

Recent Publications on Asian Elephants

Compiled by Jennifer Pastorini

Anthropologisches Institut, Universität Zürich, Zürich, Switzerland

Centre for Conservation and Research, Rajagiriya, Sri Lanka

E-mail: jenny@aim.uzh.ch

If you need additional information on any of the articles, please feel free to contact me. You can also let me know about new (2013) publications on Asian elephants.

M.J. Adkesson, R.E. Junge, M.C. Allender & T. Martín-Jiménez

Pharmacokinetics of a long-acting ceftiofur crystalline-free acid formulation in Asian elephants (*Elephas maximus*)

American Journal of Veterinary Research 73 (2012) 1512-1518

Abstract. Objective—To determine the pharmacokinetics of a long-acting formulation of ceftiofur, ceftiofur crystalline-free acid (CCFA), following SC injection to Asian elephants (*Elephas maximus*). Animals—11 adult Asian elephants. Procedures—Each elephant received CCFA (6.6 mg/kg, SC) in the area caudoventral to the base of an ear. Blood samples were collected from an ear vein immediately prior to and at 0.5, 1, 2, 4, 8, 12, 24, 36, 48, 72, 96, 120, 144, and 168 hours after CCFA administration. Plasma concentrations of desfuroylceftiofur acetamide (the acetamide derivative of ceftiofur) were measured via ultrahigh-pressure liquid chromatography–tandem mass spectrometry. Data were analyzed via a noncompartmental pharmacokinetics approach. Results—The mean \pm SD maximum plasma concentration of desfuroylceftiofur acetamide was 1.36 ± 0.74 $\mu\text{g}/\text{mL}$ and was detected at 4718 ± 31.30 hours. The mean \pm SD area under the curve from time 0 to infinity was 2278 ± 55.8 $\mu\text{g}\cdot\text{h}/\text{mL}$, and the mean residence time from time 0 to infinity was 158.2 ± 90.2 hours. The terminal elimination half-life associated with the slope of the terminal phase had a harmonic mean \pm pseudo-SD of 83.36 ± 30.01 hours. Conclusions and Clinical Relevance—Elephants tolerated CCFA at a dose of 6.6 mg/kg,

SC, well. Dosing recommendations will depend on the mean inhibitory concentration of ceftiofur for each bacterial pathogen. Desfuroylceftiofur acetamide concentrations remained >0.25 $\mu\text{g}/\text{mL}$ for the entire 168-hour study period, which suggested CCFA would provide clinically relevant antimicrobial activity against certain pathogens for 7 to 10 days.

F.S. Ahrestani, I.M.A. Heitkönig & H.H.T. Prins Diet and habitat-niche relationships within an assemblage of large herbivores in a seasonal tropical forest

Journal of Tropical Ecology 28 (2012) 385-394

Abstract. There is little understanding of how large mammalian herbivores in Asia partition habitat and forage resources, and vary their diet and habitat selection seasonally in order to coexist. We studied an assemblage of four large herbivores, chital (*Axis axis*), sambar (*Cervus unicolor*), gaur (*Bos gaurus*) and Asian elephant (*Elephas maximus*), in the seasonal tropical forests of Bandipur and Mudumalai, South India, and tested predictions regarding the species' seasonal diet browse : graze ratios, habitat selection and habitat-niche preference and overlap. Field data collected for the study included the seasonal variation in grass quality, the seasonal variation in $\delta^{13}\text{C}$ in the species' faeces and the seasonal variation in the species' habitat selection and overlap using a grid-based survey. Results of the $\delta^{13}\text{C}$ analyses showed that the chital was more of a grazer in the wet season (-17.9‰ to -21.6‰), but that it increased the proportion of browse in its diet in the dry season (-25.6‰ to -27.7‰); the gaur was a grazer for most of the year (-15.3‰ to -18.6‰); the sambar preferred to browse throughout the year (-21.1‰ to -30.4‰); and that the elephant was a mixed feeder (-14.2‰ to -21.4‰). Elephant

habitat-niche breadth was high (0.53 in wet and 0.54 in dry) and overlapped equally with that of the other species in both seasons (0.39–0.94). The gaur had the most restricted habitat-niche breadth in both seasons (0.25 in wet and 0.28 in dry), and it switched from the moist deciduous habitat in the dry season to the dry deciduous habitat in the wet season. These results offer the first insights into the seasonal variation in browse : graze diet ratios and the habitat-niche overlap amongst the common largest-bodied mammalian herbivore species found in South India. © 2012 Cambridge University Press.

F. Bibi, B. Kraatz, N. Craig, M. Beech, M. Schuster & A. Hill

Early evidence for complex social structure in Proboscidea from a late Miocene trackway site in the United Arab Emirates

Biology Letters 8 (2012) 670-673

Abstract. Many living vertebrates exhibit complex social structures, evidence for the antiquity of which is limited to rare and exceptional fossil finds. Living elephants possess a characteristic social structure that is sex-segregated and multitiered, centred around a matriarchal family and solitary or loosely associated groups of adult males. Although the fossil record of Proboscidea is extensive, the origin and evolution of social structure in this clade is virtually unknown. Here, we present imagery and analyses of an extensive late Miocene fossil trackway site from the United Arab Emirates. The site of Mleisa 1 preserves exceptionally long trackways of a herd of at least 13 individuals of varying size transected by that of a single large individual, indicating the presence of both herding and solitary social modes. Trackway stride lengths and resulting body mass estimates indicate that the solitary individual was also the largest and therefore most likely a male. Sexual determination for the herd is equivocal, but the body size profile and number of individuals are commensurate with those of a modern elephant family unit. The Mleisa 1 trackways provide direct evidence for the antiquity of characteristic and complex social structure in Proboscidea. © 2012 The Royal Society.

