significance of microvascular geometry in amphibians and reptiles. GREGORY K. SNYDER. *Dept of EPO Biology, University of Colorado, Boulder, CO 80309-0334, United States of America.* The growth of capillary networks in tissues was an integral part of the evolutionary development of a cardiovascular system that provides essential nutrients to metabolising cells and removes wastes from those cells. In each tissue the exchange process occurs between blood capillaries and surrounding cells and, in systemic tissues, exchange is by simple diffusion since the role of the capillary is passive. In the central nervous system (CNS) tissues are "vigorously isolated" from blood by capillary endothelial cells or surrounding glia which selectively exclude some materials and actively transport other materials. In this way the BBB serves to generate a unique microenvironment surrounding the neural cells of the CNS. However, because the BBB is developed from the vascular endothelium, lipid soluble substances readily pass through the lining barrier. During hypercapnia, for example, CNS is subject to the same acid-base challenges found in systemic tissues. A number of amphibian and reptilian species have developed a unique microvascular geometry in which capillaries form slender loops with the potential for countercurrent exchange. This unique capillary morphology may prevent barrier soluble materials from affecting the CNS neuronal microenvironment and, thus, be a very important part of the evolutionary development of the BBB. In this presentation I will describe the essential elements of microvascular geometry in amphibians and reptiles, including the phylogenetic distribution of the microvascular loops and the morphological differences in vessel geometry. In addition, I will present results from our recent work designed to demonstrate that countercurrent exchange in the CNS microvascular loops is a mechanism that serves to buffer CNS intracellular pH from changes in acid-base balance that arise systemically. (This work is supported by NSF DCB8818647 and NIH HL32894). [KEYWORDS: central nervous system, countercurrent, blood vessel, capillary].

Soberon-Mobarak & Cabral-Perdomo

C06–171

A hatchling turtle from the Tlayua formation, Tepeji de Rodriguez, Puebla, with comments on the fossil chelonians from Mexico. FRANCISCO SOBERON-MOBARAK AND MIGUEL ANGEL CABRAL-PERDOMO. *Instituto de Geologia, Depto de Paleontologia, Unam, Mexico.* We present a hatchling turtle from the Tlayua quarry, Tepeji de Rodrigues, Puebla, Southeastern Mexico. This specimen is associated with a emydid-like turtle from the same place, dated Upper Cretacic. The specimen is in process of determination, as well as other turtle specimens, including a possible Dermatemydid from the coal quarry in Nueva Rosita, Coahuila, dated Lower Cretacic, and several individuals of testudinids, related to *Gopherus* from Baja California Sur.

Sofianidou

S03

Electrophoretic studies of hybrids of water frogs (*Rana epeirotica, R. balcanica*) in the Ionian zone of Greece. THEODORA S. SOFIANIDOU. *Dept of Zoology, Aristoteleion University of Thessaloniki, 54006 Thessaloniki, Greece.* A number of studies on the fauna and reproductive biology of water frogs in western Greece documented two species, *Rana epeirotica* and *R. balcanica* (formerly named *R. ridibunda*) and natural interspecific hybrids distinguised mainly by the bioacoustic method (Schneider *et al.* 1984; Schneider & Sofianidou, 1986, 1987; Sofianidou & Schneider,

1989). Now a study of hybrids was made by means of vertical acrylamide electrophoresis to collect further information on the various types of hybrids. On the basis of the four most diagnostic loci (Ldh-1, Mdh-1, a muscle protein and plasma albumin) at least three types of hybrids are distinguished. The most common type is the true intermediate hybrid, having all four loci the two parental alleles in the form of typical heterozygosity, this type usually occurs syntopically with both parental species, although during the reproductive period mictrotopical association with one parental species (more frequently with *R. epeirotica*) is sometimes noticable. The other types of hybrids apparently triploid contain either two genomes of *R. balcanica* and one of *R. epeirotica* (BBE-triplod) or one genome of *R. balcanica* and two of *R. epeirotica* (EEB-triploid). Two females of Lake Ionnina had a duplicated allele of *R. epeirotica* at the locus Ldh-1 and apparently more intense Mdh-1, but was heterozygous for one *R. balcanica* and one *R. epeirotica* allele at the other loci. The possible role of the hybrid types on the control of the parental population size is discussed.

Song & Wang

C06–172

Study on herpetology fauna of the Kuankuoshui forest area. SONG XI-QUAN AND WANG SU-YING. *Dept of Biology, Zun-yi Teachers College, Guizhou Province 563002, P.R. China.* Since 1982 several herpetological surveys have been made in the Kuankuoshui Forest area 107°08'30"–107°11'20"E, 28°11'15"–28°15'35"N. 14 species and subspecies of reptiles belonging to 10 genera 5 families, 2 orders and 19 species and subspecies of amphibians belonging to 9 genera, 7 families and 2 orders were collected. The variations and rare species of *Pseudoxendon macrops sinensis nothus*, *Achalinus spinalis*, *Elaphe porphyracea nigrofa sciata*, *Natrix sauteri*, *Azemiops feae* and *Tylototriton asperrimus*, *Megophrys minor*, *M. spinatus*, *Rhacophorus chenfui* and *Rana adenopleura* have been discussed. With the difference in altitude reaching 1950 m the vertical distribution of the amphibians becomes an important feature. The wider horizontally the species is distributed, the wider vertically it is distributed. Most of the species with close phylogenetic relationships between them have been distributed in vertically overlapping. The paper compares amphibians and reptiles species diversities in Kuankuoshui and Maolan areas.

Souza et al.

C14

The effects of microgravity on *Xenopus* development. KENNETH A. SOUZA[1], STEVEN BLACK[2] AND RICHARD WASSERSUG[3]. [1]*Amos Research Center, NASA, Moffett Field, CA 94035, United States of America.* [2]*Biology Dept, Reed College, Portland, OR 97202, United States of America.* [3]*Department of Anatomy and Neurobiology, Faculty of Medicine, Dalhousie University Halifax, Nova Scotia B3H 4H7, Canada.* For over a century embryologists have debated the influence of gravity in biological processes. The amphibian eggs in particular have been studied because of their characteristic rotation after fertilisation, aligning their light and heavy hemispheres with the gravity vector. Ground-based studies have suggested that changes in the gravity vector during early stages of development can alter the position of cleavage planes, some aspects of the blastulae, and some features of the newly hatched tadpole. A Space Shuttle mission in September of 1992 enabled us to demonstrate that a vertebrate species can ovulate, fertilise, and develop in the absence of normal terrestrial gravity. Four African Clawed Frogs, *Xenopus laevis*, were flown on the Space Shuttle and injected in flight with chorionic gonadotropin, which stimulated ovulation during the eight day mission.

Eggs were collected, fertilised and yielded tadpoles that hatched in space. Approximately half of the eggs were incubated at microgravity while the other half was placed on an onboard centrifuge and rotated to create a 1 × g environment. The fertilisation rate of the 612 eggs used in the study was 91% and 73% for the microgravity and centrifuge groups, respectively. In-flight observations of newly hatched tadpoles did not reveal the expected looping behaviour previously seen on short term parabolic flights. Behavioural studies conducted on the first and second days postflight revealed significant differences between tadpoles reared on the centrifuge and those incubated at microgravity. The differences disappeared by nine days post-flight. The results of additional behavioural analyses, as well as histological studies, will be presented. [KEYWORDS: *Xenopus laevis*, tadpole, development, behaviour, weightlessness, microgravity].

Spencer & Grimmond

C06–173

Spatial and temporal variation in the use of thermal microhabitat by sympatric skinks and geckos. NICHOLAS J. SPENCER AND NICOLA M. GRIMMOND. *Dept of Zoology, University of Otago, P.O. Box 56, Dunedin, New Zealand.* The environmental constraints of substrate, temperature and time were found to control and limit the use of the microhabitat by the skink *Leiolopisma maccanni* and the gecko *Hoplodactylus maculatus* where they occur sympatrically in sites studied in Central Otago, New Zealand. Within these sites they were selective for non-random microhabitat use. Microhabitat was partitioned by the two species with a small amount of overlap in the use of under-rock areas. Skinks used a wide range of microhabitats experiencing varying physical characteristics and light conditions. Geckos were largely limited to under-rock microhabitats and were restricted to microhabitats which provided thigmothermic requirements. Species differences were evident in the selection of air temperatures in experimental thermal gradients and also there were differences in field operative temperatures. The skinks selected, and were active at, higher temperatures in both the experimental thermal gradients and in the field when compared with the geckos. However the gecko activity was not constrained by the temporal availability of microhabitat temperature whereas the skinks were so constrained. [KEYWORDS: microhabitat, temperature, time, skink, gecko].

Stamps

P5

Amphibians and reptiles as model organisms for behavioural studies. JUDY A. STAMPS. *Sect. Evol. Ecol., University of California, Davis, CA 95616, United States of America.* Amphibians and reptiles are ideal for studying a variety of important and topical questions in animal behaviour. For instance, early observations of territorial birds implied that settlers might be attracted to conspecific residents, an idea that was recently confirmed in field experiments using juvenile lizards. Conspecific attraction is relevant to conservation issues, metapopulation dynamics and mate choice, and amphibians with vocal advertisement signals are likely candidates for further tests of these new ideas. Similarly, mammalogists and theoreticians have suggested that inter-male competition and hence sexual size dimorphism might be governed by the spatial distribution patterns of adult females, an idea that was recently confirmed in an comparative analysis of *Anolis* lizards. Reptiles and amphibians can also help answer long-standing questions about the functional significance of proximate behavioural mechanisms, as in recent studies of the effects of contests on space acquisition. These and other examples show how behavioural questions originating from other taxonomic

groups or from theoretical models may lead to answers from herpetologists. [KEYWORDS: conspecific attraction, sexual dimorphism, animal contests].

Stanner

C16

Activity, body-temperature and foraging strategies in snakes: revision of concepts. MICHAEL STANNER. *Dept of Zoology, Tel Aviv University, Ramat Aviv, 69978 Tel Aviv, Israel.* Snakes are the youngest and most successful group of reptiles. The evolutionary success of snakes has been attributed mainly to their feeding strategy, namely infrequent consumption of large prey. This strategy enables snakes to minimise foraging time during which they are susceptible to predation, and thus is considered to have an adaptive value. During a telemetric study of the Montpellier snake (*Malpolon monspessulanus*) in Israel, this snake exhibited several features which do not console with this theory. During the peak-activity season (May–June) this snake was highly active, emerging from night shelters almost daily, and moving intensively throughout most of the day. Its preferred body temperature (Pbt) is high ($\approx 37°$) reaching at times 38–40°C. Same individual snakes were observed to feed frequently (during intervals of 1–3 days) on large prey. High Pbt is concluded to enable this snake to be intensively active and capture fast-moving prey, as well as to digest the prey rapidly. Based on these findings, I therefore revise the previous theory as follows: in a certain given condition a snake may subsist on infrequent consumption of large prey (first strategy). In another condition the same individual snake may choose to be highly active, hence capture large prey frequently and digest it rapidly at high Pbt (second strategy). In between these extremes, the snake has many interim options. Presumably, also a snake which adopts the second strategy would stop feeding once its energy requirements have been fulfilled, i.e. its total prey consumption during the activity season would be condensed into shorter periods than that of a snake which adopts the first strategy. The first strategy might be adaptive at times of food scarcity or when dangers such as predation, human interferences and extreme weather conditions are prevalent. The second strategy might be adaptive in productive and safe environments. [KEYWORDS: snake, ecology, telemetry, activity, foraging].

Stebbins

S24

Declining amphibians — the endocrine connection. ROBERT C. STEBBINS. *Museum of Vertebrate Zoology, University of California, Berkeley, CA 94720, United States of America.* Many local impacts, anthropogenic and climatic, are often noted in amphibian declines, but they frequently fall short of fully explaining many declines. Furthermore, declines are occurring in seemingly pristine areas, many seem to be somewhat in synchrony, and are distributed globally. Might there be a pervasive, perhaps atmospheric source of damage? Certain chemicals of the industrial age may qualify as the primary culprit. These are chemicals that intrude into developmental processes, blocking intercellular communication, inducing the production of enzymes that break down hormones, and that mimic naturally occurring estrogens — chlorinated chemicals such as DDT, PCBs and others. Many are now world wide in distribution, transported by air, water, animals and commerce. Since the middle 1940s, contamination from many of them has grown exponentially. Some accumulate and are long-lasting in the environment. Perhaps we are now seeing biotic responses on a large scale, with amphibians (among vertebrates) in the lead. These chemicals intrude into developmental processes and misdirect cell differentiation and growth. They do so even when they

exist in the physical environment at which are frequently regarded as low levels (1 part per million) because of biomagnification and the relatively low concentration at which naturally occurring hormones circulate in the blood, and produce their effects. Effects of these endocrine disrupters can be far reaching. They include thyroid dysfunction, decreased fertility, birth deformities, metabolic abnormalities, effects on sexual development, and damage to immune systems. Characteristics of amphibians that may make them particularly vulnerable to the effects of endocrine intruders will be discussed

Stewart

C06–174

A coccidian epidemic in captive *Heteronotia binoei*. DAVID A. STEWART. *Dept of Anatomical Sciences or Dept of Zoology, University of Queensland, St Lucia 4072, Australia.* A coccidian parasite has been determined to be the most likely cause of death for 59 of 108 parthenogenetic and sexual forms of Bynoe's gecko (*Heteronotia binoei*) housed in semi-natural enclosures for reproductive studies. The majority of these deaths occurred over a short period (mid December to late February) towards the end of the gecko's breeding season. A substantially higher proportion of parthenogens died (33/48) compared to the sexual form, (26/56) ($\chi^2 = 5.2462$, df = 1, $p<0.05$) however, there was no significant difference in the death rates for these two groups (163±38 and 241±43 mean number of days to death for the parthenogens and sexual respectively). The high proportion of parthenogens dying in the enclosures, may reflect, as others have predicted, parthenogenetic organisms may be at a disadvantage due to higher susceptibility to infections by parasitic pathogens. If this is the case, and similar epidemics occur in natural populations the coccidia may help to counteract reproductive advantages obtained through parthenogenetic modes of reproduction and maintain sexual forms where they occur sympatrically. [KEYWORDS: Geckkonidae, parthenogenesis, coccidiosis].

Stewart & Thompson

C13

Placentation of the viviparous Tasmanian skink, *Niveoscincus metallicus*. JAMES R. STEWART[1] AND MICHAEL B. THOMPSON[2]. [1]*Dept Biological Science, University of Tulsa, Tulsa, OK 74104, United States of America.* [2]*Zoology (A08), University of Sydney, NSW 2006, Australia.* A unique type of reptilian allantoplacenta was described by Weekes (1930) from a single embryonic stage of the Tasmanian skink, *Niveoscincus ocellatus*. She also assigned *N. metallicus* to this placental category but did not provide a description. Here we provide a description of chorioallantoic and yolk sac placentation of *N. metallicus*. The chorioallantoic placenta is distinguished by two notable features, hypertrophied epithelial cells of the chorion, and the superficial position of uterine blood vessels. The outer layer of chorionic epithelium consists of cuboidal cells supported by an extensive network of allantoic blood vessels. The degree of hypertrophy of the chorionic epithelium is regionally differentiated. Uterine blood vessels of the chorioallantoic placenta protrude into the uterine lumen as ridges supported by squamous epithelial cells. The omphaloplacenta occupies the entire ventral surface of the yolk sac. The isolated yolk mass, which forms as in other squamates, is completely absorbed, yet the bilaminar omphalopleure of the isolated yolk mass remains intact and is separated from the yolk sac splanchnopleure by the yolk cleft. The bilaminar omphalopleure of the omphaloplacenta consists of an outer layer of cuboidal or columnar cells. Cells of the uterine epithelium of the omphaloplacenta are cuboidal or columnar in shape and are supported by uterine blood vessels. (Weekes, H.C. (1930)

Proc. Linn. Soc. NSW. 55:550-576.) [KEYWORDS: placentation, viviparity, Lacertilia, *Niveoscincus*, *Leiolopisma*].

Stewart & Bishop

C06–175

Effects of increased sound level of advertisement calls on calling male frogs. MARGARET M. STEWART[1] AND PHILLIP J. BISHOP[2]. [1]*Department of Biological Sciences, University at Albany, Albany, NY 12222, United States of America.* [2]*Department of Zoology, University of the Witwatersrand, Wits 2050, South Africa.* If calling male *Eleutherodactylus coqui* are intolerant of other calling males nearby, then the sound level of advertisement calls can function as a nocturnal spacing mechanism for calling frogs. To investigate this hypothesis, we played advertisement calls to 23 individual calling males in the forest at El Verde, Puerto Rico. We played calls at six sound pressure levels from 75 to 102 decibels. The mean number of aggressive calls increased and advertisement calls decreased as sound pressure level increased. The ratio of advertisement to aggressive calls at each level decreased as sound level increased. Both behavioural responses and call types varied among individuals. Most frogs became silent or moved away as sound pressure level increased beyond 89–94 decibels. Calling males apparently space themselves by mutual avoidance and fight only in defense of retreats or nests. [KEYWORDS: vocalisation, spacing, acoustic interactions, sound levels, aggressive calls].

Stimson

SS

From fear to friend. ANTHONY STIMSON. *Featherdale Wildlife Park, 217 Kildare Road, Doonside, NSW 2767, Australia.* Zoos and Wildlife Parks have a very important role to play in the conservation of herpetofauna and, as such, are in a unique position to counter herpetophobia. Unfortunately many herpetologists and zoo educators are unaware they may actually be contributing to this phobia, in particular, the fear of snakes. The design of reptile exhibits, the associated signage and also reptile presentations will often over emphasise visitor safety and facts like "venom toxicity" and as a result reinforce many visitors' fears. At Featherdale Wildlife Park, a different and more positive approach has been adopted. Emotive words implying danger, e.g. aggressive attack etc., have been omitted where possible, and words which make visitors feel comfortable are used instead. Unsympathetic facts are avoided and information conveyed is often based on the asthetic value of the animal and its importance in the environment. A very "hands-on" approach is taken at Featherdale. Morbid fascination is not used as a lure, and people are encouraged to touch a snake during the presentations. This experience being is such a positive atmosphere, often overcomes this all too common phobia. [KEYWORDS: herpetophobia, zoos and wildlife parks].

Subba Rao

C06–176

Some observations on the ecophysiology of two selected lizards, *Sitana ponticeriana* and *Calotes nemoricola*. M.V. SUBBA RAO. *Dept of Environmental Sciences, Andhra University, Visakhapatnam 530 003, India.* The ecophysiology of two lizards, *Sitana ponticeriana* and *Calotes nemoricola* were studied under natural conditions of their habits such as basking, mating, egg laying, hatching, resting or sleeping and rhythmic adaptive radiations in the metabolic activity as reflected by the respiratory and locomotor activity. All these processes more or less synchronised with each other. This suggests the existence of a number of 'clocks' in these organisms. It is inferred that these clocks are dependent and mutually inter-related. The

habits and the rhythms fluctuates depending upon environmental factors like temperature, light, humidity, wind velocity and rainfall in different seasons and different years. Thus, the various activities studied may be placed in sequence based upon the time of their appearance and their significance in relation to the daily life of these lizards. [KEYWORDS: ecophysiology, basking, activity, rhythms].