N.C. Boedeker, L.-A.C. Hayek, S. Murray, D.M. de Avila & J.L. Brown

Effects of a gonadotropin-releasing hormone vaccine on ovarian cyclicity and uterine morphology of an Asian elephant (*Elephas maximus*)

Journal of Zoo and Wildlife Medicine 43 (2012) 603-614

Abstract. This report describes the successful use of a gonadotropin-releasing hormone (GnRH) vaccine to suppress ovarian steroidogenic activity and to treat hemorrhage and anemia associated with reproductive tract pathology in a 59-year-old Asian elephant (*Elephas maximus*). The Repro-BLOC® GnRH vaccine was administered subcutaneously as a series of 4 boosters of increasing dose from 3 to 30 mg of recombinant ovalbumin-GnRH fusion protein given at variable intervals after initial vaccination with 3 mg protein. Efficacy was confirmed over a year after initial vaccination based on complete ovarian cycle suppression determined by serum progesterone analyses. Estrous cycle suppression was associated with a significant increase in GnRH antibody binding and subsequent decrease in serum luteinizing hormone and follicle-stimulating hormone concentrations. Ultrasonographic examinations of the reproductive tract documented a reduction in uterine size and vascularity after immunization. The hematocrit level normalized soon after the initial intrauterine hemorrhage, and no recurrence of anemia has been detected. No substantive adverse effects were associated with GnRH vaccination. The results indicate that GnRH vaccination in elephants shows potential for contraception and management of uterine pathology in older elephants. © 2012 American Association of Zoo Veterinarians.

A. Herler & A.S. Stoeger

Vocalizations and associated behaviour of Asian elephant (*Elephas maximus*) calves

Behaviour 149 (2012) 575-599

Abstract. The present study describes the acoustic structure and associated behavioural contexts of vocalizations of Asian elephant calves. Three hundred twenty-seven vocalizations of six calves aged between 6 and 27 months were recorded at the Emmen and the

Cologne zoo. Based on temporal and structural characteristics including nonlinear phenomena, we structurally distinguished four call types, the rumble, the roar, the chirp and the trumpet. Most vocalizations were uttered during all forms of play behaviour, with chirps and trumpets dominating here. Rumbles were mainly recorded in combination with roars; the latter were highly chaotic in structure and associated with higher arousal contexts (e.g., being separated from the mother). These first insights into the vocal behaviour of Asian elephant calves reveal that calf vocalizations clearly differ in acoustic structure and application from those of adults and older juveniles. This highlights the importance of investigating the vocal ontogeny of elephants as well as other species having a long adolescence and developmental period. © 2012 Koninklijke Brill NV, Leiden.

A.P. Brock, R. Isaza, R.P. Hunter, L.K. Richman, R.J. Montali, D.L. Schmitt, D.E. Koch & W.A. Lindsay

Estimates of the pharmacokinetics of famciclovir and its active metabolite penciclovir in young Asian elephants (*Elephas maximus*)

American Journal of Veterinary Research 73 (2012) 1996-2000

Abstract. OBJECTIVE—To determine plasma pharmacokinetics of penciclovir following oral and rectal administration of famciclovir to young Asian elephants (*Elephas maximus*). ANIMALS—6 healthy Asian elephants (5 females and 1 male), 4.5 to 9 years old and weighing 1646 to 2438 kg. PROCEDURES—Famciclovir was administered orally or rectally in accordance with an incomplete crossover design. Three treatment groups, each comprising 4 elephants, received single doses of famciclovir (5 mg/kg, PO, or 5 or 15 mg/kg, rectally); there was a minimum 12-week washout period between subsequent famciclovir administrations. Serial blood samples were collected after each administration. Samples were analyzed for famciclovir and penciclovir with a validated liquid chromatography–mass spectroscopy assay. RESULTS—Famciclovir was tolerated well for both routes of administration and underwent complete biotransformation to the active

metabolite, penciclovir. Mean maximum plasma concentration of penciclovir was 1.3 µg/ml at 1.1 hours after oral administration of 5 mg/kg. Similar results were detected after rectal administration of 5 mg/kg. Mean maximum plasma concentration was 3.6 µg/ml at 0.66 hours after rectal administration of 15 mg/kg; this concentration was similar to results reported for humans receiving 7 mg/kg orally. CONCLUSIONS AND CLINICAL RELEVANCE—Juvenile elephants are susceptible to elephant endotheliotropic herpesvirus. Although most infections are fatal, case reports indicate administration of famciclovir has been associated with survival of 3 elephants. In Asian elephants, a dose of 8 to 15 mg of famciclovir/kg given orally or rectally at least every 8 hours may result in penciclovir concentrations that are considered therapeutic in humans.

M.J. Brunnermeier, S.A.K. Schmied, M. Muller-Boge & R. Schupfner

Dating of ivory from 20th century by determination of C-14 by the direct absorption method

Appl. Radiation & Isotopes 70 (2012) 1595-1602

Abstract. We aim to date ivory samples by determination of the concentration of C-14 in the sample. However, such data do not always represent unambiguous evidence. In these cases other nuclides have to be additionally analyzed which causes additional costs. To make the dating method still affordable, the direct CO₂ absorption method for analyzing C-14 was tested. Results show that this method has a precision of about 4.0% (95% confidence level), which is good enough for this purpose. © 2011 with permission from Elsevier.



Kaudulla National Park (Sri Lanka)

A. Campos-Arceiz & S. Blake

Megagardeners of the forest - the role of elephants in seed dispersal

Acta Oecologica 37 (2011) 542-553

Abstract. As the largest frugivores on earth, elephants have unique ecological properties. Found in deserts, savannahs, and forests, they are the last remnants of a diverse lineage. Among the three currently recognized forms, African forest elephants are the most frugivorous, followed by Asian and African savannah elephants, although their role as seed dispersers is variable and context-dependent. African forest elephants may consume more seeds from more species than any other taxon of large vertebrate dispersers, defecating them over long distances in viable conditions into nutrient-rich and protective dung. In short, elephants are forest gardeners. The signature of elephant dispersal is evident in the spatial distribution of trees suggesting that elephants maintain tree diversity and retain low redundancy in seed dispersal systems. Large numbers of forest elephants ranging over large areas may be essential for ecosystem function. The loss of elephants will have important negative consequences for the ecological trajectories of some plant species and whole ecological communities, yet the conservation status of forest elephants is catastrophic in Asia and rapidly becoming so in Africa due to hunting and other conflicts with people. In this paper we review the current knowledge of elephants as seed dispersers, discuss the ecological consequences of their decline, and suggest priority areas for research and conservation action. © 2011 Elsevier Masson SAS.

K. Conrad

Trade bans: a perfect storm for poaching?

Tropical Conservation Science 5 (2012) 245-254

Abstract. Since CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) ratification 40 years ago, trade bans have emerged as a principle conservation tool for endangered species. While trade bans have been successful in helping to stabilize populations of certain species, evidence for others suggests that such bans are proving less effective. Looking at three species, the author identifies and explores a conflux of forces

that, in the context of a trade ban, may result in an increase of illegal trade, further threatening a species already at risk. These forces include 1) inelastic demand and high profit potential, 2) long history of trade, both legal and illegal, coupled with strong cultural affiliation, 3) ambiguous property rights, 4) negative economic incentives for conservation due to human-animal conflict, and 5) inadequate enforcement. Termed a "Perfect Storm", these forces combine to accelerate the demise of the species. In essence, a trade ban hands a monopoly on commerce to the black market. It is even possible that the trade ban protects the illegal market against competition, suggesting that other conservation tactics warrant consideration. The author concludes that legal, regulated trade needs to be fully investigated using fields of science that have evolved during CITES lifetime to determine if it is a viable tactic for conservation when such conditions exist. © 2012 The Author.

A.J. Curtin, A.A. Macdowell, E.G. Schaible & V.L. Roth

Noninvasive histological comparison of bone growth patterns among fossil and extant neonatal elephantids using synchrotron radiation X-ray microtomography

J. of Vertebrate Paleontology 32 (2012) 939-955

Abstract. How is the bone tissue in skeletal supports of a neonatal elephant organized, and how does this histological structure differ among the neonates of modern species, mammoths, and insular dwarfs? We used synchrotron X-ray microtomography (SR- μ CT) to obtain high-resolution image-‘slices’ noninvasively, from the femoral and tibial diaphyses of neonatal African elephants, a young juvenile Asian elephant, Columbian mammoths, and California Channel Island pygmy mammoths. The results compared favourably in level of detail with histological sectioning, but without the shrinkage, distortion, or loss of tissue inevitable with histology. From the tomography images we were able to rank by ontogenetic stage specimens of taxa that are otherwise difficult to categorize because they vary greatly in size; from these images we observed that laminar fibrolamellar bone predominated and were able to quantify vascular patterns. Bones of the Columbian mammoth

typically had the thickest and largest number of laminae, whereas the insular dwarfs were notable in their variability. A distinct change in tissue microstructure marks the boundary between prenatal and postnatal periosteal bone deposition. Qualitatively, patterns of early bone growth of elephantids resemble those in many young tetrapods that grow into large adults, including sauropod dinosaurs. © 2012 by the Society of Vertebrate Paleontology.

D. Denk, M.F. Stidworthy, S. Redrobe, E. Latimer, G.S. Hayward, J. Cracknell, A. Claessens, F. Steinbach, S. McGowan & A. Dastjerdi

Fatal elephant endotheliotropic herpesvirus type 5 infection in a captive Asian elephant

Veterinary Record 171 (2012) 380-381

Abstract. none.