Subba Rao

C06–177

Present population of the gharials, *Gavialis gangeticus* Gmelin in India. M.V. SUBBA RAO. *Dept of Environmental Sciences, Andhra University, Visakhapatnam 530 003, India.* Among 25 species of crocodiles in the world, only three species are found in and around India. They are the gharial, *Gavialis gangeticus*, Gmelin, the salt water crocodile, *Crocodylus porosus*, Schneider and the mugger crocodile, *Crocodylus palustris*, Lesson. A distinctive large and extremely slender snouted fish eating gharial is endemic to Indian Sub-continent, India, Pakistan, Bhutan, Bangladesh and Burma. They are distributed in North Indian rivers such as Ganges, Brahmaputra, Kosi, Narayani and their tributaries. Gharials have secondary sexual characters. The male gharial shows the knob at the tip of the snout and it is absent in female gharials. In 1975 under UNDP/FAO Crocodile project in India shows estimation of gharials population in Indian subcontinent are about 100. The population of gharials in 1992 is about 1850. This is mainly due to the crocodile farming (*in situ* and *ex situ*) in India from 1975 onwards. The paper delineates the conservation and the management of the Gharials in India. [KEYWORDS: crocodiles, gharials, distribution, secondary sexual characters, population of gharials, crocodile farmimg].

Subba Rao *et al.*

C06–176

Breeding ecology of the limbless skink *Barkudia insularis*, Annandale. M.V. SUBBA RAO[1], K. KAMESWARA RAO[1] AND B. NAGESWARA RAO[2]. [1]*Dept of Environmental Sciences, Andhra University, Visakhapatnam 530 003, India.* [2]*Dept of Zoology, A.V.N. College, Visakhapatnam 530 002, India.* The limbless skink, *Barkudia insularis*, Annandale, showed sexual dimorphism. However, by probing the cloaca, some of the large adult males could be identified with the presence of hemipenis. The mean size of maturity in *Barkudia insularis* was 130 mm snout-vent length, the greatest number of adults falling into the 140–160 mm SV group for both the sexes. Smallest female *Barkudia insularis* containing eggs was 138 mm SV group. Lizards of SV length between 126 and 140 mm showed little seasonal change in the size of the gonads, which were usually 4 mm long. All male lizards had 140 mm SV length exhibited marked seasonal variation in the length of testes. The first oviduct eggs appeared in few lizards of SV length of 138 mm. Juvenile lizards of below 90 mm SV appeared only during August and September months. [KEYWORDS: limbless lizard, breeding ecology, sexual dimorphism, maturity, endemic to Visakhapatnam (L.C), juveniles].

Subba Rao & Raja Sekhar

S18

Captive rearing of an endangered olive ridley sea turtle hatchlings, *Lepidochelys olivacea* (Eschscholtz) for conservation purpose. M.V. SUBBA RAO AND P.S. RAJA SEKHAR *Dept of Environ. Sciences, Andhra University, Bisakhapatnam 530 003, AP, India.* Olive ridley sea turtle, *Lepidochelys olivacea* (Eschscholtz) hatchlings highly susceptible to predation in their early stages. Newly born hatchlings are unable to protect themselves and exposed to several dangers easily falls prey to many predators on land and at sea. Hendrickson (1958) estimated the losses 1.7%

survivality after the first week of life at sea. Several authors were also stated that a small percentage 1–2% hatchlings would survive and reached into adults due to molestation at every stage of their life cycle. To reduce the mortality and predation in early stages, captive rearing of the newly emerged hatchlings for 10–12 months is an important aspect in the conservation programmes. Eggs collected from the natural nests shifted to protected places and hatched *in situ* during 1990–91. Newly born hatchlings (579) were collected from these nests and reared under complete captive conditions in plastic pools of different sizes with sea water as the media. The hatchlings were fed with different kinds of food items from mollusca to sea fish. Health and hygiene of the hatchlings regularly monitored, any hatchlings with wounds and fungal infections separated and treated until recovered from the infections. Food and feeding, growth rates were observed regularly. After one year rearing, the hatchlings were healthy and weight increases from 19 g at the age of day 1 to 950 g at one year old. The hatchlings with prominent scutes on plastron and nails on flippers helps in protection from predators, after which they were released back into the sea. [KEYWORDS: olive ridleys, hatchlings, captive rearing, predation].

Sugiri

C06–179

Karyotype, serum protein and the status of two subspecies of *Rana macrodon* group from the western parts of Indonesia. NAWANGSARI SUGIRI. *Dept of Biology, Bogor Agricultural University, Bogor, Java, Indonesia.* Squash preparations of adult femur bone marrow were used to determine and compare two frog populations, *Rana macrodon macrodon* (from West Java) and *Rana macrodon blythi* Boulenger (giant frog from West Sumatra). Serum protein patterns were examined by means of cellulose polyacetate electrophoresis. Cross fertilisations were attempted and tadpoles morphology have been examined. Although both populations have the same chromosome number ($2n = 24$), their karyotypes are different. There are three pairs of large metacentrics and one small telocentric in *R. m. macrodon*, but two pairs of large metacentrics in *R. m. blythi*. The other chromosomes are submetacentric. The serumprotein and the trail stripes pattern of the tadpoles of the two populations are also different. These findings confirmed that the two populations belong to different species e.g. *R. macrodon* Dumeril and Bibron and *R. blythi* Boulenger. [KEYWORDS: metacentric, submetacentric, telocentric].

Sullivan

S22

Female preferences and selection on male calling vigour in North American bufonids and hylids. BRIAN K. SULLIVAN. *Life Sciences Program, Arizona State University West, P.O. Box 37100, Phoenix, AZ 85069, United States of America.* The influence of female choice on male calling vigour (call rate and call duration) was examined for *Bufo americanus*, *B. valliceps*, *B. woodhousii*, *Hyla versicolor*, and *Pseudacris crucifer*. Under laboratory conditions, females of all five taxa preferred calls broadcast at a high rate when duration was held constant. Female *B. americanus*, *B. valliceps*, and *H. versicolor* preferred long duration calls when call rate was held constant. In most populations of these anurans, females initiated mating (amplexus) in natural choruses unhindered by actively-searching or satellite males. Males of all taxa exhibited significant repeatabilities in call rate and call duration (duration was not evaluated for *B. woodhousii* or *P. crucifer*). In spite of these consistent differences in calling behavior among males, and female preferences for vigorously calling males, only in *B. woodhousii*

was selection on male calling behaviour evident under field conditions, as revealed from multivariate analyses of selection on male phenotype. These results are consistent with the hypothesis that females are less selective under natural conditions, potentially as a result of temporal constraints limiting the time available for reproductive activity. [KEYWORDS: call duration, call rate, calling vigor, female choice, male display behaviour, selection].

Sullivan & Wagner

S19

Acoustic communication in North American toads (*Bufo*): sexual selection and species recognition. BRIAN K. SULLIVAN[1] AND WILLIAM E. WAGNER JR[2]. [1]*Life Sciences Program, Arizona State University West, P.O. Box 37100, Phoenix, AZ 85069, United States of America.* [2]*Department of Biological Sciences, University of California, Santa Barbara, CA 93106, United States of America.* Female toads prefer as mates males that call vigorously (i.e. high call rate and long call duration) and that produce advertisement calls with species-typical pulse rates and dominant frequencies. Although dominant frequency of calls is negatively correlated with male body size in most toads, females do not prefer the low frequency calls of larger males. In the light of these female preferences, variation in calling behaviour within and among males was assessed for three North American toads (*Bufo americanus*, *B. valliceps*, and *B. woodhousii*). Within a single breeding season, repeatabilities (r = intraclass correlation) for male call variables ranged from 0.08 to 0.54 for call rate, and from 0.50 to 0.61 for call duration. In *B. valliceps* between year repeatability of call duration (0.39), although not significant, was higher than repeatability of call rate (0.10), similar to the general results for within year analyses. Small sample sizes limited assessment of variation in male calling behaviour across years for *B. americanus* and *B. woodhousii*. Like hylid frogs, coefficients of variation were higher for call rate (19–39%) and call duration (19–36%) than for pulse rate (4–7%) and dominant frequency (5–7%), two variables thought to be critical to species recognition and under stabilising selection in these bufonids. [KEYWORDS: call variation, repeatability, sexual selection, species recognition].

Swan

SS

***Eulamprus quoyii* — a field study.** GERRY SWAN. *94 Yarrabung Road, St Ives, NSW 2075, Australia.* A natural population of the Eastern water skink, *Eulamprus quoyii* was studied over eleven years between 1971–1982. During this period there were several very dry seasons and a severe bush fire in the study area. Over 300 captures involving 200 animals were made and information is provided on male/female ratios, growth rates, reproduction, longevity, home range and tail regeneration. Twice, in 1980 and 1982 a total population census was undertaken by catching and removing every animal seen over a period of several days. The results were consistent in terms of density and male/female ratios. [KEYWORDS: *Eulamprus quoyii*, growth, reproduction, longevity].

Swain & Jones

C06–180

Annual hormone cycles in the viviparous skink, *Niveoscincus metallicus*, from Tasmania. ROY SWAIN AND SUSAN M. JONES *Dept of Zoology, University of Tasmania, Box 252C, GPO, Hobart 7001, Australia.* The reproductive cycle was studied in *Niveoscincus metallicus*, a small viviparous skink which mates in autumn and ovulates in spring. Along with other reproductive parameters, plasma testosterone concentrations were measured in males and plasma estrogen and progesterone concen-

trations in females. Male ventral coloration is significantly greater in females although no correlation was found between colour intensity and either size or testosterone concentration. Testis size shows seasonal variation with a peak during summer (late Dec–Feb), whilst circulating testosterone levels are low (0.7–10.0 ng ml^{-1}) during most of the year but show a sharp peak in March (mean–46.2; s.e.±9.7), coincident with both maximum tail width and epididymal development. Mating occurs in April and females carry sperm through the winter. Some evidence suggests a second mating period may occur in spring. All adult females were pregnant and carry young. Plasma estrogen peaked in early September (mean–568; s.e.±103 pg ml^{-1}) prior to ovulation in late September/early October. Plasma progesterone concentrations peaked very abruptly in November (mean–17.8; s.e.±2.4 ng ml^{-1}) concurrent with rapid organogenesis in the embryos but then declined during the later stages of gestation. Most births occurred in late January and progesterone was undetectable in the blood post-partum. [KEYWORDS: Scincidae, lizard, reproduction, testosterone, estrogen, progesterone].

Sweet

S07

Regional patterns of amphibian distribution: North America. SAMUEL S. SWEET. *Dept of Biological Sciences, University of California, Santa Barbara, CA 93106, United States of America.* The North American amphibian fauna is relatively stable taxonomically, and the distributions of most species are precisely known. Nine families of salamanders include 140 species in 26 genera; 4 families, 23 genera, and 138 species are endemic. Anurans consist of 8 families with 16 genera and 95 species; no families, 3 genera, and 72 species are endemic. High endemism of salamander families and genera reflects a few relict distributions in the Pacific Northwest and southeastern US, and particularly the great radiation of plethodontid salamanders in the southern Appalachian Mountains and adjacent uplands. Low endemism in anuran families and genera reflects a preponderance of cosmopolitan lineages; conspicuous centres of anuran species richness are lacking, but diversity is high along the inland margins of the southern Atlantic Coastal Plain and Mississippi Embayment, and the coastal lowlands of northwestern Mexico, all of which display patterns of nearly parapatric boundaries with irregular overlap. The resolution afforded by precise distributional data offers little evidence of sharp biogeographic distinctions in this fauna; rather, the breadth of faunal transition zones is tied to the slopes of the relevant environmental gradients, and to the numbers of contiguously allopatric species present. [KEYWORDS: zoogeography, Amphibia, North America].

Szymura

S03

Can fire-bellied toads, *Bombina bombina* and *B. variegata* maintain distinctiveness in face of hybridisation. JACEK M. SZYMURA. *Dept of Comparative Anatomy, Jagiellonian University, Ingardena 6, 30060 Krakow, Poland.* *Bombina bombina* and *B. variegata* meet in a hybrid zone thousands of km long. Studied were 4–6 enzyme markers and abdominal pattern, and near Krakow also mitochondrial DNA and mating call. Based on several transects, the zone is where mountains meet lowlands; where data exist, the zone has not moved for 30–80 years. Electrophoretic alleles and morphology change together over 5–10 km, with allele introgression up to 40 km. The hybrid zone's structure fits one of three broad catagories: (1) best known, smooth clines. Two transects in S Poland (90 samples, over 4000 toads) are similar. Though six enzyme loci are not linked, parental allele combinations are more common than expected; linkage disequilibrium increases towards the zone's centre. The explanation is that in the hybrid zone, diffusion of parental allele combinations maintains linkage disequilibrium, despite recombination and segregation. Thus selection on gene-blocks at the centre maintains steep clines. Inter-transect differences seem to relate to the taxa's habitat preferences, rather than to the times contacts were established. (2) Mosaic hybrid zones. (3) Relics of previous hybridisation. Thus despite all the hybridisation the two species maintain their identities.

Talvi

C06–181

Herpetofaunal distribution patterns in the Estonian Islands (Baltic Sea). TÓNU TALVI. *Viidumäe Nature Reserve, Saaremaa Island, Estonia.* The geographic distribution of amphibians and reptiles was studied on 35 Estonian islands, Baltic Sea. The islands inhabitated by herptiles range from 5.4 to 267100 ha in area, and from 0.1 to 32.8 km in isolation. The relationship between species richness and biological, geographical, historical, and human impact variables was investigated. Nine of 15 extant amphibian and reptile species of the Estonia are represented in marine islands. At least four species occurring on coastal regions on mainland do not reach the islands, although comparable ecological conditions are partly available. These are *Pelobates fuscus*, *Rana lessonae*, *Rana esculenta*, and *Lacerta agilis*. Only Hiiumaa and Vormsi islands with 9 species comes close to the mainland ratio. All the other islands offer, mainly because of geographical and ecological circumstances, only a considerable impoverished herpetofauna. Very small islands do not support amphibian populations, at least not for any extended period of time. The number and distribution of several species have changed markedly during last thirty years. Our results suggest that the availability of suitable breeding habitats on islands partly, but not exclusively, determine the amphibians occurrences. Suitable habitats and prey availability are more important in predicting reptile species occurrences on islands. The species richness of amphibians and reptiles was a positive function of island area. But the slopes of the species-area curves seem relatively low compared with those given to typical archipelagos. The herpetofaunal species richness is randomly related with isolation. [KEYWORDS: amphibians, reptiles, island biogeography, area, isolation].

Tarkhnishvili

C06–182

Amphibian associations of Caucasus: guild structure and coexistence mechanisms. DAVID N. TARKHNISHVILI. *Dept of Biology, Tbilisi University, University str.2, Tbilisi 380077, Georgia.* Six anuran species coexist in the mountain forest of Central Georgia: *Rana macrocnemis*, *Bufo verrucosissimus*, *Pelodytes caucasicus*, *Rana ridibunda*, *Bufo viridis*, *Hyla arborea*. Former three species are limited by forest in their distribution. Another species prefer open plots. Number dynamics and spatial structure of "forest" species populations, exploitation of spawning sites, phenology, clutch characteristics, mortality in different stages of life, age structure and external morphology was investigated during 4 years. Ecological niches of these species are highly overlapped, and body sizes of adult animals are distributed according to Hutchinson rule. Nevertheless, simultaneously prepared analysis of reproductive resources exploitation and k-factor analysis of number dynamics showed that interspecific interactions don't play an important role in resource division and number regulation. Number dynamics in all species accord to Gill's (1978) model when all renewal of the population is ensured by a few "populatlon centres". Interspecific competition observed on the

larval stage take place outside of these centres and does not affect population numbers. Interspecific differences in equilibrium density depend on the species position on the gradient of demographic strategies. Smaller species have a lower fecundity, a higher rates of larval survival, younger age of maturation, higher density of adults. Composition of different components of life cycle, carrying capacity and variability of population number ensure comparable viability of populations in species with different equilibrium abundance and intrinsic growth rates. [KEYWORDS: Anura, life cycles, guild, population dynamics, reproductive resources, demography].

Tarkhnishvili
C06–183

Population ecology of Iranian wood frog. DAVID N. TARKHNISHVILI. *Dept of Biology, Tbilisi University, University str.2, Tbilisi 380077, Georgia.* The population of Iranian wood frog (*Rana macrocnemis*) was investigated since 1989 in Central Georgia. The population is limited by natural borders (mountain canyon) and migration rates from and to neighbour populations are low. Spawning takes place in about 100 rain and stream pools. The number of adult females varied during 5 years from 970 to 1110. The main reason of embryonal and larval mortality is overdrying. For all the population, survival rates from egg to metamorphosis reach 0.8–1.0% in different years. At the same time, survival in non-dried pools reaches 4–10%, and up to 16–17% in separate "effective" spawning sites (1–3 each year). About 10% of females spawn in "effective" sites, but they ensure 80–90% of offsprings. The total number of metamorphosed froglets vary between 15–45 thousands. Judging from age composition in adults 1992, surivival rates in the generation emerged in 1989 were in average about 0.37 year^{-1}. Annual survival rates of adult frogs are about 0.3 in males and 0.5 in females. The population could be divided in 35 demes each containing 1–115 adult females. Increasing of female number in deme from year to year is negatively correlated with actual female number. It must be resulted in density-dependent migrations between demes. Such migrations appear to be the main factor of keeping population number in stable level. Density-dependent larval mortality also takes place but it does not play any role in the stabilisation of population as a whole. The imitation model of population dynamics and regulation was developed using the pair of Leslie matrixes (for effective and non-effective parts of the populations). [KEYWORDS: population centres, larval survival, age structure, number dynamics, *Rana macrocnemis*].

Teo *et al.*
C06–185

The paracrystalline structures in the pineal gland of *Tiliqua rugosa*: an ultrastructural study. E.H. TEO, B.T. FIRTH AND R.A. BARBOUR. *Dept of Anatomy and Histology, The University of Adelaide, SA 5005, Australia.* In *Tiliqua rugosa,* the pineal complex comprises a parietal eye and an elongated pineal gland proper. Electron microscopy shows that the epithelial wall of the pineal gland is chiefly made up of modified photoreceptor cells (MPC) interspersed with supporting glial cells. In *T. rugosa,* no true photoreceptor cells are found in the pineal gland. Instead, the outer segments of the MPCs show regression and the basal processes of the cells abut on blood vessels which may be indicative of a secretory function. Scattered among the mitochondria and Golgi saccules in the ellipsoid area of the MPC are found frequent lozenge shaped paracrystalline structures. Although these structures vary in size and number in each cell, their characteristic lattice formation is easily discernible in the electron microscope. Sections treated up to 48 hr with the proteolytic enzyme, pronase,

show a gradual digestion of the paracrystalline structures with time, accompanied by fading of the lattice formation. Thus, the paracrystalline inclusion in the MPCs of *T. rugosa* pineal gland is proteinaceous in nature. In view of the lack of dense cored vesicles in the MPCs, the paracrystalline structures may be storage sites for protein(s) secreted by the gland. [KEYWORDS: *Tiliqua rugosa*, pineal gland, paracrystalline structures, proteinaceous nature].