S. de Silva & G. Wittemyer

A comparison of social organization in Asian elephants and African savannah elephants

Internat. J. of Primatology 33 (2012) 1125-1141

Abstract. Asian and African elephant species have diverged by ca. 6 million years, but as large, generalist herbivores they occupy similar niches in their respective environments. Although the multilevel, hierarchical nature of African savannah elephant societies is well established, it has been unclear whether Asian elephants behave similarly. Here we quantitatively compare the structure of both species' societies using association data collected using the same protocol over similar time periods. Sociality in both species demonstrates well-defined structure, but in contrast to the African elephants of Samburu the Uda Walawe Asian elephants are found in smaller groups, do not maintain coherent core groups, demonstrate markedly less social connectivity at the population level, and are socially less influenced by seasonal differences in ecological conditions. The Uda Walawe Asian elephants, however, do maintain a complex, well-networked society consisting of ≥ 2 differentiated types of associates we term ephemeral and long-term affiliates. These findings imply we must broaden our recognition of multilevel social organization to encompass societies that fall along a gradient of nestedness, and not merely

those that exhibit hierarchical nesting. This in turn suggests that multilevel structures may be more diverse and widespread than generally thought, and that phylogenetic comparisons within species-rich clades, such as that of primates, using the methods presented can provide fresh insights into their socioecological basis. © 2012 Springer Science+Business Media, LLC.

J.G. Estes, N. Othman, S. Ismail, M. Ancrenaz, B. Goossens, L.N. Ambu, A.B. Estes & P.A. Palmiotto

Quantity and Configuration of available elephant habitat and related conservation concerns in the Lower Kinabatangan Floodplain of Sabah, Malaysia

PLoS ONE 7 (2012) e44601

Abstract. The approximately 300 (298, 95% CI: 152–581) elephants in the Lower Kinabatangan Managed Elephant Range in Sabah, Malaysian Borneo are a priority sub-population for Borneo's total elephant population (2040, 95% CI: 1184–3652). Habitat loss and human-elephant conflict are recognized as the major threats to Bornean elephant survival. In the Kinabatangan region, human settlements and agricultural development for oil palm drive an intense fragmentation process. Electric fences guard against elephant crop raiding but also remove access to suitable habitat patches. We conducted expert opinion-based least-cost analyses, to model the quantity and configuration of available suitable elephant habitat in the Lower Kinabatangan, and called this the Elephant Habitat Linkage. At 184 km², our estimate of available habitat is 54% smaller than the estimate used in the State's Elephant Action Plan for the Lower Kinabatangan Managed Elephant Range (400 km²). During high flood levels, available habitat is reduced to only 61 km². As a consequence, short-term elephant densities are likely to surge during floods to 4.83 km⁻² (95% CI: 2.46–9.41), among the highest estimated for forest-dwelling elephants in Asia or Africa. During severe floods, the configuration of remaining elephant habitat and the surge in elephant density may put two villages at elevated risk of human-elephant conflict. Lower Kinabatangan elephants are vulnerable to the natural disturbance regime of the river due to their limited dispersal options. Twenty

bottlenecks less than one km wide throughout the Elephant Habitat Linkage, have the potential to further reduce access to suitable habitat. Rebuilding landscape connectivity to isolated habitat patches and to the North Kinabatangan Managed Elephant Range (less than 35 km inland) are conservation priorities that would increase the quantity of available habitat, and may work as a mechanism to allow population release, lower elephant density, reduce human-elephant conflict, and enable genetic mixing. © 2012 The Authors.

A.A. Farouq, D.K. Abdullah, F. Hooi-Ling & N. Abdullah

Isolation and characterization of coprophilous cellulolytic fungi from Asian elephant (*Elephas maximus*) dung

Journal of Biology, Agriculture and Healthcare 2 (2012) 44-51

Abstract. A lot of work has been done on isolation of cellulolytic fungi from the natural environment, but no such work was done on Asian elephant dung in Malaysia. Fungi that grow on elephant dung, which is full of fibres may serve as a source of potential cellulase enzymes. Commercial cellulase enzymes used for the hydrolysis of lignocellulose biomass are not only expensive, but may as well hinder progress in the bioethanol industry. In this study, eight new fungi were isolated from Asian elephant dung sourced from Malaysian forest reserve. The fungi were identified morphologically and by molecular assay. The sequences of the fungi were deposited in the Gen Bank NCBI and were assigned accession numbers. Phylogenetic tree of the fungi was constructed to show similarities of the new fungi to known strains. The fungi were tested



‘Silindu’ waiting to be translocated (Sri Lanka)

for cellulolytic potential using carboxymethyl cellulose (CMC). *Trichoderma aureoviride* strain UPM 09 (JN811061) and *Fusarium equiseti* strain UPM 09 (JN811063) proved to be potential cellulolytic fungi. This study shows that nature harbors the best cellulolytic fungi for biotechnological applications yet to be exploited.

P. Fernando, P. Leimgruber, T. Prasad & J. Pastorini

Problem-elephant translocation: Translocating the problem and the elephant?

PLoS ONE 7 (2012) e50917

Abstract. Human-elephant conflict (HEC) threatens the survival of endangered Asian elephants. Translocating “problem-elephants” is an important HEC mitigation and elephant conservation strategy across elephant range, with hundreds translocated annually. In the first comprehensive assessment of elephant translocation, we monitored 16 translocations in Sri Lanka with GPS collars. All translocated elephants were released into national parks. Two were killed within the parks where they were released, while all the others left those parks. Translocated elephants showed variable responses: “homers” returned to the capture site, “wanderers” ranged widely, and “settlers” established home ranges in new areas soon after release. Translocation caused wider propagation and intensification of HEC, and increased elephant mortality. We conclude that translocation defeats both HEC mitigation and elephant conservation goals. © 2012 The Authors.