Teo *et al.*
C06–184

The innervation of the pineal complex in *Tiliqua rugosa*: an immunofluorescence study. E.H. TEO[1], I.L. GIBBINS[2], B.T. FIRTH[1] AND R.A. BARBOUR[1]. [1]*Dept of Anatomy and Histology, The University of Adelaide, SA 5005, Australia.* [2]*Dept of Anatomy and Histology, The Flinders University of South Australia, Bedford Park, SA 5042, Australia.* The pineal complex in *Tiliqua rugosa* consists of a pineal gland proper and a parietal eye. By immunofluorescence techniques, we have demonstrated that the pineal gland of *T. rugosa* is richly innervated by noradrenergic nerve fibres containing immunoreactivity (IR) to tyrosine hydroxylase and dopamine-beta-hydroxylase. Fibres immunoreactive to substance P (SP), calcitonin gene related peptide (CGRP), galanin and neuropeptide Y (NPY) were found mainly in the leptomeningeal covering and in the pericapillary spaces of the pineal gland. In the parietal eye, the immunoreactive fibres were confined to the outer limits of the capsule of the eye with the exception of a few SP-IR fibres that were found within the plexiform layer of the retina and in the parietal nerve. Double immunolabelling revealed that SP, CGRP and galanin co-existed in a population of fibres. No cell soma within the pineal and parietal eye parenchyma was labelled by the antibodies. No fibres containing vasoactive intestinal peptide (VIP-IR) were found. Thus, the *T. rugosa* pineal complex receives not only noradrenergic innervation, of possibly sympathetic origin, but also peptidergic fibres from sources yet to be determined. [KEYWORDS: pineal complex, innervation, immunofluorescence, *Tiliqua rugosa*].

Thompson
S10

Nest-site selection and the nest environment in reptiles. MICHAEL B. THOMPSON. *School of Biological Sciences (A08), University of Sydney, N.S.W. 2006, Australia.* Successful incubation of reptilian eggs requires the female to place her eggs in a position where suitable temperatures, water availability and respiratory gas concentration will occur for the whole of incubation. The range of conditions required by eggs of different species varies (often associated with the structure of the eggshell) and thus a range of nest types occur. Clearly nest site selection is important, yet we do not know how the female selects a site to deposit her eggs. While there is considerable correlative information on the positioning of nests (e.g. in open areas, on north-facing slopes, in sand) there are essentially no studies that examine nest site selection from the female's perspective. This paper presents information on environmental conditions in nests of tuatara that shows nest site selection is important and may involve facultative modifications of distance travelled to oviposit, depending upon conditions that prevail in the normal home range of the female at the time of oviposition. Given that the conditions prevailling at the time of oviposition may not reflect the conditions at other times during incubation and that most female reptiles abandon their eggs after completion of the nest, the method of nest site selection is even more intriguing. Additionally, the embryos may influence nest conditions. Confounding the influence of

environmental conditions is the need to conceal the nest from potential predators. The most likely factors that female reptiles can assess when selecting a nest site are temperature and soil moisture. In a rare study of female nest site selection, temperature was shown to influence nesting behaviour of loggerhead turtles. The actual temperature sensors are not known and whether they are activated by hormonal changes at nesting time remains to be assessed. Many reptiles nest only during or after rainfall, again a suggestion that soil moisture may be important. No experimental studies have yet been performed to measure the ability of female reptiles to assess environmental characteristics such as temperature and soil moisture in selecting nest sites. This paper is designed to stimulate someone to do so.

Thomson

SS

Sub-species identification of Galapagos tortoises (*Geochelone elephantopus*) in Australia and New Zealand. SCOTT THOMSON. *33 Baird St., Dubbo, NSW 2830, Australia.* Using morphological and morphometric analysis but with an emphasis on the complete history of each specimen the tentative sub-species identification of each of the twenty-one living Galapagos tortoises in Australian and New Zealand Zoos was determined. Australasia currently has 5.6 tortoises which were born at the Honolulu Zoo which have been identified as *G. e. vicina,* 6.0 tortoises from San Diego Zoo which must be considered as hybrid until it is possible to prove otherwise, 0.2 tortoises from the Townsend Expedition which have been identified as *G. e. guntheri,* 0.1 tortoise which arrived in about 1870 on a whaling ship and has been identified as *G. e. porteri* and 1.0 tortoise which was smuggled out of the Galapagos Islands to Switzerland in about 1962 and purchased by Peter Kraus off Walter Ziniker in 1963. This animal has been identified as *G. e. becki.* Approximate ages have also been determined for the four wild-caught tortoises. The tortoise from Switzerland weighed approximately 1kg when purchased (Kraus pers. comm.) and was therefore probably less than two years old in 1963. The two Townsend tortoises were among a group of eight sent to Taronga in 1930. This group had a weight range of 2.75 to 3.25 lbs on the 27th July 1928 (Townsend unp.notes) and were probably two to three years old in 1928. The tortoise which arrived in 1870 was captured for food and was therefore most likely at least sub-adult or ten years old in 1870. This gives her a current age of at least 130 years and makes her the oldest tortoise in Australasia. [KEYWORDS: sub-species, identification, history, morphology, morphometrics].

Thorpe

P1

Ecology and phylogeny in microevolution. ROGER S. THORPE. *Dept of Zoology, University of Aberdeen, Aberdeen AB9 2TN, Scotland, United Kingdom.* Understanding causal factors is at the centre of evolutionary studies. However, the relative influence of the current ecological (natural selection) and phylogenetic (historical) processes that influence a given microevolutionary pattern can be very difficult to determine. Using lizard and snake geographic variation, various procedures for testing causal factors have been evaluated. These include:- 1) Randomisation tests such as partial Mantel tests which allow various causative factors to be tested simultaneously. Work on island lizards (Canaries and Lesser Antilles) and venomous snakes reveal the relative importance of ecogenetic and phylogenetic factors. Other procedures are necessary to reveal how complexes of characters respond to complexes of causative factors. 2) Parallel patterns of variation in ecologically parallel, but geologically independent, islands

reveals ecogenetic adaptation in lizards. 3) large scale field experiments indicate very rapid evolution in response to ecogenetic factors and 4) the combined use of molecular phylogenies and partial Mantel tests allows one to determine the relative contribution of phylogenetic and specific ecogenetic factors for individual morphological characters. A worked example on inter-island evolution in lizards indicates the utility of this procedure. [KEYWORDS: geographic variation, phylogenesis, ecogenesis].

Thurley & Bell

C06–212

Distribution of a new population of terrestrial *Leiopelma* in the northern King Country, New Zealand. TERTIA THURLEY AND BEN D. BELL. *School of Biological Sciences, Victoria University of Wellington, PO Box 600, Wellington, New Zealand.* A new population of *Leiopelma* was discovered in the northern King Country, New Zealand, in 1991. Frog surveys have been carried out since June 1991 to identify the species and to document variation in external morphology, habitat and local distribution. These confirmed that a terrestrial frog resembling Archey's frog *L. archeyi* was present in the area, as well as Hochstetter's frog *Leiopelma hochstetteri* and the introduced *Litoria aurea.* The terrestrial *Leiopelma* species was recorded by day in sites more open than those known for other *Leiopelma* species, such as in crown fern *Blechnum discolor*, tree fern *Cyathea smithii* and rice grass *Microlaena avenacea.* Biochemical studies are needed to clarify the taxonomic status of this new population of terrestrial frog. The local impact of *Litoria aurea* on the endemic frogs needs to be assessed. [KEYWORDS: *Leiopelma*, conservation, distribution].

Tinsley & Tocque

S14

The population dynamics of a desert anuran, *Scaphiopus couchii*. RICHARD TINSLEY AND KAREN TOCQUE. *School of Biological Sciences, University of Bristol, Bristol, BS8 1UG, United Kingdom.* The spadefoot toad, *Scaphiopus couchii,* occurs in the southwestern deserts of North America where its seasonal activity cycle is strictly regulated by summer rainfall. Breeding populations which assemble after torrential storms have been sampled from the same area of the Sonoran Desert from 1981 to 1992. Analysis of growth rings from the bones of toads collected during 7 consecutive seasons has enabled a comprehensive reconstruction of population age structure. Females may first breed at 3 years of age and males at 2 years, with maximum longevity around 13 and 11 years respectively. The majority (65%) of breeding animals are at least 5 years old, 33% are 7 years and older and 5% may live over 10 years. Studies on the age structure of two separate breeding populations have revealed a series of dominant cohorts which originate in wet summers particularly favourable for reproduction, and each cohort can be followed for up to 3 successive years until it is replaced by the next dominant age-group. The annual growth ring record of these toads has shown that individual growth rates are highly variable and the width of bone produced each year can be correlated with the amount of summer rainfall (and hence feeding opportunities). During the 12 year's fieldwork, there has been a virtual alternation between wet (1981, 1983, 1984, 1986, 1988, 1990, 1991) and dry (1982, 1985, 1987, 1989, 1992) summers and 48% of toads show corresponding alternation of thick and thin growth bands. Despite a period of pre-metamorphic development of only 10 days, tadpole mortality is high in ephemeral ponds, and post-metamorphs are vulnerable during the very restricted period in which to accumulate reserves for hibernation. However, evidence from age analysis indicates good survival after maturity. These studies have shown that the population

dynamics of *S. couchii* in the desert are governed by the duration and intensity of summer rainfall, the effects of which are recognisable in the individual growth records and in the age-structure of breeding congregations. [KEYWORDS: annual growth rates, breeding cohorts, age determination, longevity, population dynamics, *Scaphiopus couchii*].

Tocque & Tinsley

S20

Ecological constraints on feeding and growth of *Scaphiopus couchii*. KAREN TOCQUE AND RICHARD TINSLEY. *School of Biological Sciences, University of Bristol, Bristol, BS8 1UG, United Kingdom.* The ecology of the desert toad, *Scaphiopus couchii*, is very precisely regulated by rainfall: in the Sonoran Desert, Arizona, toads remain dormant underground for the majority of the year and activity is restricted to around 2 months during the Summer. Within this season, emergence is limited to damp nights following rainfall and may be less than 20 nights per year. There are estimates in the literature that, at best, *S. couchii* can obtain all its energy requirements for an entire year from a single, very large meal (comprising of 50% its body weight in lipid-rich termites). However, our field data, collected over 12 seasons, show that the toads are generalist feeders taking prey groups which appear in sequence during the short summer season, including a remarkable range of noxious animals (solpugid spiders, scorpions, centipedes, pogonomyrmid ants). Alate termites emerge briefly after the first rains and seldom represent a major component of the diet. On the other hand, beetles and other hard-bodied insects form a consistent food type throughout the season. Laboratory studies have measured gut development, digestion rate, fat storage and growth during the limited feeding period. Following hibernation, stomach capacity and digestion rate increase gradually with the number of meals eaten and are maximal after 7 feeds. Fat body weight initially declines during the first 4 meals, then increases rapidly. At the end of 10 feeds, fat reserves are correlated with the total food consumed and are, on average, sufficient for one year's survival. Permanent growth, as determined by the production of new bone, is also correlated with food intake. Both appetite and bone growth are negatively related to toad age but, irrespective of food intake, younger animals grow more. However, recently metamorphosed toadlets have a small stomach capacity, the smallest prey size range and the briefest feeding period prior to hibernation. Their growth is therefore the most severely limited by the desert environment but, if continually provided with food under lab. conditions, appetite and growth are unrestricted. [KEYWORDS: age-specific growth, feeding opportunity, prey selection, resource accumulation, *Scaphiopus couchii*].

Tokunaga

C06–186

The Iwakuni Shirohebi, albino *Elaphe climacophora* : its origin estimated from a questionnaire. SHOJI TOKUNAGA. *Dept of Public Health, School of Medicine, 3-1-1, Maidashi, Fukuoka 812, Japan.* The Iwakuni shirohebi is a group of albino *Elaphe climacophora* in a limited area of the city of Iwakuni (34°10'N, 132°13'E), Japan. To elucidate why high-frequency albinism was established and maintained, a questionnaire survey was done in 1989 in the city of Iwakuni. The survey showed: 1) the distribution and the habitats of albinistic form and normal type of *E. climacophora* overlapped. 2) citizens of Iwakuni had different feelings on the shirohebi and normal type. Most of them regarded shirohebis as "auspicious" animal and some admired them as "the god of money". Normal type, however, was considered as the fearful animal. 3) Although about ten percent of the respondents answered that they have killed normal type,

shirohebis were rarely killed. These results suggest that albinistic form and normal type of *E. climacophora* intermingle in Iwakuni, and the residents in Iwakuni protected albinistic form whereas normal type was selected against. [KEYWORDS: *Elaphe*, albino, selection, questionnaire].

Toriba

C06–187

Morphology of ectopterygoid-maxillary joint in crotaline snakes. MICHIHISA TORIBA. *Japan Snake Institute, Yabuzuka-honmachi, Nitta-gun, Gunma, 379-23, Japan.* As one of the differences between Viperinae and Crotalinae, Liem *et al.* (1971) mentioned the ectopterygoid-maxillary joint quoting Dullemeijer (1959). They considered that Viperinae has articular fossa on the posterior surface of maxilla and articular condyle on the anterior end of ectopterygoid, while Crotalinae has articular fossa on ectopterygoid and articular condyle on maxilla. I have obtained rather different view examining the bones of the following genera (one to two species in each genus): *Daboia*, *Agkistrodon*, *Trimeresurus*, *Ovophis*, *Deiagkistrodon*, *Calloselasma*, *Tropidolaemus*, *Crotalus*, and *Bothrops*. Their statement is true for viperine snakes, but not in crotalines. All of the crotaline genera except *Crotalus* do not possess fossa on the anterior end of ectopterygoid as mentioned by them. Articular fossa is present in maxilla in all the cases and shifted to medial corner, which resulted in Y-shape of ectopterygoid. Thus, the tip of medial branch of ectopterygoid acts as articular condyle, and the lateral branch is somewhat modified to articulate with lateral posterior part of maxilla. The modification of anterior part of ectopterygoid is variable among genera, and their possible relationship will be discussed. [KEYWORDS: evolution, morphology, ectopterygoid-maxillary joint, Crotalinae].

Torr

S06

The ecology of Boyd's forest dragon, *Hypsilurus boydii*. GEORDIE A. TORR. *Dept of Zoology, James Cook University, Townsville, Qld 4811, Australia.* Boyd's forest dragon (*Hypsilurus boydii*) is a moderately large, arboreal agamid found in rainforest in north Queensland. A brief study on populations at Mossman and Paluma provided baseline ecological information on this poorly known species. *H. boydii* is sexually dimorphic in maximum adult body size; males are larger than females. Males have non-overlapping home ranges that usually contain one or more females. Female home ranges are smaller than those of males and also appear not to overlap. *H. boydii* are fairly passive thermoregulators and show little or no basking behaviour, a trait they share with several other species of arboreal, closed forest lizards. Individuals, perch vertically on trees and vines, preferring small diameter saplings. Unlike the majority of agamids, Boyd's forest dragons don't appear to be exclusively sit-and-wait predators. Although they spend long periods perching they also show active terrestrial foraging behaviour; spool-trailed lizards travelled up to 130 m on the ground in a day. Lizards sleep arboreally, either vertically on the trunk or horizontally on the end of a branch facing the trunk. [KEYWORDS: Agamidae, arboreality, rainforest, ecology, foraging, home range, thermoregulation].

Towns

S23

The role of ecological restoration in conservation of Whitaker's skink (*Cyclodina whitakeri*), a rare New Zealand lizard (Lacertilia: Scincidae). D.R. TOWNS. *Science and Research Division, Dept of Conservation, Private Bag 68 908, Newton, Auckland, New Zealand.* A programme to substantially improve the conserva-

tion status of Whitaker's skink *(Cyclodina whitakeri)*, previously confined to <20 ha of useable habitat, is described. The programme involved eradication of introduced Pacific rats (*Rattus exulans*) from 18 ha Korapuki Island (Mercury Islands, northeastern New Zealand), documentation of the response of resident lizards to release from predation, and transfer of 28 Whitaker's skinks from nearby Middle Island between 1988 and 1990. Following removal of rats from Korapuki, resident lizard numbers at some coastal sites increased within 12 months and rose 30 fold over five years, but measurable increases in forest areas took up to six years. Since their release there have been 36 recaptures of 15 of the founding Whitaker's skinks on Korapuki Island, as well as captures of five Korapuki-born individuals. The population is now estimated as 33. The increase in number of resident lizards and the success of the introduction of Whitaker's skinks demonstrates that predation rather than habitat deficiencies were responsible for the depleted resident lizard fauna on Korapuki Island. [KEYWORDS: islands, Pacific rats, eradication, lizards, conservation, transfer, predation].

Tracy & Esque

S20

Optimal resource acquisition: herbivores are different. C. RICHARD TRACY[1] AND TODD ESQUE[2]. [1]*Dept of Biology, Colorado State University, Ft Collins, CO 80523, United States of America.* [2]*Dixie Resource Area, US Dept of Interior, Bureau of Land Mgmt, St George, UT, United States of America.* We have combined models of optimal foraging and optimal digestion into a comprehensive model of optimal resource acquisition. From this model, we learn that the energetic value of different food types for vertebrate herbivores is not constant. Instead, each time a herbivore switches to a new food type, that switch causes a change in the resource base for the endosymbionts which are responsible for digestion of the fiber in the herbivore's diet. This change in the resource base results in (a) a change in the gut endosymbiont community, (b) a transient reduction in efficiency of the gut to digest the new food type, and (c) a reduced energetic value of the food type. Thus, switching food types carries an energetic cost. This cost of switching leads to the prediction that herbivores should avoid switching food types unless the time-integrated cost of switching is less than the time-integrated cost of searching for a new food type. This prediction suggests that, under some circumstances, herbivores will appear to specialise on particular food items, but that different individuals may not "specialise" in the same food type(s). This pattern is exactly that found from an analysis of observations from more than 150,000 instances of biting (and eating) food items by desert tortoises (*Gopherus agassizii.*) We conclude that a new form of foraging (avoiding switching among food types taking precedent over a search for food types with the highest energy content) explains the pattern of feeding by desert tortoises. We also conclude that this foraging mode should occur in all vertebrate herbivores when the digestive cost of switching food types is greater than the cost of searching for a new food type. [KEYWORDS: optimality, herbivore, foraging, digestion, *Gopherus*].

Tramontano

C19

Competition between tadpoles of *Rana temporaria* and *R. dalmatina*: metamorphosis as a disruption of asymmetric competition. RALPH TRAMONTANO. *Dept of Animal Ecology, Ecology Building, Lund University, S-223 62 Lund, Sweden.* The common frog, *Rana temporaria*, is one of the most common anuran species in northern and central Europe, yet in southern Scandinavia it is absent from most of

the range of the agile frog, *R. dalmatina*. The hypothesis that this distribution pattern is the result of competitive exclusion at the larval stage was investigated in a 2×2 factorial experiment. Tadpoles of both species were reared at two density levels (20 or 40 tadpoles) and in two competitive regimes (one species or equal numbers of both species). Each treatment was replicated four times and housed outdoors in plastic containers filled with 80 l pond water. Tadpoles fed on naturally developing algae. Weight at metamorphosis, larval period length, length for agile frog tadpoles at the onset of metamorphosis in the common frog, and survival were recorded. Significance testing was performed by means of randomisation tests. The results showed that common frog metamorphs were larger and had higher mean growth rates when reared with the agile frog, while agile frog tadpoles were smaller in the interspecific treaments. The earlier metamorphosis of *R. temporaria* apparently led to a reversal of its competitive effect so that by the end of the experiment there was no significant difference between competitive regimes in any of the response variables for agile frog metamorphs. At the higher density metamorphs of both species were smaller and had lower average growth rates while *R. dalmatina* also had longer larval periods and higher mortality rates. The larval period of the common frog was longer only in the intraspecific, high density treatment. Instead of supporting the competitive exclusion hypothesis for the common frog's distribution in southern Scandinavia, these results suggest that communities dominated by species with complex life cycles can represent an unstable coexistence maintained by environmental heterogenity in time. The distribution pattern of these two species in southern Scandinavia is more likely the result of local environmental factors. Instead of exhibiting a minimum size threshold for metamorphosis there was a negative correlation between weight at metamorphosis and larval period length across both high density treatments for *R. temporaria*. The existence of a such a threshold size for the levels of competition occurring in this experiment would have led to longer larval periods than occurred here. Longer larval periods increase the risk of desiccation and it is suggested that this risk (incurred by maintainence or a minimum threshold size for metamorphosis) has been greater than the increased risk of juvenile mortality incurred by metamorphosing earlier at a smaller size. [KEYWORDS: community structure, competition, complex life cycles, metamorphosis, ponds, *Rana*, Scandinavia. size at metamorphosis, Sweden, timing of metamorphosis].