The status of large mammals in eastern Cambodia: a review of camera trapping data 1999–2007

T.N.E. Gray, R. Ou, K. Huy, C. Pin & A.L. Maxwell

Cambodian Journal of Natural History 2012 (2012) 42–55

Abstract. The seasonally dry forests of eastern Cambodia form a globally important area for biodiversity conservation. Between 1999 and 2007, the World Wide Fund for Nature (WWF) and government counterparts from the Forestry Administration and the Ministry of the Environment undertook extensive camera trapping in semi-evergreen and deciduous

dipterocarp forests throughout eastern Cambodia. More than 400 locations across nine sites were camera-trapped. Threatened large mammals were recorded from all sites, with the total number of threatened species recorded per site between 16 (Mondulkiri Protected Forest, Mondulkiri Province) and one (Prek Prasab, Kratie Province). Important records, never previously published, include the most recent tiger *Panthera tigris* camera trap records from Cambodia, the only wild water buffalo *Bubalus arnee* camera trap records from Indochina, and Eld's deer *Cervus eldii* and dhole *Cuon alpinus* from five and seven sites respectively. We discuss the implications of the camera trap records upon the status and ecology of selected large mammals in eastern Cambodia. Because only two of the nine camera trapping sites (Phnom Prich Wildlife Sanctuary and Mondulkiri Protected Forest) currently receive relatively effective protection, it is likely that some of the species documented in this paper have already become locally extirpated by hunting or habitat degradation.

S. Harikrishnan, K. Vasudevan, A. Udhayan & P.K. Mathur

Biodiversity values of abandoned teak, *Tectona grandis* plantations in southern Western Ghats: Is there a need for management intervention?

Basic and Applied Ecology 13 (2012) 139-148

Abstract. Abandoned plantations could potentially support a large number of native tree species through succession and restore the original tree community. In order to assess the ability of abandoned teak plantations to recover through regeneration, teak stands from 29 to 80 years old were sampled for seedling and sapling density, species richness and the use by large ungulates in the southern Western Ghats using 10 m circular plots. The influence of the forest-plantation edge was also studied. There was regeneration of a species-rich tree community in the understorey of abandoned teak plantations. However, regeneration was arrested, and thereby the large girth-class tree community remained species-poor. There was no significant change in the tree species richness with distance from natural forest, suggesting that the forest-plantation edge had little influence on the penetration of native

tree species inside plantations. Asian elephant and Indian gaur dung densities were significantly lower in the plantations than in the forest. Indian gaur and sambar used the younger plantations intensively, and the density of their dung was negatively correlated with age of the plantation. Abandonment of mature teak stands arrested the succession of native trees. We provide evidence that abandoned teak plantations might not serve as suitable habitats for large herbivores during the dry months of the year in the region. The study highlights the need for active management of mature teak plantations inside wildlife reserves, in order to promote succession and improve the habitat for wild flora and fauna in the Western Ghats. © 2012 Gesellschaft für Ökologie. Published by Elsevier GmbH.

P. Imrat, S. Mahasawangkul, J. Gosálvez, P. Suthanmapinanth, P. Sombutputorn, S. Jansittiwate, N. Thongtip, A. Pinyopummin, B. Colenbrander, W. V. Holt & T.A.E. Stout

Effect of cooled storage on quality and DNA integrity of Asian elephant (*Elephas maximus*) spermatozoa

Reproduction, Fertility and Development 24 (2012) 1105-1116

Abstract. Artificial insemination (AI) is a potentially useful tool for breeding captive elephants because it facilitates efforts to minimise inbreeding. However, cooled storage of elephant semen markedly reduces fertility. This study compared the effects on semen-quality parameters, including sperm DNA fragmentation, of storing elephant semen at 4°C or 15°C in a commonly-used diluent (TEST) or a diluent developed to protect against sperm DNA damage (BullMax). Storing elephant semen for >24 h in either extender at either temperature resulted in decreases in sperm motility, viability, acrosome integrity and DNA integrity ($P < 0.05$); the decrease in motility was especially rapid. A subjective impression of circular sperm movement in TEST was confirmed by a higher curvilinear velocity and amplitude of lateral head displacement, but lower straight-line velocity and linearity than in BullMax. Initial percentages of spermatozoa with fragmented DNA (%SDF) did not differ between extenders or temperatures, but the rate of increase in %SDF during a 48-h

incubation at 37°C was higher in TEST than in BullMax ($P < 0.05$). In conclusion, BullMax allows more linear movement and better preserves DNA stability of stored elephant spermatozoa than TEST. Sperm DNA stability during incubation at 37°C is a promising, discriminative parameter for selecting semen storage conditions of bulls for elephant AI.