Travis

P4

The ecology of larval amphibians, lessons from exemplary teachers. JOE TRAVIS. *Dept of Biological Sciences, Florida State University, Tallahassee, FL 32306-2043, United States of America.* Several features of the biology of larval amphibians have made them excellent test cases for many central concepts in ecology and evolutionary biology. Most non-herpetological ecologists can cite from memory studies of larval amphibians that have taught them about population regulation, interspecific competition, the behaviour of predators and prey, the interacting forces that structure species assemblages, and the action of natural selection on growing organsims. Perhaps less widely appreciated are the studies that offer broad lessons about evolutionary processes such as selection and evolution of suites of traits, the evolution of environmental responsiveness in life-history traits and the interaction of developmental processes with selection that channels the pathways of evolution. But the lessons learned from larval amphibians are also lessons about larval amphibians; the research programs that have

exploited the special features of larval amphibians have offered important insights into how these special features evolved and why they are retained. In this sense larval amphibians have been exemplary teachers as they have taught us about general ecological and evolutionary processes, they have also taught us about themselves. And like good teachers, their lessons have guided us toward clearer, more operational questions about more complex ecological and evolutionary problems such as the sources of chaotic population dynamics, the interaction of biotic and abiotic effects on population processes, and the evolution of the amphibian life cycle itself.

Tucker

S12

Demography of the freshwater crocodile, *Crocodylus johnstoni*, in Queensland. A.D. TUCKER. *Centre for Conservation Biology and Dept of Zoology, University of Qld, Brisbane Qld 4072, Australia.* A population of *Crocodylus johnstoni* was studied in the headwaters of the Lynd River in Queenland from 1976–1993. Preliminary data on reproductive ecology (confirmed by laparoscopy and gonadal biopsy) suggests that maturity is primarily mass-related rather than age-related for males but less so for females. The study incorporates estimates of population size, age structure, survivorship, and sex ratio to determine if age or stage-based population models were most appropriate for the species. Revised skeletochronology methods were developed for age determination of wild crocodiles and validated from a mark-recapture study of individuals marked as hatchlings. The long-term history of the population permits changes in demographic factors to be investigated. Hatchling tissue samples were obtained for paternity testing to determine effective population size and to confirm if multiple paternity exists. Paternity testing offers a comparative method to contrast reproductive strategies between hole-nesting and mound-nesting crocodilians. Finally, ranching scenarios are simulated by population viability analyses to determine if sustained harvest of the species is possible. [KEYWORDS: crocodile, demography, modelling, viability analysis].

Tuniyev

C06–189

On morphological variation of the West Caucasian newts. BORIS TUNIYEV. *Caucasian State Biosphere Reserve, Sochi RU-354347, Russia.* Eight morphometric characters were measured and used for analyses of variation of 3 species of newts from the both slopes of the Western Caucasus. A total 234 specimens (7 populations) of *Triturus vulgaris lantzi*, 35 specimens (2 populations) of *T. cristatus karelini* and 423 specimens (16 populations) of *T. vittatus ophryticus* were examined. Big geographic and altitude variation of *T. vulgaris* and *T. vittatus* is a result of autochthon (since Pliocene) development supposedly. Apparently more late penetration (since Holocene) of *T. cristatus* didn't give possibility for development of its adaptable radiation. [KEYWORDS: West Caucasus, newts, variation].

Tunner

C02

Why does the water frog *Rana lessonae* migrate at Lake Neusiedl (Central Europe)? HEINZ G. TUNNER. *Dept of Zoology, University of Vienna, Althanstrasse 14, A-1090 Wien, Austria.* Lake Neusiedl, a shallow lake (max. depth 1.80 m) with an area of approx. 300 km^2, is the habitat of two water frog taxa *R. lessonae* and the hybridogenetic all female hybrid *R. esculenta*. *R. esculenta* can only persist through sexual parasitism on *R. lessonae* due to its hybridogenetic reproduction and unisexuality. *R. esculenta* females result from mating with *R. lessonae* males. The distribution

and hibernation of the two taxa still appears to be very different: *R. esculenta* is common throughout the entire lake. It hibernates preferably in the lake or ditches surrounding it. *R. lessonae*, however, hibernates mainly on land along the southern shore. It is found in more northern parts only during breeding. Thus, every year many *R. lessonae* migrate from the wintering area in the south towards northern breeding grounds where they mate with conspecifics and hybrids. After mating *R. lessonae* returns to the southern hibernation sites (we have shown 15 km migration). A possible evolutionary explanation for the extensive migration in *R. lessonae* may reflect: 1. The geomorphological history of the lake (historical). 2. The preference for fen (peat) habitats (ecological). 3. Intraspecific interactions among larvae — "crowding effect" (physiological). [KEYWORDS: migration, hibernation, hybridogenesis, *Rana lessonae*, *Rana esculenta*].

Groups and refuge site fidelity in the little whip snake *Suta flagellum* (Elapidae). GRANT TURNER. *103 Settlement Road, Bundoora, Victoria, 3083, Australia.* Some curious habits and aspects of behavior are described in a small species of elapid snake belonging to the nocturnal, live-bearing genus, *Suta*. The Little Whip snake (*Suta flagellum*) is known to form small overwintering groups (of typically two or three individuals), as are other members of the genus. I present data on the frequency and composition of these groups in field populations of *S. flagellum* and examine the hypotheses concerning their significance. I report on the existence of groups formed in early summer which comprise exclusively of gravid female *S. flagellum*. Gravid females are observed to emerge during daylight hours from their refuge to bask. The groups disband immediately following parturition. I also report on observations of male *S. flagellum* occupying particular refuges for extended periods of time, and annually returning to the same refuge to overwinter. [KEYWORDS: gravid females, group composition, overwintering groups, refuge sites].

Turner

SS

Tyler

S07

Regional patterns of amphibian distribution: a global perspective: the Australian zoogeographic region. MICHAEL J. TYLER. *Dept of Zoology, The University of Adelaide, SA 5005, Australia.* Approximately 12% of the world's anuran fauna is confined to the land masses of Australia, New Guinea, New Zealand and the islands of the Pacific. Abundance and diversity are associated with dense vegetation and high and reliable rainfall, and amongst reproductive modes, direct development is a common strategy amongst members of several families. The fossil record indicates a substantial contraction of geographic ranges of many genera within the Tertiary, and there is evidence for concern at significant recent population declines amongst certain montane elements. The nature and situation of these declines pose a significant challenge to concepts of conservation management.

Van Devender

C21

Annual and local size variation in *Pseudotriton ruber* larvae. ROBERT WAYNE VAN DEVENDER. *Dept of Biology, Appalachian State University, Boone, NC 28608, United States of America.* Information on local and annual variation in life history data are desperately needed for most species if we are to understand the relationship between observed variation, adaptive responses to environmental characteristics, and plastic responses to imposed climatic variation. Red salamanders (*Pseudotriton*

ruber) spend 2.5 years as larvae in most areas and provide a good system for examining local and annual variations in growth and size. Two sites in Watauga County, NC were studied to provide this type of baseline data. A total of 72 samples including 2586 larvae were collected between 1979 and 1993. Samples were collected, preserved, and analyzed using the Harding probability paper method or a computer program MIX to separate year class differences. These samples included both drought years and wet years at both sites and allowed separation of size variation based on local differences in growth and that based on deviations from normal water levels. ANOVA revealed significant relationships between size weather (year), and sites. These results wlll be related to current models predicting growth and metamorphosis under different environmental conditions. [KEYWORDS: populations, variability, growth, larvae, *Pseudotriton ruber*, Caudata, Plethodontidae].

van Marken Lichtenbelt

S29

Body temperature and energy balance in free living green iguanas (*Iguana iguana*). WOUTER D. VAN MARKEN LICHTENBELT. *Dept of Human Biology, University of Limburg, P.O. Box 616, 6200 MD Maastricht, The Netherlands.* Body temperatures of free living lizards, *Iguana iguana*, on Curaao (Netherlands Antilles) were determined by using telemetry and taxidermic mounts. Thermoregulatory behaviors, food intake, and locomotor activities were recorded along with the temperature measurements by continuous observations. Green iguanas maintained relatively constant body temperatures (32.9–36.6°C) during the midday period (0945–1545). Temperature measurements of a taxidermic mount and of ambient air show that on Curaao body temperatures between 29–40.5°C could readily be attained. The range of potential body temperatures is thus much larger than selected body temperatures. Selected field body temperatures were in close agreement with selected body temperatures in a laboratory thermal gradient (35.4±0.6°C). Daily metabolisable energy intake (MEI) varied much between individual iguanas: from no food intake for several days to 49.3 $kJ.kg^{-1}.d^{-1}$. There was a significant linear relation between MEI and body temperature. In laboratory experiments costs and benefits along a range of body temperatures were investigated revealing relations between body temperature and resting metabolic rate (RMR), and between body temperature and maximal energy intake. These relations combined with the field data demonstrate that selected body temperatures coincide with those temperatures at which energy gain from ingested food is optimal. The data show that food digestion in herbivorous reptiles may be an important factor in shifting selected body temperatures above the temperature at which the metabolic scope is maximal. [KEYWORDS: body temperature selection, energetics, lizard, temperature telemetry, thermoregulation].

Van Sluys

C06–190

Food habits of *Tropidurus itambere* (Tropiduridae), a tropical lizard from southeastern Brazil. MONIQUE VAN SLUYS. *Dept of Zoology, IB, CP 6109, UNICAMP, Campinas, 13081-970, São Paulo, Brazil.* The diet of the lizard *Tropidurus itambere* was studied throughout the year, in the São Paulo State, southeastern Brazil. Diet analysis was based on the stomach contents of monthly noosed lizards (n = 175). The potential preys were collected, also monthly, to estimate their relative availability. Ants were the most common food item in the stomachs, found in 98.3% of the lizards. Hemipterans, coleopterans, lepidopteran larvae, spiders and plant remains were also

frequent in the diet composition. The proportions of the different taxa in the diet of adult males and females were not significantly different ($\chi^2 = 35.1$; $p > 0.05$), whereas those between adults and juveniles were significantly different ($\chi^2 = 76.4$; $p < 0.01$). A significant difference in diet composition was also detected between summer and winter. The lizards diet was significantly related to prey availability in the environment ($r_s = 0.43$; $p < 0.01$) and this relationship varied between the two seasons studied (wet summer: $r_s = 0.11$; $p > 0.05$; dry winter: $r_s = 0.50$, $p < 0.01$). *Tropidurus itambere* tend to be more generalists in the dry season probably due to the reduced food availability whereas in the rainy season they tend to be more selective as food is more abundant. [KEYWORDS: lizard, *Tropidurus itambere*, diet composition, ontogenetic variation, prey availability, seasonal variation].

Van Sluys

C06-191

Reproductive cycle of the lizard *Tropidurus itambere* (Tropiduridae) in southeastern Brazil. MONIQUE VAN SLUYS. *Dept of Zoology, IB, CP 6109, UNICAMP, Campinas, 13081-970, São Paulo, Brazil.* The reproductive cycles of tropical lizards show great variability although they are mainly associated with rainfall. The reproductive cycle of the lizard *Tropidurus itambere* was studied in two open areas near Campinas city, São Paulo State, southeastern Brazil. I caught 176 lizards in one area by noosing at monthly intervals between June 1988 and June 1989. Growth rates were estimated from mark-recapture study carried out in the second area. I determined the reproductive state of females based on the presence and number of vitellogenic follicles, oviductal eggs and/or corpora lutea. For males I sectioned the right testes and epididymes at 7 μm and stained them with Toluidine Blue. Males were considered reproductive when they had spermatozoa in either testes or epididymes. I calculated the growth rate (mm/day) using the difference in lizards' snout-vent length between successive captures. Females had vitellogenic follicles or oviductal eggs only during the wet season, whereas males had large testes with spermatozoa throughout the year. Hatchlings were found during the height of the rainy season (January to April). Mean growth rate was inversely related to snout-vent length ($r = -0.53$; $p < 0.01$). Juveniles from eggs laid at the beginning of the rainy season could potentially have reproduced in the first wet season after they hatched. [KEYWORDS: lizard, *Tropidurus itambere*, reproductive cycle, growth, recruitment].

Vassiliev

C06–192

Physiological characteristics of sound localisation in reptiles. BORIS D. VASSILIEV. *Biological Faculty, Moscow State University, Russia.* In some agamid, lacertid, anguid and gekkonid lizards registration of evoked potentials from acoustic medulla complex, superior olive and torus semicircularis in response to tone stimuli and white noise clicks of optimal intensity and coming under different angles of incidence reveals changements of potentials' amplitude of contralateral and ipsilateral sides, but they aren't too pronounced. Much more illustrative as the criteria of lateralisation of acoustic images in reptiles' hearing system appear to be changements in latent periods of reactions, characters of threshold curves and dependence of response amplitudes on intensity of stimuli. The most acute perceptive capacities to the angle of sound incidence demonstrate gekkonid lizards, then go some Anguidae, Lacertidae and Agamidae. The most efficient are lateral and rostro-lateral sounds. [KEYWORDS: physiology, reptiles, evoked potentials, sound localisation].

Veith C04

Gene flow in fire salamander populations — strength, directions and isolation barriers. MICHAEL VEITH. *Institut für Zoologie, Universitst Mainz, Saarstraße 21, D-6500 Mainz, Germany.* Allozyme electrophoresis was carried out on fire salamander populations *(Salamandra salamandra)* in Central Europe. Gene flow estimates were calculated from allele frequencies. The gene flow between populations was estimated to be one of the highest that has been ever reported for urodelan populations. By means of uni- and multivariate statistics the effect of potential natural (rivers, water-sheds) and artificial (streets) isolation barriers was investigated. The direction of gene flow can basically act along two major spatial vectors: one parallel to the brooks where the salamanders breed, and a second one perpendicular to these brooks (across the mountain ridges that separate two neighbouring populations); the latter direction was estimated to be more important in *S. salamandra* populations. The reasons for the high amount of gene flow and its major direction are discussed in the light of until now published data about the population ecology of *Salamandra salamandra*. [KEYWORDS: *Salamandra salamandra*, allozymes, gene flow, isolation].

Veith *et al.* S27

International trade in frog legs from SE Asian *Rana species*— problems of trade control and conservation. MICHAEL VEITH[1], REINART FELDMANN[2], JOACHIM KOSUCH[1] AND HARALD MARTENS[3]. [1]*Institut füt Zoologie, Universität Mainz, Saarstraße 21, D(W)-6500 Mainz, Germany.* [2]*Umweltforschungszentrum Leipzig-Halle, Permoserstraße 15, D(O)-7050 Leipzig, Germany.* [3]*Bundesamt für Ernährung und Forstwirtschaft, Mallwitzstraße 1-3, D(W)-5300 Bonn, Germany.* In 1987 frog legs of about 80,000,000 specimens were imported into the European Community. Import companies officially exploit populations of three species only: *Rana blythi*, *R. cancrivora* and *R. macrodon*. However, a species determination using unskinned frogs legs is not possible. Thus we are developing a biochemical key (allozyme data) for the determination of imported frogs legs of the genus *Rana*. For that purpose reference specimens of several *Rana* species were sampled in Indonesia. Additional specimens of *R. catesbeiana*, the American Bullfrog, from an Indonesian frog farm are included in this survey. All frog species exhibit specific allozyme patterns, allowing species determination of the specimens. However, to prepare a key that covers all presently known Indonesian *Rana* species makes it necessary to get further reference species. Field data from Indonesia make it evident that farming native *Rana* species seems to be no suitable source for frog legs export. In addition, *Rana* species seem to be very rare in paddy fields, although according to information from trade companies, most specimens are exploited from this kind of habitat. [KEYWORDS: *Rana*, SE Asia, frog leg trade, allozymes, species conservation].

Veloso C06–193

Diversity of Chilean amphibians and reptiles and its protection in natural protected areas. ALBERTO VELOSO. *Dept of Ecological Sciences, Universidad de Chile, P.O. Box 653, Santiago, Chile.* The Chilean herpetofauna comprises 41 species of frogs, 90 lizards and 7 Serpentes, grouped in 28 genera and 8 families. Endemisms reaches 60% in both amphibians and reptiles. Climatic changes (drought), habitat destruction and commercial exploitation are decimating their populations. The high diversity of herpetozoans occurs in the desertic and the Mediterranean regions of Chile, while the lowest diversity is found in the tropical and oceanis regions. The State National System of Protected Areas (SNAPE), holds 14,000,000 hectares, representing 18% of the mainland territory. Ecological regions are not evenly represented. Furthermore, SNAPE does not have protected areas for coastal desert, coastal boundaries and tropical boundaries, where lizards are highly diversified. Here I advance an approach to define the areas required for the conservation of the herpetofauna. I use a simple "refuge model" based on contours of species diversity at regional scale. [KEYWORDS: conservation, herpetofauna, biodiversity].

Veloso *et al.* S09

Phylogeny and geographic distribution of *Liolaemus* and related taxa (Squamata : Tropiduridae) in the desert regions of northern Chile. ALBERTO VELOSO, JOSÉ NAVARRO AND PABLO ESPEJO. *Dept of Ecological Sciences, Science Faculty, Universidad de Chile, P.O. Box 653, Santiago, Chile.* In Northern Chile, between 18°S and 30°S the main climatic tendency is towards aridity. The extreme climatic condition is represented north 25°S by the "absolute desert", without vegetation. The aridity decreases with altitude and latitude. Desert region, has an endemic and evolutionary important lizard fauna consisting primarily of tropidurines grouped in small genera with restricted geographic distribution. The major exception is *Liolaemus*, with over 100 species, from which 20 are represented in the desert region. Other congeneric species extends genus distribution to almost every ecological regions of Chile mainland, Southern Peru, the Altiplano (high plateau), the Monte region in Argentine and Patagonia. Available paleoclimatic and vegetation studies, give evidence that prevailing clime conditions arose relatively recently, being a late Pleistocenic and Holocenic event. Northern *Liolaemus* species show distinct cytogenetic features which in combination with morphological attributes are a good system for a phylogenetic study. The phylogenetic hypothesis, in combination with available information on past and present climatic and vegetation patterns of the desert region, provide the basis for a discussion concerning present distributional pattern of these lizards. [KEYWORDS: phylogeny, biogeography, lizards, aridity].

Vernet *et al.* S11

Biology and ecophysiology of the Lacertidae (*Gallotia* genus) from Canary Islands. R. VERNET[1], J. CASTANET[2] AND M. BAEZ[3]. [1]*Lab. d'Ecologie, URA CNRS 258. Ecole Normale Supérieure, 75005 Paris, France.* [2]*E.R. "Formations Squelettiques", URA CNRS 1137. Université Paris. 75005 Paris, France.* [3]*Universidad de la Laguna, Dept de Zoologia, 38206 La Laguna, Tenerife Islas Canarias (E).* In the Canary Islands, Lacertidae belong to an endemic genus showing a special evolutive situation according to species. One recently extincted (*G. goliath*). Four extant (*G. galloti**, *G. simonyi*, *G. stehlini**, *G. atlantica**) are more or less polymorphic with very different geographical distributions and population densities. Up to day, only some morphological and biochemical studies have tried to explain the phyletic relationships between these taxons, but basic data on biology, demography, or ecophysiology, of their populations are lacking. Thus, no reliable explanations about life histories and evolutionary process of these species are available. From a comparative study conducted several years in field and at laboratory on three species (*) we can now present accurate data on: demographical structures (population denstities, age, maturity, survivorship), growth rates, water turnover, field and basal metabolic rate, daily energetical expenditures. From these first results, it appears that their are differences

between *G. atlantica* and the two other species, probably according to more drastic environmental constraints and a stronger intraspecific competition. [KEYWORDS: *Gallotia*, Lacertidae, Canary Islands, ecophysiology, life histories].