S. Jadhav & M. Barua

The elephant vanishes: Impact of human–elephant conflict on people’s wellbeing

Health & Place 18 (2012) 1356-1365

Abstract. Human-wildlife conflicts impact upon the wellbeing of marginalised people, worldwide. Although tangible losses from such conflicts are well documented, hidden health consequences remain under-researched. Based on preliminary clinical ethnographic inquiries and sustained fieldwork in Assam, India, this paper documents mental health antecedents and consequences including severe untreated psychiatric morbidity and substance abuse. The case studies presented make visible the hidden mental health dimensions of human–elephant conflict. The paper illustrates how health impacts of conflicts penetrate far deeper than immediate physical threat from elephants, worsens pre-existing mental illness of marginalised people, and leads to newer psychiatric and social pathologies. These conflicts are enacted and perpetuated in institutional spaces of inequality. The authors argue that both wildlife conservation and community mental health disciplines would be enhanced by coordinated intervention. The paper concludes by generating questions that are fundamental for a new interdisciplinary paradigm that bridges ecology and the clinic. © 2012 with permission from Elsevier.

W.K. Kiso, A. Asano, A.J. Travis, D.L. Schmitt, J.L. Brown & B.S. Pukazhenth

Pretreatment of Asian elephant (*Elephas maximus*) spermatozoa with cholesterol-loaded cyclodextrins and glycerol addition at 4°C improves cryosurvival

Reproduction, Fertility and Development 24 (2012) 1134-1142

Abstract. Asian elephant spermatozoa are sensitive to chilling and do not respond well to

cryopreservation. The objectives of the present study were to: (1) determine whether cholesterol content can be modified by preincubation of Asian elephant spermatozoa with cholesterol-loaded cyclodextrin (CLC); and (2) assess the effects of CLC concentration(s), temperature at time of glycerol addition (22°C vs 4°C) and dilution medium on post-thaw sperm survival. Spermatozoa incubated with ≥ 1.5 mg CLC exhibited increased ($P < 0.05$) cholesterol concentrations. Pretreatment of spermatozoa with 1.5 mg CLC resulted in improvements ($P < 0.05$) in all post-thaw parameters. Glycerol addition at 4°C also improved all post-thaw parameters compared with 22°C. Dilution of thawed spermatozoa in an egg yolk-based medium improved ($P < 0.05$) motility compared with Ham’s F-10 culture medium. In summary, our findings indicate that modifying cholesterol content within the plasma membrane improves the cryosurvival of Asian elephant spermatozoa. The development of an improved cryopreservation method that includes modification of membrane cholesterol and the addition of glycerol at 4°C, as reported in the present study, is an important step towards utilisation of cryopreserved spermatozoa in captive management of this species.

T.T.C. Lin

Cross-platform framing and cross-cultural adaptation: Examining elephant conservation in Thailand

Environmental Communication 6 (2012) 193-211

Abstract. This case study investigates cross-platform framing process and framing alignment strategies of the world famous elephant conservation NGO. It examines how the intercultural adaptation facilitates the frame transformation against entrenched domesticated elephant traditions in Thailand. Besides web observation, this study conducted two field trips to interview the NGO staff and conservation experts, and observed human–elephant interaction. Enhancing the understanding of ecotourism, this study expands the framing theory by incorporating cross-platform and cross-cultural adaptation factors and provides insights of an effective Asian ecotourism model which transcends cultural differences and overcomes resistance by disseminating culturally sensitive

and integrated framing strategies through various communication channels. © 2012 Taylor & Francis.

I. Lueders, K. Taya, G. Watanabe, Y. Yamamoto, T. Yamamoto, S. Kaewmanee, C.A. Niemuller, C. Gray, W.J. Streich & T.B. Hildebrandt

Role of the double luteinizing hormone peak, luteinizing follicles, and the secretion of inhibin for dominant follicle selection in Asian elephants (*Elephas maximus*)

Biology of Reproduction 85 (2011) 714-720

Abstract. No permission to print it.

I. Lueders, C. Niemuller, P. Rich, C. Gray, R. Hermes, F. Goeritz & T.B. Hildebrandt

Gestating for 22 months: luteal development and pregnancy maintenance in elephants

Proc. of the Royal Society B 279 (2012) 3687-96

Abstract. The corpus luteum, a temporally established endocrine gland, formed on the ovary from remaining cells of the ovulated follicle, plays a key role in maintaining the early mammalian pregnancy by secreting progesterone. Despite being a monovular species, 2–12 corpora lutea (CLs) were found on the elephant ovaries during their long pregnancy lasting on average 640 days. However, the function and the formation of the additional CLs and their meaning remain unexplained. Here, we show from the example of the elephant, the close relationship between the maternally determined luteal phase length, the formation of multiple luteal structures and their progestagen secretion, the timespan of early embryonic development until implantation and maternal recognition. Through three-dimensional and Colour Flow ultrasonography of the ovaries and the uterus, we conclude that pregnant elephants maintain active CL throughout gestation that appear as main source of progestagens. Two LH peaks during the follicular phase ensure the development of a set of 5.4 ± 2.7 CLs. Accessory CLs (acCLs) form prior to ovulation after the first luteinizing hormone (LH) peak, while the ovulatory CL (ovCL) forms after the second LH peak. After five to six weeks (the normal luteal phase lifespan), all existing CLs begin to regress. However, they resume growing as soon as an embryo becomes ultrasonographically apparent on day 49 ± 2 . After

this time, all pregnancy CLs grow significantly larger than in a non-conceptive luteal phase and are maintained until after parturition. The long luteal phase is congruent with a slow early embryonic development and luteal rescue only starts '1st minute', with presumed implantation of the embryo. Our findings demonstrate a highly successful reproductive solution, different from currently described mammalian models. © 2012 The Royal Society.