Vershinin C06–194

Specific of populations of the urban amphibians. V.L. VERSHININ. *Institute of Plant & Animal Ecology, Ekaterinburg, Russia.* Due to long term study of amphibian in the city area it have been found disappearance of some forest species and exchange this one to another. Spatial structure of the populations have been transformed. City area include big quantity of a small isolates with high density of amphibian. Pollution is the reason of disorganisation in normal development of sexual products, fecundity, process of fertilization and embryo's development. Environmental changes is the cause of abnormalities: mutations, developmental anomalies, regeneration mistakes; there are also physiological and behaviour adaptations. Urban populations of amphibians have different genetic structure and phenotypical specific as a result of another mortality dynamic. It have been found that food chains become shorter and speed of metabolism higher. So we can assume that there are some general features of structure and functional physiology specific which depend from each other. It was working out general conception of batrachocomplex transformation in the city area including changes in metabolism, main negative and adaptive populations features which appearance connected with exposing of urbanisation and identified main factors affecting on amphibian declining and target species and populations for long term (constant) ecological monitoring. We determined strategy in order to stop amphibian declining, organised effective protection of habitats and reintroduction of amphibians to new sites on the urban territory. Since 1977 I also use simple traditional zoological methods to control populations dynamics that's why all this work practically is long term monitoring for the state of amphibian populations.

Viets *et al.* C14

Sex-determining mechanisms in lizards. BRIAN E. VIETS[1], MICHAEL A. EWERT[2], LARRY G. TALENT[3] AND CRAIG E. NELSON[2]. [1]*Biology Dept, Nebraska Wesleyan University, Lincoln, NE 68S04, United States of America.* [2]*Dept of Biology, Indiana University, Bloomington, IN 47405, United States of America.* [3]*Dept of Zoology, Oklahoma State University, Stillwater, OK 74078, United States of America.* Two modes of sex determination occur in lizards: genotypic sex determination (GSD) and temperature-dependent sex determination (TSD). Within each of these two major modes, there are many different variants, or mechanisms. Male heterogamety, female heterogamety, multiple sex chromosome systems, and homomorphic sex chromosome systems are all types of GSD found in lizards. Two patterns of TSD have been reported. Although less than 50 lizard species have been investigated, there is considerable diversity in the sex-determining mechanisms reported thus far. Apparently, TSD (and/or GSD) has evolved multiple times within a given taxon. Presently, both GSD and TSD are found in the Agamidae, Eublepharidae, and Gekkonidae, and possibly in the Iguanidae, Lacertidae, and Varanidae as well. Only GSD has been reported for the Scincidae and Teiidae. [KEYWORDS: sex determination, lizard, genotypic sex determination, temperature-dependent sex determination, reproductive ecology].

Villamor C06–195

Morphometric gonadal and feeding characteristics and some insights on the conservation status of water monitor lizard (*Varanus salvator*). CARMELITA I. VILLAMOR. *Ecosystems Research and Development Bureau, College, Laguna, Philippines.* A study to determine the morphometric gonadal and feeding characteristics of randomly collected water monitor lizards in Laguna and vicinities was done from May 1989 to April 1990. A questionnaire survey to determine knowledge base economic importance and conservation status of water monitors in selected localities in Laguna, Quezon and Bulacan was also done during the period. Data collection on weights and body measurements were done on randomly collected specimens. Pattern of monthly collection showed a tendency towards decreasing catch during the colder months of October to February. The body weights of all samples ranged from 0.4 to 3.25 kg. with an average of 1.35 kg. However, figures obtained are not indicative of minimum and maximum weights. A highly significant ($P < 0.01$) linear regression of body weight was obtained with the length of head, body, tail and hind legs. Average total body length for all samples was 1.9 m. Male and female gonads represent 0.4 and 0.5%, respectively of the animal's body weight. Gonadal weights changes with time and are largely affected by the weight of the animal. Strong dependence on poultry (birds included), crustaceans, insects and small reptiles in the order of importance has been observed with wild-caught specimens. Results of field survey to determine economic importance and conservation of the species were also discussed. [KEYWORDS: morphometric, gonadal, feeding, conservation status].

Villarreal & Heras C23

Life history strategies of *Anolis* and their population dynamic consequences in Los Tuxtlas, Mexico. JOSÉ-LUIS B. VILLARREAL AND LISBETH L. HERAS. *Lab. de Ecol., Evol. y Biol. de los Organismos y Sistemas, Matamoros 14, Catemaco, Veracruz, C.P. 95870, Mexico.* Life-history of two similar-sized anoles, *Anolis sericeus* and *Anolis uniformis*, was studied using both demographic and laboratory approaches, within a longitudinal vegetation gradient. Microhabitat was characterised in terms of resource availability and microclimatic conditions. We compared life-history strategies in response to large environmental influences. This study attempts to interpret the observed life history characteristics and their population consequences in terms of environmental constraints. We found that a large proportion of the variation covaried with growth rates and that this is strongly determined by available ambient temperature, through differences in digestion performance. However, a combination of the growth rate and the variations in survivorship throughout the year produces a rich behavioural population dynamics. [KEYWORDS: demography, life history traits, population dynamics].

Vliet S22

Behavioural interactions associated with mating behaviour of the American alligator. KENT A. VLIET. *University of Florida, Division of Biological Sciences, 210 Carr Hall, Gainesville, FL 32611, United States of America.* Courtship and mating behaviours were observed over a three year period in a captive population of about 150 adult American alligators (*Alligator mississippiensis*)of known size and gender. Reproductive behaviours show similarities to those of other large reptiles but are clearly modified by the aquatic theater in which they are performed. Courtship behaviours are strongly oriented to tactile exchanges between partners. These involve bumping, rubbing, pushing and pressing the head and neck of the partner. Pushing and pressing behaviours appear to stimulate partners to continue courtship prior to mounting and act

to restrain the movements of females following mounting. Mounting was highly variable in length. In one study season, mounts averaged 2.7 minutes (162.7 sec) in length (S.D. = 210.2 sec, N = 623). Mounts were frequently disturbed by other alligators. The length of the pre-mounting courtship encounter and the length of the mount were not significantly correlated in either males or females. Copulation is difficult to detect in alligators and accurate measures of the duration of copulation could not be made.

Vogt & Villarreal

C21

Variation in growth rates and life history strategies in *Kinosternon* from tropical Mexico. RICHARD C. VOGT[1] AND JOSÉ-LUIS B. VILLARREAL[2]. [1]*Estacón de Biología Tropical "Los Tuxtlas", A.P. 94, San Andrés Tuxtlas, Veracruz, C.P. 95700, Mexico.* [2]*Lab. de Ecol., Evol. y Biol. de los Organismos y Sistemas, Matamoros 14, Catemaco, Veracruz, C.P. 95870, Mexico.* Long term mark and recapture studies were conducted on different populations of *Kinosternon leucostomum* and *Kinosternon acutum*. Through the analysis of growth rings on the plastral scutes we were able to construct growth rate curves. These data were related to life history characteristics, in particular reproductive output. This information confirms with more empirical data the models proposed for life history patterns for long lived organisms such as turtles. Individuals from populations living in favorable habitats grow more rapidly than turtles from less favourable habitats, at the onset of maturity when growth slows these turtles have reached larger sizes. Populations where the turtles grow faster and reach larger body size at maturity, have a determinate growth rate which results in the ability to have larger clutch sizes, larger eggs sizes, and larger annual reproductive effort. [KEYWORDS: Life history traits, reproductive effort, demography, freshwater turtles].

Vogt & Villarreal

C06–196

Species-abundance, biomass, and resource-use distributions in freshwater turtles: geographic perspectives. RICHARD C. VOGT[1] AND JOSÉ-LUIS B. VILLARREAL[2]. [1]*Estación de Biología Tropical "Los Tuxtlas", A.P. 94, San Andrés Tuxtlas, Veracruz, C.P. 95700, Mexico.* [2]*Lab. de Ecol., Evol. y Biol. de los Organismos y Sistemas, Matamoros 14, Catemaco, Veracruz, C.P. 95870, Mexico.* Species abundance has been used to infer interspecific patterns in resource partitioning. However, these patterns can differ from those predicted by the distribution of species abundance, depending on the relationship within the communities between the abundance of one species and its body size. In many groups, the largest species in the community tend to have lower population densities than smaller ones. Many theories have tried to explain the patterns of species abundance in terms of resource use, by studying the different ways that species which vary in their biological characteristics partition the resources of the community. Inverse relationships have been found between the size of organisms and their abundance when a large number of species are pooled taxonomically or ecologically. These expectations based on the per capita use of resources are irrelevant for many populations which maintain one or more orders of magnitude below the carrying capacity; furthermore the empirical data are not compatable with these theories. However, in turtles such inverse relationships can occur because of their low adult mortality, high biomass, and structural similarity between species. Community structure and biomass data from turtle communities in temperate and neotropical regions are used to test theories about species abundance. [KEYWORDS: freshwater turtles, biomass, resource partitioning, community structure].

Voris et al.

S12

The thermal ecology of the yellow-lipped sea krait, *Laticauda colubrina*. HAROLD VORIS[1], ENGKAMAT AD. LADING[2] AND ROBERT STUEBING[2]. [1]*Dept of Zoology, Field Museum, Chicago, Il 60605, United States of America.* [2]*Sabah State Museum, Jalan Muzium, Sabah, Malaysia.* Yellow-lipped sea kraits, *Laticauda colubrina*, were studied on Kalampunian Damit Island in the Pulau Tiga State Park, Sabah, Malaysia (Borneo). Copper snake models placed in seven microhabitats were monitored for temperature. Cloacal temperatures of live snakes were taken and several snakes were fed temperature transmitters and monitored. Temperatures on the island ranged from a minimum of 23.5°C to a maximum of 48°C. The average temperature for 53 snakes was 29.1°C with a range from 26 to 34°C and the temperatures of individuals closely matched the temperature of their immediate surroundings. Thermoregulating behaviors were observed. A comparison of these results obtained near the equator to observations made by others on Fiji, New Caledonia and in the Philippines highlights the behavioral plasticity present in this species that ranges over 5,000 miles from the Bay of Bengal to New Caledonia. [KEYWORDS: sea krait, *Laticauda* , thermoregulation, Borneo].

Wake

S05

Implications of direct development for morphological ontogeny in salamanders. DAVID B. WAKE. *Museum of Vertebrate Zoology, University of California, Berkeley, CA 94720, United States of America.* Most work on salamander morphogensis has dealt with species that hatch early and have larval stages. However, most species of salamanders have direct development, and I will show that their embryos develop rather differently than do the embryos and larvae of species with indirect development. Jaw muscles form early in species with larvae, but in direct developing species jaw muscles form at about the same time as head muscles. In bolitoglossine salamanders the highly specialised tongue is present at a surprisingly early stage of development, and is well developed when the weak gill muscles are still present. Muscle morphogensis is unusual in direct developing taxa and will be described. The limb skeleton of direct developing species is more similar to that of amniotes than is that of species with larval development, and the fore and hind limb buds appear early and develop more or less simultaneously. [KEYWORDS: direct development, Plethodontidae, head, tongue, limbs].

Wake

C02

Evolutionary morphology of caecilians. MARVALEE H. WAKE. *Dept of Integrative Biology and Museum of Vertebrate Zoology, University of California, Berkeley, CA 94720, United States of America.* Work in progress on the comparative and developmental morphology of caecilians is yielding both new and non-traditional characters of systematic utility. Comparative neuroanatomy, including that of the brain, special sensory organs, and patterns of peripheral innervation, provides many characters. Examination of reproductive structure, including phallodeal and sperm morphology, also generates characters. Developmental morphology of the skeleton and musculature not only provides new characters, but also a better understanding of adult features long employed systematically. Morphologists should not constrain their analyses of patterns of evolution to mapping features on existing cladograms, but should also examine their data for the possible existence of new characters appropriate to the generation of hypotheses of phylogenetic relationships. This will allow elucidation of such concepts as ontogenies as characters, developmental and topological vs. congruence criteria for as-

sessment of homology, and morphological vs. genic evolution. [KEYWORDS: Caecilians, neuroanatomy, skeleton, reproductive biology].

Waldman

C25

Advertisement vocalisations of toads: brothers sound alike. BRUCE WALDMAN. *Dept of Zoology, University of Canterbury, Christchurch, New Zealand.* Many amphibians show high degrees of philopatry; that is, they return to the same ponds to breed year after year. By analysing variation in nuclear and mitochondrial DNA within and among populations of American toads (*Bufo americanus*) in Massachusetts, United States of America, I determined that most individuals probably mate in the pond from which they metamorphosed. Unless individuals can recognise and avoid mating with their siblings, natal philopatry should increase the frequency of matings between close relatives. Behavioural observations suggest that females actively choose mates at breeding ponds. To examine whether males might communicate information about their kinship identities in their mating calls, I compared (1) the calls given by different males at breeding sites and (2) the genetic relatedness of these males by DNA fingerprinting, using Jeffreys 33.6 and 33.15 probes. I found that the resemblance of males calls was positively correlated with the similarity of their fingerprints. Kinship information is encoded in temporal aspects of call structure, but not in frequency components of calls. Because incestuous matings occur significantly less often than expected by models of random pairing, these data suggest that females might avoid mating with their brothers by recognising their calls. The hypothesis currently is being tested by comparing responses of females to speakers broadcasting calls of their relatives and non-relatives. [KEYWORDS: mating behaviour, communication, DNA fingerprinting, kin recognition, *Bufo americanus*].

Walsh & Rosscoe

C24

The history, husbandry, and breeding of Komodo monitors at the National Zoological Park. TROOPER WALSH AND ROGER ROSSCOE. *Dept of Herpetology, National Zoological Park, Washington, DC 20008, United States of America.* On 13 Sept 1992, 13 Komodo dragons hatched at the National Zoo after a nine month incubation. This was the first successful breeding outside of Indonesia. In its 100 year existence the National Zoological Park (NZP) has exhibited seven dragons that have lived an average of five years, and there were no successful breedings. In May of 1988 the zoo received a pair of dragons. These animals were kept in a greenhouse exhibit that had a hot spot for basking (over 35°C), a pool, and soil for burrows. Courtship began on 7 Dec 1991 with the male constantly attending and tongue flicking the female. During this time copulations took place almost daily. After three weeks the female rejected the male and he was removed from the exhibit. As she began to be noticeably gain weight she dug burrows daily. On 23 July the female appeared much slimmer and a search for eggs was made. Twenty six eggs were found at a depth of 61 cm. The eggs averaged 167.3 g in weight and 58.5 mm by 89.2 mm in size. They were incubated in vermiculite and water at three concentrations; 1:1, 1:2, and 1:4. Incubation temperature was between 27.5 and 29°C. The first egg hatched after 237 days and a total of 14 hatched during the next six weeks. The hatchlings had an average weight of 91.8 g and length of 41 cm. The young were housed in tubs with a hide box, perch, and water bowl. Heat was provided by a 75 watt lamp that produced a hot spot temperature of 33–35°C. The young dragons ate young adult mice within a week of hatching. Mice are fed every

5 days. The young animals are being loaned to zoos interested in participating with NZP in a Komodo monitor conservation program. This program will include research on Komodo monitors in the field as well as a captive breeding program. [KEYWORDS: Komodo, husbandry, breeding].

Warren & Northwood

S02

The Arcadia formation: an early Triassic terrestrial community. ANNE WARREN AND CAROLINE NORTHWOOD. *Dept of Zoology, La Trobe University, Bundoora, Vic 3083, Australia.* A quarter century of collecting in the Arcadia Formation of Queensland has yielded the most taxonomically diverse terrestrial community known from the Early Triassic. Scrap as well as other remains from the two most fossiliferous localities have been collated in an attempt to determine the composition of the fauna. Seven temnospondyl families predominate along with lungfish, small reptiles (procolophonids, prolacertids, undescribed diapsids) and rare proterosuchids and therapsids. The Arcadia Formation is unique in an Australian context for the diversity of its reptile fauna, while among Gondwanan members it is outstanding for the relative abundance of its temnospondyls and the paucity of large reptiles. [KEYWORDS: Triassic, temnospondyl, procolophonid, proterosuchid, taphonomy].

Wassersug

S15

Ecological versus endocrinological factors influencing amphibian metamorphosis. RICHARD J. WASSERSUG. *Dept of Anatomy & Neurobiology, Dalhousie University, Halifax, Nova Scotia B3H 4H7, Canada.* Ecological studies in recent years have confirmed that variation in both the size at and time to metamorphosis may affect later life history events, such as size at first reproduction. These, in turn, correlate positively with clutch size and reproductive success in many amphibians. This information has renewed the interest of ecologists in the factors affecting metamorphosis; those factors will be reviewed in this presentation. It is now known that deterioration of the physical environment (e.g. pond drying) hastens metamorphosis in certain species. Biological factors such as food level, the presence of potential predators, and the density of competitors, have all been shown to affect metamorphosis. Independently, endocrinologists have been revising their understanding of the internal mechanisms regulating amphibian metamorphosis. Thyroid hormones are still considered the primary promoter of metamorphosis, but other endocrinological products appear to have important agonistic and antagonistic effects; these will be discussed here. Least understood is how the ecological factors relate to the endocrinological factors. I will review here one specific model for how the internal environment of tadpoles may "assess" the external environment to allow anurans to vary the start of metamorphosis. The model assumes that tadpoles produce in their oral mucus a natural inhibitor of metamorphosis, which they swallow with food. I will review the evidence available in support of this model. Finally. I will show how this model fits with both our current understanding of ecological factors affecting metamorphosis and the endocrinology of the process. [KEYWORDS: metamorphosis, amphibians, feeding, endocrinology, ecology, epidermal growth factor].

Watson

S06

Introduction to the frog fauna of Australia. GRAEME F. WATSON. *Dept of Zoology, University of Melbourne, Parkville, Vic 3052, Australia.* A brief introduction to the diversity and historical biogeography of the Australian anuran fauna will be presented. Particular attention will be directed towards distinguishing the two distinct

faunal strata that are evident in the fauna: an ancient, Gondwanan element represented by the Leptodactylidae (or, for some, the Myobatrachidae) and Hylidae (or, for even less, the Pelodryadidae), and a more recent faunal element with affinities to south east Asian groups and represented in Australia by the Microhylidae and Ranidae. Emphasis will be given to the nature of the adaptive radiations we see in the two ancient families, especially the development of a number of unique life history patterns.

Weatherby

C27

Movement patterns, home range and seasonal site fidelity of the North American box turtle, *Terrapene carolina carolina*. CRAIG WEATHERBY. *Biology Dept, 110 S. Madison, Adrian College, Adrian, MI 49221, United States of America.* Daily telemetry monitoring of 13 individuals was conducted during the activity seasons of 1991, 1992, and 1993. Results from the first two years revealed an average, 24 hour, straight line distances traveled for adults of 35.7 m (the male's average, 46.9 m, being greater than the female's, 30.0 m). In contrast, the three greatest, 24 hour, travel distances recorded (for three different adult turtles, of both sexes) were 412.5, 445.9, and 480.0 m. Although the average home range size for adult turtles (of both sexes) was 10.0 ha, 75.95% of the time these adults were restricted to an average of 11 different locations (activity nuclei) within each of their home ranges totalling, on average, only 1.0 ha. Seasonal site fidelity was identified when, on average, 76.4% of each male's, and 67.9% of each female's, 1991s total home range overlapped with 1992s. With regard to overlap of each turtle's activity nuclei, on average, 2 of the 11 nuclei overlapped, representing 36% of the total nuclei area for males and 29% for females. Site fidelity for hibernacula selection was also partially present in 9 turtles examined, three of which chose hibernacula within 10m of the previous year's locations (10.0 m, 6.1 m, and 2.2 m) while most of the rest chose the same general, but more distant, locations. [KEYWORDS: ecology, hibernation, home range, telemetry, turtle].

Webb

S27

Introduction — the links between wildlife conservation and sustainable use. GRAHAME J.W. WEBB. *G. Webb Pty Ltd, P.O. Box 38151, Winnellie, NT 0821, Australia.* The concept of "wise use" or "conservation through sustainable use" has been around for decades and was fundamental to both the World Conservation Strategy and to CITES. Yet to many in the public, the goals of *conservation* and *use* seem diametrically opposed — mutually exclusive. It is argued that this situation is at best misguided and at worst the result of animal rights and welfare activists advancing their causes irrespective of conservation merit. In reality, *conservation* is and always has been intimately linked to *use* and *value*. Reptiles, particularly crocodiles, have played an important role in educating the public about conservation through sustainable use.

Webb & Shine

C17

Retreat-site selection by the endangered broad-headed snake, *Hoplocephalus bungaroides*. JONATHAN K. WEBB AND RICHARD SHINE. *School of Biological Sciences A08, University of Sydney, NSW 2006, Australia.* Broad-headed snakes are nocturnal elapids that rarely bask but instead spent the day sequestered under rocks or in crevices in cliff-top habitats. We investigated habitat use by Broad-headed Snake on a west-facing cliff-top using conventional radio telemetry and a novel approach using miniature reflective diodes in conjunction with a harmonic radar. In spring most of the rocks selected by snakes were of intermediate thickness (5–10 cm) even though

both thinner and thicker rocks were available. Snakes consistently selected unshaded rocks in the field despite the fact that half of the available rocks were shaded. Spring temperatures under thick rocks (> 10 cm thick) or under shaded rocks of all thicknesses were too low for snakes to attain high body temperatures. In contrast, snakes sequestered under unshaded rocks of intermediate thickness were able to maintain high body temperatures for most of the day. Telemetered snakes showed a dramatic shift in habitat use in summer, moving to deep crevices or to dead hollow branches high up in trees well away from the cliff. This seasonal shift in habitat use coincided with an increase in the temperatures under surface rocks, to a point where temperatures under rocks of intermediate thickness were too high for snakes to tolerate. Snakes utilising tree hollows and crevices, however, were able to maintain suitable body temperatures for most of the day. [KEYWORDS: body temperature, habitat selection, rock temperatures, telemetry].

Webb & Shine

S20

Prey-size selection, gape limitation and predator vulnerability in the eastern Australian blindsnake, *Ramphotyphlops nigrescens*. JONATHAN K. WEBB AND RICHARD SHINE. *School of Biological Sciences, Zoology A08, University of Sydney, NSW 2006, Australia.* Blindsnakes, *Ramphotyphlops nigrescens*, are small worm-like fossorial snakes that feed principally on the larvae and pupae of ants. Examination of stomach contents showed that larger blindsnakes consumed larger prey items than, and different prey species from, smaller blindsnakes. Only the largest snakes consumed brood of the large and formidable 'bulldog ants', *Myrmecia*. Three hypotheses for the causal basis of this size-related shift in dietary habits were tested. Observations on captive snakes suggested that they are gape-limited predators, and the prey items eaten by small snakes in the field are as large as they could physically ingest in the laboratory. Hence, the absence of large prey items from small snakes may be due simply to gape-limitation. However, medium-sized blindsnakes were capable of ingesting items larger than those which they take in the field. The absence of *Myrmecia* brood in the diets of these snakes is not due to prey choice (*Myrmecia* brood were readily eaten in the laboratory) or to an inability to locate or follow pheromonal trails of this ant genus, because all size classes of blindsnakes readily followed *Myrmecia* trails in the laboratory. Instead, the absence of *Myrmecia* from the diets of smaller snakes is probably due to the snakes' size-dependent vulnerability to nest defence by the bulldog ants. In laboratory encounters *Myrmecia* workers were able to bite and sting (and eventually kill) small blindsnakes, but larger snakes were relatively invulnerable to attack. [KEYWORDS: blindsnakes, bulldog ants, prey-size selection, gape limitation, predator vulnerability].

Wei & Li

C06–198

Study on the amphibian distribution in the vegetation destroyed area in East Wumenshan Mountains. WEI GANG AND LI DEJUN. *Dept of Biology, Zunyi Medical College, Guizhou 563003. P.R. China.* An amphibian survey was carried out in Yezhong area, Guizhou, China (within 104°50'13"–104°57'24" E and 26°11'7"–26°17'2" N). 9 species and subspecies of amphibians (85 specimens) belonging to 5 genera, 5 families and 2 orders were collected. The variations of *Rana spinosa*, *R. pleuraden* and *R. japonica* have been discussed. With the difference in altitude reaching 1576 m, the vertical distribution of the amphibians becomes an important feature. The wider hor-

izontally the species distributes, the wider vertically it is distributed. The southwest-plateau elements are widespread in vertical distribution, the Central-Southern Chinese elements are of narrow vertical distribution. Most of the species with close phylogenetic relationships between them have been distributed in vertically overlapping. The paper compares amphibian species diversities in Yezhong Kuankuoshui and Maolan areas. The reasons for the difference in species diversity in the areas are discussed. [KEYWORDS: amphibians, vertical distribution, species diversity].

Wei *et al.*

C06–199

Study on the phylogenetic relationship between species of genus *Oreolalax*. WEI GANG[1], XU NING[1], YE CHANGYUAN[2] AND FEI LIANG[2]. [1]*Dept of Biology, Zunyi Medical College, Guizhou 563003, P.R. China.* [2]*Chengdu Institute of Biology, Academa Sinica 610015, P.R. China.* On the basis of the taxonomy, differentiation, distribution and phylogeny between genera of high altitude pelobatid toads, the comparative analyses of 29 characters of 1293 specimens belonging to 14 species of genus *Oreolalax* are made, including the external morphological characters, the skeletal characters, the tadpole characters and the colours of the ova. The phylogenetic relationship between the species of *Oreolalax* is studied with the principles and methods of cladistics. Based on the phylogenetic cladogram and the evolutionary order of the species, *Oreolalax*, may be divided into *O. schmidti* species group, *O. omeimontis* species group, *O. liangbeiensis* species group and *O. rugosus* species group. The paper also deals with the distributive centre and origin centre of *Oreolalax*. It is considered that the evolution of the genus *Oreolalax* is closely related to the formation of Himalayan mountains. [KEYWORDS: phylogeny, cladistics, genus *Oreolalax* , species group].

Weldon & Vallarino

S12

Adaptations of the yellow-bellied sea snake (*Pelamis platurus*). PAUL J. WELDON[1] AND OSCAR VALLARINO[2]. [1]*Dept of Biology, Texas A&M University, College Station, United States of America.* [2]*Asociacion Nacional para la Conservacion de la Naturaleza, Apartado 1387, Rep. de Panama.* The yellow-bellied sea snake (*Pelamis platurus*) is the most abundant and widely distributed snake in the world, ranging from the east coast of Africa to the west coast of Central America. The extensive range and pelagic existence of this species is attributed to, among other features, the rarity of its predators and its ability to give birth to live young. Behavioural studies indicate that a variety of fishes and birds avoid *Pelamis*, and tests with fishes indicate that chemical cues mediate these responses. Rare observations are reported on the birth and mating behavour of *Pelamis*. A survey of the sizes of snakes taken from the Gulfs of Panama and Chiriqui throughout the year indicate that parturition in *Pelamis* occurs once a year. [KEYWORDS: sea snake, *Pelamis platurus*, anti-predator defence].

Welsh & Lind

C28

Ontogenetic changes in foraging behaviour and habitat use by the Oregon aquatic garter snake (*Thamnophis atratus hydrophilus*). HARTWELL H. WELSH, JR AND AMY J. LIND. *USDA Forest Service, Redwood Sciences Laboratory, 1700 Bayview Dr. Arcata, CA 95521, United States of America.* We have conducted three to five mark-recapture censuses of the Oregon aquatic garter snake (*Thamnophis atratus hydrophilus*) on a 5 km section of a cold mountain stream in northwestern California each year since 1986. Data were collected on food habits, habitat use, movement, growth, repoduction, and demographics from over 900 snakes. In addition we made 154

behavioural observations on individuals in three age classes for a total of 32.4 hours. We have observed significant differences in movement, habitat use, foraging modes, and prey selection among age classes. Neonate and juvenile snakes forage less actively with ambush modes in stream margin habitats and consume primarily first year salmonids and tadpoles of the foothill yellow-legged frog (*Rana boylii*). Adult snakes forage with more active search modes in fast-water habitats and consume primarily larval and neotenic Pacific giant salamanders (*Dicamptodon ensatus*) which dwell in mid-stream rocky substrates. We propose that this ontogenetic shift in foraging behaviour, prey selection, and habitat use results form a tension between developmental constraints and an innate, possibly phylogenetically imposed, behavioural propensity on the part of the snakes to seek and capture larger prey. [KEYWORDS: *Thamnophis*, foraging ecology, ontogeny of foraging behaviour].

Werner

S09

Israel bridge or barrier between African and Arabian sand deserts? YEHUDAH L. WERNER. *Dept of Evolution, Systematics and Ecology, The Hebrew University of Jerusalem, 91904 Jerusalem, Israel.* Between the Saharan and Arabian sand deserts, the Negev of Israel contains sand "islands", totalling 28 arenicolous reptiles. Of these, six which are Saharo-Arabian are euryoecious and occur also on other soils throughout the Negev; two others live on various soils throughout Israel. For these Israel is a bridge. But twelve Saharan species, stenoecious psammophiles, are mostly confined in Israel to the Western Negev sands; two others, to the southeastern sands. Five Arabian arenicolous reptiles are limited to the easternmost Negev ('Arava) and one Iranian species occurs in the central Negev sands. For all these, Israel is a barrier. The barrier function of the rocks bordering the 'Arava on the east is shown by three Saharan psammophiles which reach the 'Arava but no further, and by *Phrynocephalus arabicus*, recently discovered east of the 'Arava but absent in it. [KEYWORDS: Middle East, Negev, Arava, reptiles, zoogeography].

Werner & Sivan

S03

Systematics and zoogeography of *Ptyodactylus* (Reptilia: Sauria: Gekkonidae) in the Levant: 3. Experimental and natural hybrids of *P. guttatus* and *P. puiseuxi*. YEHUDAH L. WERNER AND NAOMI SIVAN. *Dept of Evolution, Systematics and Ecology, The Hebrew University of Jerusalem, 91904 Jerusalem, Israel.* Contact zones between Israeli *Ptyodactylus* species were evaluated from museum material and small-scale hybridisation experiments, the first controlled hybridisation between gekkonid species. In southern Israel and Sinai *P. guttatus* and *hasselquistii* are partly sympatric, occasionally syntopic. Intermediate specimens were absent and experimental hybridisation failed. Probably prezygotic isolation operates. In northern Israel, *P. guttatus* and *P. puiseuxi* are parapatric; in and near their boundary, occasional putative hybrids occur. These resemble the few laboratory hybrids obtained. No F_2 were obtained. Probably the two separated by a combination of partial isolating mechanisms. [KEYWORDS: *Ptyodactylus*, gecko, Israel, systematics, hybridisation].

Weygoldt & Jungfer

C20

Oviphagy and the evolution of complex parental care in frogs. PETER WEYGOLDT AND KARL-HEINZ JUNGFER[2]. [1]*Institut für Biologie I (Zoologie), Albert-Ludwigs-Universität, Albertstr. 21a, 7800 Freiburg i. B.* [2]*Schulstraße 4, 7097 Tannhausen, Ostalb.* Although most frog species accumulate near water during the breeding season, many

species, in particular in the tropics, have become more or less independent of larger bodies of water. Some arboreal species, instead of descending from their trees, use tree holes, water filled bromeliad leaf axils or similar phytothelms for reproduction. Such water reservoirs are usually small, they are a limited resource, and they lack a considerable primary production or other authochthonous nutrients. The larvae of several species of frogs breeding in such small bodies of water have therefore become specialised egg eaters, and a few species have evolved an advanced parental care: the female returns regularly to feed her own tadpoles with eggs. Such a behaviour was first reported for *Dendrobates pumlio* and other species of the same species group. We here report that a similar behaviour has also evolved in some neotropical tree frogs (Hylidae). One such case is *Anotheca spinosa*. The female returns to a certain tree hole or bromeliad every 5 to 6 days and lays eggs which are immediately consumed by the larvae. A similar though more facultative behaviour has been observed in *Osteocephalus* sp. Since there are many species of bromeliad or tree hole breeding hylids, we expect to find all degrees from accidental egg laying into a phytothelm with larvae to obligatory feeding of the tadpoles.

Whitaker

C17

Thermal ecology and microclimatic correlates of behaviour in Tasmanian tiger snakes *Notechis ater* (Serpentes, Elapidae). PATRICK B. WHITAKER. *Dept of Geography and Environmental Studies, University of Tasmania, Tas 7001, Australia. Current address: School of Biological Sciences (A08), University of Sydney, NSW 2006, Australia.* I investigated the thermal ecology of adult female Tasmanian Tiger Snakes *Notechis ater* during summer, using stomach-implanted radio-telemetry and a comprehensive microclimate monitoring program. Patterns of activity and eccritic body temperatures were compared between snakes at sea-level and 830 m elevation. The study documented: the microclimatic conditions associated with retreat site and basking site selection, behavioural responses to micrometeorological variation, diel rhythmicity and range of body temperatures, and eccritic body temperatures. Laboratory determined eccritic body temperatures showed elevational differences between means and voluntary thermal limits for non-gravid females but similar temperatures for gravid females. A predictive empirical model of activity was developed based on microclimatic correlates of body temperature. This model identifies those microclimatic parameters and quantities which correlate with emergence, time required for the daily warm-up phase, day-time movement, and point of entry into nocturnal retreat sites. The microclimatic parameters found to closely correlate with body temperature and daily activity patterns included: total down-welling radiation, global radiation, ground surface temperature, ground heat-flux, and inground temperature at five centimetres. Cloud cover and wind direction influenced the snake's thermoregulatory behaviour, but light rainfall and relative humidity did not. [KEYWORDS: behaviour, body temperature, eccritic temperature, Elapidae, microclimate, radiotelemetry, site selection, thermoregulation, tiger snake].

White

S30

Snakebite — an overview. JULIAN WHITE. *State Toxinology Services, Adelaide Childrens Hospital, North Adelaide, SA 5006, Australia.* Snakebite is a significant medical problem globally, with current information indicating that in excess of one million people are bitten by venomous snakes annually and estimates of fatal cases

ranging from 20,000 to greater than 100,000 annually. Most cases and deaths occur in the rural tropics. Vipers, particularly *Echis* spp., *Daboia* spp., *Bothrops* spp., are leading causes of fatal snakebite, but many viperid and elapid snakes can and do cause fatalities. For most rural tropical areas, statisitics on snakebite are either incomplete or contradictory. For savanna west Africa a WHO survey estimated 9 snakebite deaths in 5 years, yet a more recent epidemiological study at village level in Nigeria estimated 23,000 deaths annually from snakebite. Modern treatment with antivenom and supportive treatment for paralysis, coagulopathy, and renal failure could salvage most severe cases of snakebite, as demonstrated in more developed nations, but in areas in most need, these modalities of treatment are either unavailable or poorly resourced. Many antivenoms available are of poor quality, being minimally refined horse serum, and the incidence of significant side effects approaches 100% in some areas. Newer methods of antivenom production can produce a more effective and safer product, but cost pressures may reduce availability in developing nations, where antivenoms may potentially consume a major protion of national pharmaceutical budgets. Similarly, provision of adequate intensive care and renal dialysis facilitates to salvage all patients requiring such treatment, is often beyond financial resources. However, in some areas, even less expensive treatments, which might be available, are not utilised effectively, both because of patient ignorance and lack of appropriate training of health care workers. WHO initial efforts to remedy this are being undertaken through the INTOX project. [KEYWORDS: snakebite, vipers, elapids, paralysis, coagulopathy, renal failure, antivenom].

White

S30

Snakebite in herpetologists in South Australia. JULIAN WHITE. *State Toxinology Services, Adelaide Childrens Hospital, North Adelaide, SA 5006, Australia.* Snakebite is a relatively small medical problem in Australia, compared to the rural tropics, but up to 3,000 cases occur annually, with the average of 2 fatalities per year. Brown snakes, *Pseudonaja* spp., account for the majority of bites and deaths. As in other "western" nations, illegitimate snakebite, that is snakebite in reptile keepers, particularly amateurs, has been perceived as a problem, accounting for a significant proportion of all bites. There is a general assumption that this problem is irremediable. Experience in South Australia has been contrary to the above assumptions. A review of over 250 snakebites showed that reptile keepers and those inappropriately handling venomous snakes accounted for less than 25% of all bites. Following an education campaign targeting amateur reptile keepers, explaining the causes and consequences of their being bitten, the proportion of illegitimate bites has reduced further, accounting for 10% or less of cases. This is despite a rise in the number of dangerous venomous snakes registered in captivity in SA. Prior to the education campaign, the leading causes of illegitimate snakebite were accidents while feeding snakes and free handling of snakes. Particularly in the latter, there was an association with excessive alcohol intake. Since the campaign, neither cause has been common and no case of an intoxicated envenomed herpetologist has been seen by the author. These few cases of illegimate snakebite recorded in the last three years are almost exclusively in those professionally involved in herpetology, either through husbandry of venomous snakes in establishments involved in commercial venom production, or through collection and removal of snakes from urban areas (e.g. Adelaide Snake Catchers). Both groups have high exposure and so a comparatively higher risk. Neither group existed to any major extent prior to 6 years

ago. By working with herpetologists, the Adelaide experience is that snakebite in this group can be a minor problem. [KEYWORDS: snakebite, herpetologists, elapids, paralysis, coagulopathy, renal failure, antivenom].

Wicker C24

The captive breeding of *Varanus acanthurus* in the Zoological Garden Frankfurt. R. WICKER. *Zoologischer Garten, Alfred-Brehm-Platz 16, 60316 Frankfurt am Main 1, Germany.* Frankfurt Zoo keeps *Varanus acanthurus* since 1985, breeding started in 1987. Since that time 107 animals hatched. Feeding, social composition of the breeding group and management problems are discussed. Number of eggs per clutch, number of clutches per year as well as the time of egg deposition in the northern hemisphere are reported.