K.P. Lyashchenko, R. Greenwald, J. Esfandiari, S. Mikota, M. Miller, T. Moller, L. Vogelnest, K.P. Gairhe, S. Robbe-Austerman, J. Gai & W.R. Waters

Field application of serodiagnostics to identify elephants with tuberculosis prior to case confirmation by culture

Clinical and Vaccine Immunology 19 (2012) 1269-1275

Abstract. Three serologic methods for antibody detection in elephant tuberculosis (TB), the multiantigen print immunoassay (MAPIA), ElephantTB STAT-PAK kit, and DPP VetTB test, were evaluated using serial serum samples from 14 captive elephants infected with *Mycobacterium tuberculosis* in 5 countries. In all cases, serological testing was performed prior to the diagnosis of TB by mycobacterial culture of trunk wash or tissue samples collected at necropsy. All elephants produced antibody responses to *M. tuberculosis* antigens, with 13/14 recognizing ESAT-6 and/or CFP10 proteins. The findings supported the high serodiagnostic test accuracy in detecting infections months to years before *M. tuberculosis* could be isolated from elephants. The MAPIA and/or DPP VetTB assay demonstrated the potential for monitoring antimycobacterial therapy and predicting TB relapse in treated elephants when continuously used in the posttreatment period. History of exposure to TB and past treatment information should be taken into consideration for proper interpretation of the antibody test results. Data suggest that the more frequent trunk wash culture testing of seropositive elephants may enhance the efficiency of the TB diagnostic algorithm, leading to earlier treatment with improved outcomes. © 2012 American Society for Microbiology.

A. Menargues, V. Urios, R. Limiñanaa & M. Mauri

Circadian rhythm of salivary cortisol in Asian elephants (*Elephas maximus*): A factor to consider during welfare assessment

J. of Applied Animal Welfare Science 15 (2012)

Abstract. Elevated glucocorticoid levels during an extended time period might be a stress indicator in nonhuman animals. Therefore, knowledge of the circadian pattern of cortisol secretion is very important to correctly interpret data obtained for welfare assessment of animals in captivity through salivary cortisol. In order to define the circadian rhythm of salivary cortisol secretion in the Asian elephant (*Elephas maximus*), morning and evening saliva samples of 3 Asian elephants were collected and analyzed by radioimmunoassay. Significantly higher salivary cortisol concentrations were found in the morning than in the evening in all individuals. These results show that salivary cortisol of Asian elephants follows a diurnal pattern of secretion, which could be taken into account when using this methodology to assess welfare in captive Asian elephants. © 2012 Routledge.

C.L. Myhrvold, H.A. Stone & E. Bou-Zeid

What is the use of elephant hair?

PLoS ONE 7 (2012) e47018

Abstract. The idea that low surface densities of hairs could be a heat loss mechanism is understood in engineering and has been postulated in some thermal studies of animals. However, its biological implications, both for thermoregulation as well as for the evolution of epidermal structures, have not yet been noted. Since early epidermal structures are poorly preserved in the fossil record, we study modern elephants to infer not only the heat transfer effect of present-day sparse hair, but also its potential evolutionary origins. Here we use a combination of theoretical and empirical approaches, and a range of hair densities determined from photographs, to test whether sparse hairs increase convective heat loss from elephant skin, thus serving an intentional evolutionary purpose. Our conclusion is that elephants are covered with hair that significantly enhances their thermoregulation ability by over 5% under all scenarios considered, and by up to 23% at low wind speeds where their

thermoregulation needs are greatest. The broader biological significance of this finding suggests that maintaining a low-density hair cover can be evolutionary purposeful and beneficial, which is consistent with the fact that elephants have the greatest need for heat loss of any modern terrestrial animal because of their high body-volume to skin-surface ratio. Elephant hair is the first documented example in nature where increasing heat transfer due to a low hair density covering may be a desirable effect, and therefore raises the possibility of such a covering for similarly sized animals in the past. This elephant example dispels the widely-held assumption that in modern endotherms body hair functions exclusively as an insulator and could therefore be a first step to resolving the prior paradox of why hair was able to evolve in a world much warmer than our own. © 2012 The Authors.

V. Nijman & C.R. Shepherd

The role of Lao PDR in the ivory trade

TRAFFIC Bulletin 24 (2012) 35-40

Abstract. none.

B.F. Platt, S.T. Hasiotis & D.R. Hirmas

Empirical determination of physical controls on megafaunal footprint formation through neoichnological experiments with elephants

Palaios 27 (2012) 725-737

Abstract. We performed a series of neoichnological experiments with elephants to investigate the relationship between the various factors involved in controlling megafaunal footprint formation. Our ultimate goal was to provide a means to calculate original sedimentary properties of fossil-footprint-bearing siliciclastic rocks, especially those containing sauropod dinosaur tracks. Previous semiquantitative and model-based research identified multiple variables that influence footprint creation and preservation, but no rigorous, empirically based models have been constructed. We conducted track-making trials with experimental sediments and one adult female African elephant (*Loxodonta africana*) and one adult female Asian elephant (*Elephas maximus*) in a zoo setting. Data collected included track dimensions, sediment particle size distribution, sediment bulk density (ρ_b), volumetric water content of the sediment (θ_v),

and trackmaker walking velocity (v) and weight. We performed multiple regression analysis with a backward elimination technique to obtain the following relationship: $V_n = 0.812\theta_v^2 - 26.4\theta_v - 157\varrho_b - 20.5v + 518$, where V_n is track volume normalized by track length, measured in cm^2 , θ_v is in percent, ϱ_b is measured in g/cm^3 , and v is measured in m/s . We demonstrate the utility of this equation by calculating the original moisture content of sauropod-track-bearing siltstone and sandstone beds in the Upper Jurassic Morrison Formation. Original water content values are extremely useful for paleoenvironmental and paleohydrological interpretations of sediments and paleosols. Furthermore, paleoclimate studies can benefit greatly from original soil moisture values calculated from megafaunal footprints associated with paleosols. © 2012 SEPM.