Wikramanayake *et al.* S17

The thermal ecology of adult and juvenile komodo dragons, *Varanus komodoensis*. ERIC D. WIKRAMANAYAKE[1], DALE MARCELLINI[1] AND WAWAN RIDWAN[2]. [1]*Dept of Herpetology, National Zoological Park, Washington DC 20008, United States of America.* [2]*Taman Nasional Komodo, Labuanbajo, Flores, NTT, Republic of Indonesia.* Four adult and four juvenile Komodo dragons were radio-tagged and each animal was followed continuously for at least 3 consecutive days from 0600 to 1800 hr. Some animals carried two temperature-sensitive transmitters; one externally to measure microhabitat temperature and the other internally to measure body temperature. The former was glued to the dorsal surface of the pelvis, and the latter was fed to the animal. A transmitter strapped to an isolated tree recorded an ambient air temperature profile. Overhead shade protected the transmitter from direct sunlight throughout the day. Readings from each transmitter were taken at 30 min intervals to obtain daily temperature profiles for microhabitat and/or body temperature, and ambient air temperature. When possible we also determined habitat, microhabitat, and behaviour of each radio-tagged animal. Average body temperatures for three juvenile (X=35.1±0.7°C) and three adult (X=35.4±0.9). Komodo dragons were similar, as were the maximum body temperatures (39.2±0.9 and 38.3±1.4, respectively). However, the low body temperature of juveniles (X=25.9±2.9) was as much as 5°C less than in adults (X=30.3±0.9). Adults overnight in burrows, but are also found in the open at night. Juveniles often overnight on trees. Thus, both thermal inertia associated with the large body size and the choice of stable microhabitats may help adults to maintain a higher body temperature during the nights, whereas the juveniles, perched high on trees, are exposed to the cooler ambient air temperatures. The body temperature profiles of juveniles closely tracked microhabitat temperatures, suggesting that juvenile dragons may be selecting warmer microhabitats during the early part of the day to elevate body temperatures. By about 1030 hr juveniles were in warmer microhabitats than were adults. [KEYWORDS: *Varanus komodoensis*, thermal ecology].

Wilkinson *et al.* C03

Phylogeny and historical biogeography of some east Asian tree frogs of the Family Rhacophoridae. JEFFERY ALAN WILKINSON[1], MASAFUMI MATSUI[2], TORU TERACHI[3], KUANG YANG LUE[4] AND ZHITONG KOU[5]. [1]*Dept of Biological Sciences, Texas Tech University, P.O. Box 43131, Lubbock, TX 79409-3131, United States of America.* [2]*Graduate School of Human and Environmental Studies, Kyoto University, Yoshida-Konoe-cho, Sakyo-ku, Kyoto 606-01 Japan.* [3]*Inst. for National Land Utilization and Development, Kyoto Sangyo University, Motoyama, Kamigamo, Kita-ku, Kyoto 603 Japan.* [4]*Dept of Biology, National Taiwan Normal University, 88 Roosevelt Road, Section 5, Taipei Taiwan R.O.C.* [5]*Dept of Biology, Yunnan University, Kunming 650091, Yunnan, P. R. China.* A molecular data set was utilised to infer the phylogenetic relationships of some East Asian tree frogs within the family Rhacophoridae Twenty-two species from five genera were compared using ca. 160 restriction site characters of a 2 kbp fragment of the mitochondrial 12S and 16S ribosomal RNA genes. The genera included *Buergeria*, *Polypedates*, *Chirixalus*, *Rhacophorus*, and *Philautus* principally from Japan, the Ryukyu Archipelago, and Taiwan but also from mainland China and Malaysia. Since *Buergeria* is considered basal within Rhacophoridae according to Liem (1970), representative taxa of Hyperoliidae and Ranidae were used as successive outgroups. The data set was subjected to phylogenetic analysis using PAUP. Three questions will be addressed with this study: 1. the apparent uniqueness of *Buergeria* within Rhacophoridae; 2. the phylogenetic relationships of three closely related genera *Rhacophorus*, *Chirixalus*, and *Polypedates;* and 3. the historical biogeography of the Ryukyu Archipelago using the phylogenetic information from species within *Rhacophorus* and *Buergeria* which are endemic to certain islands and island groups. [KEYWORDS: phylogeny, historical biogeography, mitochondrial rRNA genes, restriction sites, Rhacophoridae].

Williams & Mirtschin S30

Variation in the composition of the venom from a family of tiger snakes over a one year period. V. WILLIAMS[1] AND P.J. MIRTSCHIN[2]. [1]*Haematology Dept, Adelaide Children's Hospital, North Adelaide, SA 5006, Australia.* [2]*Venom Supplies, Tanunda, SA 5352, Australia.* A family of tiger snakes consisting of a female parent and three female and one male offspring, were milked bi-monthly over a twelve month period. The snakes were maintained at a constant temperature with seasonally variable photoperiod and were offered mice and rats at fortnightly intervals. The venoms were examined for their enzymic activity and clotting activity, polyacrylamide gel electrophoretic pattern and their interaction with antivenom in a simple Ouchterlony. There was little variation in the protein content between the snakes or within a single snake over the twelve months. Considerable variability was noted in the levels of enzymic activity in the individuals over the twelve months and this individual variability appears to be a far greater influencing feature than any seasonal influence. The clotting activity showed very little variation between months although some small difference was noted between the individual snakes. There were no differences noted in the electrophoretic patterns of the individuals over the twelve month period and the gel patterns indicated genetic similarity of the five snakes. The Ouchterlony patterns showed strong precipitin lines and again no seasonal pattern was obvious but the similarity in the precipitin lines between the snakes was further evidence of their genetic similarity. [KEYWORDS: venom variation, seasonal variation, tiger snakes].

Williamson C20

Seasonal changes in the clutch parameters of the frog *Ranidella signifera*. I. WILLIAMSON. *School of Life Science, Queensland University of Technology, GPO Box 2434, Brisbane, Qld 4001, Australia.* Clutch parameters of the Australlan frog *Ranidella signifera* were studied over 3.5 years in a population in the Adelaide Hills, South Australia. During its prolonged breeding season from March to November, peak

breeding occurred in July and August. There was significant variation in clutch parameters over the breeding season. Egg size was largest in the peak breeding period and smaller earlier and later in the season. Clutch size was smaller late in the season. This seasonal variation in clutch parameters was also related to temperature for the 30 day period prior to egg laying. Only clutch size showed a significant effect of season after adjustment for temperature. The most likely explanation for the observed variation in egg size was that it depended on the environment (particularly temperature) experienced by the female during egg formation. These observations are consistent with other data suggesting that egg size has less impact on fitness than temperature at development, sibship and the timing and position of egg laying. A negative correlation between egg size and clutch size, after correction for female size and temperature, suggested a trade-off between size and number of offspring. However, a positive relationship between female size and clutch size indicated that larger females could produce large eggs and still produce more eggs than smaller females. The data also suggest that different factors may influence the way a late season clutch is packaged, relative to early and mid-season clutches. [KEYWORDS: egg size, clutch size, seasonal variation, temperature].

Withers S13

Role of the skin in anuran amphibians to evaporative water loss: an Australian perspective. PHILIP C. WITHERS. *Dept of Zoology, University of Western Australia, Nedlands, WA 6009, Australia.* The skin of typical anuran amphibians evaporates as if it were a free water surface, and there is no epidermal resistance to evaporative water loss (EWL). This physical property corresponds to the morphological absence of an epidermal stratum corneum in the anuran skin epidermis. However, some anuran amphibians have a reduced cutaneous EWL, due to either the formation of a cocoon during aestivation, or the presence of a surface lipid layer or lipids located within the epidermis. A consideration of the water relations of Australian frogs provides examples of all three patterns of EWL in anuran amphibians. Typical Western Australian frogs evaporate water essentially as if they were a free water surface; their EWL is high and their resistance to water loss is close to 0. The resistance of the skin to EWL is determined almost completely by the resistance of a boundary layer of air above the skin surface, rather than the skin itself, and so EWL is not expected to be proportional to body mass ($\propto M^{1.0}$) or surface area ($\propto M^{0.67}$) because of the complex effects of air flow rate and body size on the boundary layer resistance. There is a significant relationship between body mass (M, grams) and rate of evaporative water loss (mg H_2O min^{-1}) for the Western Australian frogs; EWL = 3.41 $M^{0.3\pm0.5}$ (n=18, r^2=0.67), but the mass exponent is significantly lower than 1.0 and 0.67. The theoretical relationship between resistance and body mass is $R \propto M^{0.133}$; for typical Western Australian frogs, the observed relationship is R = 1.9 $M^{0.-0.04\pm0.09}$ (n=18, r^2=0.01); the exponent -0.04 is not significantly different from 0 or 0.133. The structure and function of the anuran cocoon was first reported for a few Western Australian aestivating frogs (Lee and Mercer, 1967). Since this study, cocoon structure and function has been investigated in a number of other anuran and urodele amphibians. Cocoon formation is observed in all species of arid Western Australian *Neobatrachus* and *Cyclorana* that have been investigated, but not in any other genera. EWL decreases markedly with cocoon formation, but in a graded fashion, by up to 50–100×, and resistance increases from about 1 to 100 or even more. [KEYWORDS: anuran, amphibian, skin, epidermis,

evaporation, cocoon, lipids, Australia].

Withers & Bradshaw S11

Material and energy balance of the thorny devil, *Moloch horridus* : a reptilian sloth? PHILIP C. WITHERS AND S. DONALD BRADSHAW. *Dept of Zoology, The University of Western Australia, Nedlands, WA 6009, Australia.* The thorny devil (*Moloch horridus*) is a bizarre agamid lizard found in arid to semi-arid sand-plain areas of western and central Australia; it is an obligate myrmecophage, consuming large numbers of small ants. Field metabolic rate (FMR), and water and sodium turnovers, were measured for free-ranging thorny devils over a 3 year period using doubly-labelled water ($^3HH^{18}O$) and ^{22}Na. Injected individuals were fitted with small (×1.5 gram) radio-transmitter to facilitate recapture, and an estimate of daily movement was gained for some individuals by spooling. In April 1989, FMR of 8 individuals (body mass = 23.7±3.1 g) was 0.080±0.03 ml $CO_2g^{-1}h^{-1}$ (1.3kJ day^{-1}); water influx and efflux were balanced at 0.36±0.05 and 0.29±0.07 ml day^{-1} respectively. In February 1991, conditions were extremely hot, but the FMR of 4 lizards (body mass = 51.6±6.3) was slightly higher at 0.133 ml $CO_2g^{-1}h^{-1}$ (4.0 kJ day^{-1}), water influx and efflux were 17.4±10.9 and 19.3±10.5 ml $kg^{-1}day^{-1}$ respectively, and sodium influx and efflux were balanced at 2.38±0.48 and 2.53±0.61 mmol $kg^{-1}day^{-1}$ respectively. March 1993 coincided with ideal foraging conditions for the thorny devils, but the FMR for 10 individuals (body mass = 30.6±1.9) was only 0.138±0.05 ml $CO_2g^{-1}h^{-1}$ (2.61 kJ day^{-1}), the water influx and efflux were 0.22±0.05 and 0.37±0.06 ml day^{-1} respectively, and sodium influx and efflux were 1.57±0.3 and 2.12±0.3 mmol $kg^{-1}day^{-1}$. The field metabolic rate and water influx rate are less than one half of the values predicted for a similar-sized desert iguana (3.44 kJ day^{-1} and 0.57 ml day^{-1}). The standard metabolic rate (SMR) measured for thorny devils in the laboratory (0.114±0.011 ml $O_2g^{-1}h^{-1}$ at 35°C) is similar to the predicted rate. The small ant *Iridomyrmex purpurens* is the commonest component of the diet. The food intake rate of thorny devils estimated from the sodium turnover rates and sodium content of *I. purpurens*, was 0.75 to 1.94 wet weight day^{-1} for trips 3 and 4 respectively (which corresponds to 240–625 ants per day). These feeding rates of thorny devils are much higher than that predicted for a similar-size desert iguanid lizard (0.24–0.57 g day^{-1}). These data suggest that the thorny devil *Moloch horrridus*, rather than representing an example of a highly-adapted desert agamid lizard, is a lizard with an abundant and assured food and water supply, and its low metabolic activity and water intake reflect instead the low levels of activity needed to assure its daily energy and water requirements. [KEYWORDS: desert, lizard, oxygen-18, FMR, SMR, water, electrolytes, diet].

Withers & Thompson S17

The relationship between body mass and metabolism for Australian goannas. PHILIP C. WITHERS[1] AND GRAHAM G. THOMPSON[1,2]. [1]*Dept of Zoology, University of Western Australia, Nedlands, WA 6009, Australia.* [2]*Dept of Recreation, Edith Cowan University, Churchlands, WA 6018, Australia.* The scaling of metabolic rate (power) might be expected to vary from $mass^{0.66}$ (biological or kinematic similarity) or $mass^{0.73}$ (biological similarity with operational-time concept) to $mass^{1.16}$ (mechanical or dynamic similarity). The interspecific allometric relationship for standard (SMR; ml O_2 h^{-1}) and maximal (MMR; ml O_2 h^{-1}) metabolic rates of squamates generally have a mass exponent of about 0.8, whereas the intraspecific mass exponents are gen-

erally about 0.67. It is therefore of considerable interest that the genus *Varanus* is reported to have inter-specific and intra-specific allometric relationships for standard metabolism of SMR$\propto$Mass$^{1.0}$. The inter-specific exponent for SMR for adult Australian varanids at 35°C is 0.91 (eight species, n=58; VO_2= $0.703M^{0.91\pm0.02}$). The intra-specific SMR mass exponent for adults at 35°C is approximately 1.0; *V. eremius*, VO_2 = $0.27M^{0.85\pm0.01}$ (n=4, mass range 8.7–34.2 g); *V. acanthurus*, VO_2 = $0.042M^{1.26\pm0.14}$ (n=8, mass range 20–83 g); *V. gouldii*, VO_2 = $0.10M^{1.04\pm0.13}$ (n=7, mass range 20–402 g); *V. panoptes*, VO_2 = $0.014M^{1.30\pm0.11}$ (n=7, mass range 228–2925 g); *V. giganteus*,VO_2 = $0.13M^{0.96\pm0.04}$ (n=6, mass range 84–5660 g). The inter-specific mass exponent for MMR at 35°C for Western Australian varanids is 0.55 (four species, n=54; VO_2 = $16.4M^{0.55\pm0.02}$). Intra-specific mass exponents for MMR at 35°C are generally less than 1.0; *V. acanthurus*, VO_2 = $2.78M^{0.99\pm0.17}$ (n=10, mass range=33–104 g); *V. caudolineatus*, VO_2 = $9.18M^{0.81\pm0.18}$ (n=14, mass range=10.6–21.8 g); *V. brevicauda*, VO_2=$8.65M^{0.64\pm0.19}$ (n=5, mass range=13.6–24.8 g); *V. gouldii*, VO_2 = $38.0M^{0.40\pm0.13}$ (n=23, mass range=162–704 g). The low and variable inter-specific and intra-specific mass exponents for MMR of these varanids is possibly due to the difficulty associated with ensuring that the goannas produce a sustained maximal effort while running on a treadmill. The body shapes of Western Australian goannas are considerably conservative, being almost geometrically similar over a mass range of 15 g (*V. brevicauda*) to 7000 g (*V. giganteus*) in terms of ratio of body length to various parts of the body (e.g. head, head+neck, fore-limb, and hind-limb lengths). This geometric similarity of body shape may account for the unusual allometry of SMR in varanids. It is also notable that the diet of varanids remains conservative over a wide range of body mass; both small and large varanids are insectivorous or carnivorous predators, or scavengers. [KEYWORDS: *Varanus*, goanna, allometry, metabolism, SMR, MMR, Australia].

Witten

C06–201

The phylogenetic significance of acrodonty. GEOFFREY J. WITTEN. *Dept of Anatomy and Physiology, RMIT Bundoora, P.O. Box 71, Bundoora, Vic 3083, Australia.* Acrodonty has been assumed to be a derived condition within the Squamata. Acrodont teeth occur in only two lizard families, Agamidae and Chamaeleonidae. These families, with iguanids, form the Iguania, containing the most primitive lizards. Acrodont teeth also occur in the sister group to the Squamata, the Sphenodontida. Agamids share with sphenodontids the character of anterior successional teeth. These teeth are pleurodont, as are the teeth of many lizard families. Agamids are thought to have evolved posterior acrodont teeth. Chamaeleons are assumed to have lost the anterior teeth. The anterior teeth of some Australian agamids are not typically pleurodont, but are embedded within the anterior part of the dentary. These are morphologically nearer the anterior successional teeth of *Sphenodon*, which are functionally acrodont, but at least one fossil sphenodontid has anterior pleurodont teeth. If the normal rules of parsimony are applied to members of the Iguania and their sphenodontid relatives the accepted relationships need reassessment. Acrodonty is apparently primitive for Squamata, and is retained in only two primitive families, which may or may not be closely related. Pleurodont teeth of the Squamata are likely to have been derived from anterior successional teeth like those of agamids, but the agamids might best be considered the least derived squamates. [KEYWORDS: Agamidae, Chamaeleonidae, acrodonty, successional teeth, phylogeny, Squamata].

Wüster

S01

DNA and morphological systematics at the species level: Asiatic cobras. WOLFGANG WÜSTER. *Dept of Zoology, University of Aberdeen, Tillydrone Avenue, Aberdeen, AB9 2TN Scotland, United Kingdom.* Many systematists specialise in the use of either molecular or morphological information systems. This study attempts to show how a combination of these approaches can resolve complex systematic problems, which may not be resolvable through the use of one information system alone. This strategy is illustrated with the problem of the population systematics of the cobras of Indochina, which are investigated by means of comparative PCR-based mtDNA sequencing. The results are compared with those obtained by means of multivariate analysis of morphological data. Previous to this study, two subspecies of *Naja naja* were generally recognised in the region. These comprised a confusing array of colour varieties, some of which were given subspecies status by some recent authors. Through the use of a combination of comparative mtDNA sequencing and multivariate morphometrics, this study demonstrates that there are in fact 3 species of cobra in this region. The conventional taxonomic arrangement, and the previously recognised colour varieties entirely failed to represent these species. [KEYWORDS: molecular systematics, multivariate morphometrics, *Naja*, Asia].

Wüster *et al.*

C08

Systematics of South American lanceheaded pit vipers (*Bothrops atrox* species group). WOLFGANG WÜSTER[1], GIUSEPPE PUORTO[2], ROGER S. THORPE[1] AND BBBSP[3]. [1]*Dept of Zoology, University of Aberdeen, Aberdeen AB9 2TN, Scotland, United Kingdom.* [2]*Laboratorio de Herpetologia, Instituto Butantan, Av. Vital Brasil 1500, 05504 São Paulo SP, Brazil.* [3]*Butantan-British Bothrops Systematics Project: M.F.D. Furtado, S.A. Hoge, G. Puorto, M.G. Salomo, R.D.G. Theakston, R.S. Thorpe, D.A. Warrell & W. Wüster.* We investigate the systematics of the *Bothrops atrox* species group in South and Central America by means of multivariate morphometrics and comparative sequencing of mtDNA. The members of this complex are responsible for the majority of snakebite accidents within their range. At present, the group is split into approximately a dozen rather poorly defined species with unclear distributions. Improving our understanding of the systematics of these snakes is essential for the optimization of antivenom therapy for snakebite patients in South America. We present preliminary multivariate morphometric results on the systematics of these snakes. *Bothrops* spp. show considerable geographic variation both between and within the currently recognised species. (Funded by the EC). [KEYWORDS: *Bothrops*, multivariate analysis, systematics, South America].

Wygoda

S13

Influence of skin resistance to water loss on body temperature in North American tree frogs. MARK L. WYGODA. *Dept of Biological and Environmental Sciences, McNeese State University, Lake Charles, Louisiana 70609-2000, United States of America.* Comparisons of body temperatures between North American arboreal frogs of the genera *Hyla* and *Osteopilus* with either nonarboreal frogs or water-saturated frog models have revealed the presence of higher temperatures in the arboreal species. In the field, *Hyla cinerea* experiences body temperature elevations of up to 7°C during the day, with less extreme elevations common at night. Mean temperature elevations ranging from 0.4°C (at 25°C air temperature and 87% relative humidity) to 8.7°C (at 30°C and 25% RH) have been recorded for this species under steady-state con-

ditions in the lab. However, body temperature in aerially exposed larval *Hyla cinerea* is not elevated until Gosner stage 43, the stage of emergence from the water. Laboratory studies consistently show body temperature elevation in *Hyla* and *Osteopilus* is due to the presence of a skin resistance to evaporative water loss, a physiological trait completely absent in nonarboreal species. Skin resistance appears to be inversely related to both water vapor density and air temperature. Due to its reduced evaporative heat loss rate, *Hyla cinerea* heats nearly 3× faster and cools only one-half as fast as nonarboreal frogs in response to a step-change in ambient temperature. Body temperature in this species also is much less coupled to relative humidity: a 50% decrease in RH at 25°C results in a 6°C drop in body temperature of nonarboreal frogs, but that of *Hyla cinerea* changes by only 2°C. Skin resistance may in part be due to the intermittent release of skin secretions which then dry on the surface, forming a partial barrier to subsequent evaporation. The evaporation of water from these secretions, however, causes slight, temporary drops in body temperature, often resulting in erratic temperature patterns during steady-state. [KEYWORDS: body temperature, skin, water loss, tree frog, North America].

Xu *et al.*

C06–202

The karyotypes of *Zaocys dhumnades* and *Entechinus major* from Guizhou Province. Xu Ning, Wei Gang, Wang Jian, Li Dejun and Song Xiquan. *Dept of Biology, Zunyi Medical College, Guizhou 563003, P.R. China.* The karyotypes of *Zaocys dhumnades* and *Entechinus major* from Guizhou are reported and analysed preliminarily. The diploid numbers of both species are 36, comprising 8 pairs of macro- and 10 pairs of microchromosomes. Among the macrochromosomes of the former, pairs 1, 3, 5 and 6 are metacentric, pair 2 subtelocentric, pair 8 submetacentric. It can be found by comparison that there exist minor differences of relative length and arm ratio between specimens of the same species collected from different areas. [KEYWORDS: *Zaocys dhumnades*, *Entechinus major*, karyotype].

Yasukawa

C06–203

Sexual differences of four Japanese batagurine turtles. Yuichirou Yasukawa. *Dept of Zoology, Faculty of Science, Kyoto University, Sakyo, Kyoto, 606-01, Japan.* Sexual differences of four Japanese batagurine turtles, *Geoemyda japonica*, *Mauremys japonica*, *M. mutica*, and *Chinemys reevesii* were examined on a large number of specimens. Females of *M. japonica* and *C. reevesii* were greater than males in carapace length (CL). There were no significant differences in CL between the sexes in *G. japonica* and *M. mutica* (Honshu population). However, males of *M. mutica* were slightly greater than females in the population of the Yaeyama Group of the Ryukyu Archipelago. Proportional differences between the sexes of these four turtles were revealed by allometric comparisons. Plastral kinesis was observed only in females of *G. japonica*. Light markings disappear only in males of *C. reevesii* as melanism strengthens at the adult stage. [KEYWORDS: Batagurinae, Japan, sexual dimorphism, melanism].

Ye *et al.*

C06–205

Polymorphism and geographic distribution of skin texture of six species of amphibians in Qinghai-Xizang Plateau. Ye Changyuan, Fei Liang and Chen Suwen. *Chengdu Institute of Biology, Academia Sinica, Chengdu 610041, P. R. China.* In the present paper the polymorphism of the phenotypic texture of the skin in Amphibia is discussed. The skin texture of the variant individuals differs sharply

from that of normal individuals by having skin very rough, covered with warts, which is not correlated with sex of the individuals. The polymorphic variants (PV) of the same texture are found at present in six species of Amphibia in the southeast margin of Qinghai-Xizang plateau. Among them there are 2 species of urodeles (*Batrachuperus pinchonii*, and *B. tibetanus*) and 4 species of anurans (*Scutiger* (*Scutiger*) *boulengeri*, *S.* (*Aelurophryne*) *brevipes*, *S.* (*A.*) *mammatus* and *S.* (*A.*) *muliensis*). Based on the localities and number of PV in 4307 adults of above six species, it shows that the distribution ranges of appearing PV are very narrow and frequencies very low. That account only for 0.39–6.6% of total individuals of each species in every area, but 6.67–51.90% in the same niche. The cause of this structural polymorphism may probably be closely related to habitat. Particularly, the variants of 4 species with similar special skin character exhibit simultaneously in the same mountain stream and the proportions of the variants in these populations are correlated with inhabitable time in the water. [KEYWORDS: skin texture polymorphism, geographic distribution, Qinghai-Xizang plateau, *Scutiger*, *Batrachuperus*].

Ye *et al.*

C06–204

Study on the phylogenetic relationships of genus *Scutiger* (Anura : Pelobatidae). Ye Changyuan[1], Fei Liang[1], Wei Gang[2] and Xu Ning[2]. [1]*Chengdu Institute of Biology, Academia Sinica, Chengdu 610041, P.R. China.* [2]*Dept of Biology, Zunyi Medical College, Guizhou 563003, P.R. China.* Based on the studies of the taxonomy, geographic distribution, differentiation and phylogeny between genera of high altitude pelobatid toads, the paper deals with the comparative studies on the features of 16 species in *Scutiger*, including the external morphological features of 1867 adult specimens, the skeletal features of 51 adult specimens and the general features of the tadpoles. The phylogeny of the species of genus *Scutiger* is discussed with the main principles and methods of cladistics. It is considered that the subgenus of *S.* (*Scutiger*) may be divided into *S.* (*S.*) *pingwuensis* species group and *S.* (*S.*) *nyingchiensis* species group, and the subgenus of *S.* (*Aelurophryne*) may be divided into *S.* (*A.*) *brevipes* species group and *S.* (*A.*) *gongshanensis* species group. The paper also deals with the character of the geographic distribution, the relationship between the differentiation and the environmental changes. It is considered that the middle and northern Hengduan mountains may be the centre of the differentiation of genus *Scutiger*. The evolution of genus *Scutiger* is closely related to the uplifting of Qinghai-Xizang plateau and its adjacent areas. [KEYWORDS: Pelobatidae, *Scutiger*, phylogenetic relationship, cladistics, Qinghai-Xizang plateau].

Yeomans

C27

Turtle orientation: field tests of a water-finding ability in adult aquatic turtles. S. Rebecca Yeomans. *Savannah River Ecology Laboratory, Drawer E, Aiken, SC 29801 and Dept of Zoology, University of Georgia, Athens, GA 30602, United States of America.* Freshwater turtles live in a diversity of habitats with fluctuating water regimes. Turtles are long-lived and individuals repeatedly face the problem of surviving forced emigration that results from droughts. I tested the hypothesis that adult aquatic turtles have an ability that allows orientation to aquatic habitats. Adult yellow-bellied pond slider turtles (*Trachemys scripta*) were trapped and moved beyond their home ranges to an unfamiliar terrestrial habitat that had a single source of standing water nearby. After an acclimation period, groups of 10 turtles were released approxi-

mately 300 metres from the water's edge and out of sight of the water. Mean directions of turtles were calculated using vector addition and analysed using standard circular statistical tests. The released turtles oriented significantly in the direction of the nearest water, suggesting that pond sliders have a water-finding ability. Turtles with the ability to move to another aquatic habitat in a direct, efficient manner should have a selective advantage because reduced exposure to predators, reduced water stress, and reduced time away from feeding would lower the cost of overland travel. [KEYWORDS: orientation, turtle, water-finding, migration, drought].

Yu
S30

The report of the emercency treatment of 48 cases with respiratory arrest due to Chinese banded-krait (*Bungarus multicinctus*) bite. YU PEI-NAN. *Hospital of TCM, Wuzhou, Guangxi, China.* We report the emergency treatment in 48 cases (37 of men, 11 of women) of many system organ failure (M.S.O.F.) due to Chinese Banded-krait bite during 1974–1992. In those cases, there were 40 cases (32 of male, 8 of female) with success in treatment and on the other hand, 8 of death (5 of male, 3 of female). Use trachea intubation in 40 cases, tracheotomy in 27 cases, artificial respiration in 38 cases, simple respirator of oxygen supplying with anaesthesia machine in 10 cases. In the early stage of krait-bite, there had no significant symptoms to be recognised. So, usually, both of the patients and doctors might neglect its serious consequences. Among these 48 cases just on admission. Only 27 cases of them could be diagnosed correctly by doctors. Therefore, to make sure the early diagnosis may be the first step to get success in emergency treatment. The main principle of this snake venom is the neuro-toxin-Bungarotoxin which is one of the most toxic venom toxin of all snake species. Bungarotoxin can block nerve transmission at the neuromuscular junction.This is the main cause of patients died due to paralysis of respiratory muscle and M.S.O.F. According to this view, to effectively maintain the respiratory function is the first thing of all in the courses of treatment. To take sufficient dosage of effective snake-bite drugs is the crux of success in treatment. Specific Antivenon Serum for Chinese banded-krait is the higher.

Yu
S30

A summary of snakebite cases in Bingyang People's Hospital in Guangxi. YU YONGYAN. *Internal Medicine Section, Nanning No. 1 People's Hospital, Guangxi, China.* There are more male than female cases of snakebite among the cases reported. Bites occurred throughout the year except in the months of February and March with peaks in July and September. Bites did not occur between 5–7 a.m. with most at 20–22 p.m. Bites occurred mostly to the feet and most cases occurred in the fields. Some were bitten at home and some whilst sleeping. Most cases were cured and restored by a combination of Chinese and Western medicine.

Yuwono
S27

The trade of live reptiles and amphibians in Indonesia. FRANK BAMBANG YUWONO. *CV. Terraria Indonesia, Jl. Dr. Makaliwe Raya 24, Jakarta 11450, Indonesia.* This paper gives an overview of the live reptile and amphibian trade in Indonesia. The variety of the species involved, the geographic extent of harvest patterns and the chain of people involved are described. The varieties and harvest methods of popular species are explained. In areas where live reptiles are harvested, the trade in live reptiles quickly becomes a source of much needed cash income to people in remote

areas of Indonesia. The conservation status of the species, including the distribution, abundance and geographical varieties seem to be minimal, some species are susceptible to over-harvesting. Sustainable use and its implementation in the live reptile trade is discussed. Only a few species that are susceptible to depletion by over-harvesting need to be watched. Most common species are obnoxious by nature and will unquestionably survive the normal volume of trade. [KEYWORDS: Boidae, Varanidae, Indonesia, Wallace line, Jawa, Sumatra, Kalimantan, Sulawesi, Irian Jaya, Maluku].

Zerova
C06–207

Significance of morphological characters for partition of the genus *Vipera* s.l. GALINA A. ZEROVA. *Dept. of Paleozoology, Institute of Zoology, 15 Bogdan Khmelnitsky str., 252030 Kiev, Ukraine.* 35 characters on skull bones and 15 vertebral characters appeared to be valuable for diagnosis of vipers of the family Viperidae. Characters connected with the structure of Vidian canal and position of its anterior orifice, presence/absence and shape of basisphenoid ridge, position and length of parietal ridges as well as angle between them, shape of anterior descendent part of parietal bone, presence/absence and shape of basi-occipital process, shape and length of internal and external rami of ectopterygoid, as well as height of neural spine, shape, length and dimensions of parapophyseal processes, dimensions between prezygapophyses, postzygapophyses and pre- and postzygapophyses are supposed to be valuable for partition of the genus *Vipera* s.l. into subgenera *Vipera* s.s., *Pelias*, *Macrovipera* and *Daboia*. They might be included in the diagnosis of these taxa. Another characters might be used for determination of the above-listed bones to subfamilial or generic level. Several characters appeared to be of subspecies taxonomic value and are included in the diagnosis of Asiatic subspecies of Levantine viper *Vipera* (*Macrovipera*) *lebetina*. [KEYWORDS: subgenera, *Vipera* s.s, *Pelias*, *Macrovipera*, *Daboia*].

Zerova
C06-206

Viperinae snake complexes of ancient Mediterranean region, it's significance for biostratigraphy and paleogeography. GALINA A. ZEROVA. *Dept of Paleozoology, Institute of Zoology, 15 Bogdan Khmelnitsky str., 252030 Kiev-30, Ukraine.* History of the herpetofauna of Ukraine, being the part of the large natural-historical region — northern part of the Eastern Parathetys — comprising the part of the ancient Mediterranean region, is well documented for the period of Late Miocene (Middle Sarmatian, MN 9) until Early Pleistocene. Based on available materials especially that of the genus *Vipera* s.l. one can distinguish 8 faunistic complexes some of them being subdivided into faunistic subcomplexes in general coinciding with those being established for small and large mammals. Vipers of the subgenus *Macrovipera* occured on this territory until Early Pliocene (Pontian) (*V. (M.) kuchurganica*, locality Kuchurgan, MN 14). This find might be the evidence of the invasion of asiatic elements during apparently short- term global event for ancient Mediterranean region as so called "Messinian crisis". Vipers of the subgenus *Vipera* s.s. existed on this territory until the Middle Pliocene (MN 15), 1 and vipers of the subgenus *Pelias* - from Upper Sarmatian (MN 11b) up to the present. [KEYWORDS: vipers, Late Miocene — Early Pleistocene, Ukraine, ancient Mediterranean region, Eastern Parathetys].

Zimmermann
S25

Husbandry, breeding and conservation of 'dart-poison' frogs; a long-term project of the DGHT anuran specialist group. HELMUT ZIMMERMANN. *DGHT*

Anuran Specialist Group, D-70597 Stuttgart, Abraham - Wolf Strasse 39, Germany. During the last 20 years, husbandry and breeding of more than 40 species of 'dart-poison frogs' (family Dendrobatidae) were examined by members of the DGHT Anuran Specialist Group. As a result, unique reproductive strategies were discovered and analysed. Previously unknown "egg-feeding" behaviour was revealed in *Dendrobates granuliferus*, *D. histrionicus*, *D. lehmanni*, *D. pumilio* and *D. speciosus*. More than 12,000 froglets from 39 species were bred over the last 10 years, through breeding programs established and managed by 15 co-ordinators in the Group. The efforts of the Group will be outlined through the long-term breeding program of the rare *D. variabilis*. [KEYWORDS: Dendrobatidae, reproduction, management, *Dendrobates variabilis*].

Zuffi & Macchia

C27

Home-range and activity patterns of *Vipera aspis*; in a Mediterranean ambience during spring. MARCO A.L. ZUFFI AND MARINA MACCHIA. *Museo di Storia Naturale e del Territorio, Università di Pisa, via Roma 103 56011 Calci (Pisa), Italy.* Home-range, activity patterns and movements of the asp viper, *Vipera aspis*, were studied in a few occasions only in different habitat and climate (Naulleau 1966; Monney 1988). The Ciofi and Chelazzi's (1991) method was employed in radio-tracking 2 adult males and 3 adult females, from February to May 1993, a female of which from December 1992 to February 1993, in a 3.9 ha triangular shaped area, 3 km East from the Thyrrhenian Sea (Tuscany, C-Italy). On average each specimen was radio-tracked along a 70 day period. Home-range was calculated with the 95% Ellipse estimator (Jennrich and Turner 1969), but comparisons with Minimum Convex Polygon (Mohr 1947) were also made. Males had wider home-ranges than those of females (89,000 m^2, 16,500 m^2 and 8.38 m^2, 381.22 m^2, 25,700 m^2 respectively). Longer was the viper and wider was its home-range (Regression Analysis: c=0.68, r^2 = 46.65%), whilst heavier was the viper and narrower was its home-range (c = 0.546, r^2 = 29.80%). Home-ranges of males were greater in March and April (i.e. during mating time), than in February or in May; female home-ranges were extremely little in early spring and tend to be relatively wider in late season. Males performed most long movements especially during the mating season, females moved much less than males (i.e. during their feeding period); both sexes reduced their displacements during foraging activities, after the mating period. The winter female was active underground to 15–30cm depth from 13 to 26 December 1992 and from 28 January 1993 to 4 February 1993; in this first period she moved 75 m (11.3±1.45°C air; N=3, 13:00 hour), following the Southwestern border of the study area; in the second period she was inactive (10.35±1.08°C air; N=17, 13:00 hour); in the last period (5.87±0.9°C air, N=4, 13:00 hour) she begun moving for a few cm only, just before emerging from hibernation site. [KEYWORDS: home-range, activity patterns, *Vipera aspis*, Mediterranean area, C-Italy].

Zuiderwijk

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Patterns of declines and disjunctions in amphibian distributions in relation to the rise of mountain chains in the Western Palearctic during the Miocene. ANNIE ZUIDERWIJK. *Institute of Taxonomic Zoology, University of Amsterdam, Postbox 4766, 1009 AT Amsterdam, The Netherlands.* Divergences of amphibian lineages to the modern genera predate the Tertiary; divergence of lineages to subgenera and species groups are estimated to have occurred in the Early Tertiary; whereas the lineages of the modern (super)species most often trace back into the Mid Tertiary. These calculations

come from biochemical studies on protein evolution. Fossil data (especially available in Miocene and Pliocene sediments) corroborate the estimated ages of lineages. Major physiogeographic events caused considerable impact through time on amphibian distributions. The severe climate deterioration at the Eocene- Oligocene transition, "Le Grand Coupure" caused the extinction of three-fourths of the fauna. This paper is focussed on physiogeographic events during the Miocene. Several sister-groups, born in this period, show an east/west vicariance in Europe, like *Triturus cristatus* superspecies and *T. marmoratus*, *T. vulgaris* and *T. helveticus*; or a north/south vicariance in Turkey, like the *Triturus vittatus* subspecies. Other lineages, *Salamandra terrestris*, *Triturus alpestris*, *Bufo bufo*, *Rana temporaria*, did not diverge. The latter taxa are mountain (and lowland) dwelling species; the former group are non-alpine species. During this period of speciation, the final structuring of mountain chains, like the Alps and the Neo-Pyrenees in Europe, and the Taurus Mts in Turkey, took place. These mountain chains, in combination with changes in climate and sealevel, were barriers to non-alpine species for millions of years. Non-alpine species were most probably affected by the fragmentation of their range. The impact of area fragmentation and contraction through time is worked out for several taxa. [KEYWORDS: biogeography, paleoecology, Miocene, amphibians, vicariance].

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Production Notes

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Input and input processing

Submitted hard-copy abstracts were scanned using a Hewlett-Packard ScanJet II monochrome scanner[1]. OmniPage Direct optical character recognition (OCR) software was used in conjunction with Microsoft Word for Windows 2 to convert the scanned image to editable text. Microsoft Word for Windows 2 was used for minor copy editing, and the insertion of the majority of LaTeX typesetting codes using Microsoft WordBasic macro commands. The Word for Windows file was saved as "text-only-with-line-breaks" and transferred to a MicroVAX 3100/90. The Ludwig text editor was used for further editing and insertion of the final LaTeX codes.

Output

The abstracts were typeset in Computer Modern (CM) Roman and CM Sans Serif using LaTeX typesetting software on the MicroVAX. Two runs of LaTeX were needed to allow the preparation of the author index. The final `.DVI` file was converted to postscript code with PSPRINT 3.0. The camera-ready copy was printed on an NEC SilentWriter 300 dpi laser printer.

[1] We gratefully acknowledge the assistance of the Department of Botany, The University of Adelaide, for allowing us access to their scanner and OCR software.