J.K. Rattan, P.F.J. Eagles & H.L. Mair

Volunteer tourism: its role in creating conservation awareness

Journal of Ecotourism 11 (2012) 1-15

Abstract. This paper explores the perceptions of the impact that volunteer tourism has on the conservation awareness of non-volunteer tourists at the Elephant Nature Park (ENP) in Chiang Mai, Thailand. The ENP is a privately owned sanctuary that rehabilitates injured and abused elephants and relies on tourism and volunteer tourism for its upkeep. Data for this study were obtained through the use of self-administered questionnaires administered to 200 participants during both their pre-visit and post-visit at the ENP. Results showed that after spending time at the park, visitors' awareness about volunteer tourism increased. Participants felt that volunteer tourism increases awareness about conservation issues and volunteering, makes a considerable contribution to conservation, and brings necessary funding to conservation projects. Furthermore, non-volunteer tourists also expressed an interest in volunteering at the ENP, volunteering at home, and donating money to animal conservation organisations. The model of volunteer tourism utilised by the ENP was thus shown to be an effective tool for creating awareness about domestic elephant conservation issues in non-volunteer tourists. © 2012 Taylor & Francis.

P.B. Roy & R. Sah

Economic loss analysis of crops yield due to elephant raiding: A case study of Buxa Tiger Reserve (West), West Bengal, India

Journal of Economics and Sustainable Development 3 (2012) 83-88

Abstract. The aim of this study is to analyze the pattern of crop damage by elephant raiding that has been prevailing around Buxa Tiger Reserve (BTR), West Bengal, India, particularly at its western parts due to growth of substantial quantity of nutritious food. The work has been done based on the data collected from official records and through a structured questionnaire, the analysis of those shows that the extent of damage is highly significant from economic point of view and a huge amount of financial loss is realized by the farmers living here very often. To handle this loss, few conservative proposals have been suggested.

C. Santiapillai, B. Read, G. Jacobson, S. Wijeyamohan & S. Rambukpotha

A paradigm shift in the management of musth among bull elephants in captivity in Sri Lanka
Ceylon Journal of Science (Biological Sciences) 40 (2011) 25-32

Abstract. The phenomenon of musth among Asian elephants has been known since ancient times. Musth is a temporary post-pubertal, reproductive phenomenon commonly observed in the healthy male Asian elephant (*Elephas maximus*) both in the wild and in captivity. However, the treatment of musth bulls in Asia has remained almost unchanged. The traditional way of dealing with musth bulls involves restraining the animals by tethering them to trees and reducing the food intake so as to weaken them, with the assumption that they would drop out of musth faster. But such methods can cause severe wounds on the legs from the ropes used to tie the animals, and make the bulls more aggressive and traumatic, thereby posing a serious danger to their keepers or mahouts. The alternative method described in the paper provides a strong, safe, and secure tool for the management of musth bulls in captivity. The method not only assures the safety of the bulls but ensures that of the mahouts as well. Being a predominantly Buddhist country, Sri Lanka can lead the way in promoting the bull

pen as an alternative tool in the management of bulls in musth, while assuring the utmost safety of their keepers.

L. Sariya, J. Chatsirivech, P. Suksai, W. Wiriyarat, A. Songjaeng, S. Tangsudjai, O. Kanthasaewee, U. Maikaew & K. Chaichoun

Development of a SYBR Green I-based real-time PCR for detection of elephant endotheliotropic herpesvirus 1 infection in Asian elephants (*Elephas maximus*)

Journal of Virological Methods 185 (2012) 160-165

Abstract. Elephant endotheliotropic herpesvirus 1 (EEHV1) can cause fatal hemorrhagic disease in Asian elephants (*Elephas maximus*). Several studies have described this virus as a major threat to young Asian elephants. A SYBR Green I-based real-time polymerase chain reaction (PCR) was developed to identify EEHV1 on trunk swabs and necropsied tissues. Two of 29 (6.9%) trunk swab samples from healthy Asian elephants were positive for EEHV1. The viruses were analyzed and classified as EEHV1A based on 231 nucleotides of the terminase gene. Necropsied spleen and heart tissue showed the highest level and second highest levels of DNA virus copy accumulation, respectively. The detection limit of the test was 276 copies/ μ l of DNA. There was no cross-reaction with other mammalian herpesviruses, such as herpes simplex virus 1 and equine herpesvirus 2. Inter- and intra-assay showed low coefficients of variation values indicating the reproducibility of the test. The results indicated that the test can be practically used for epidemiological study, clinical diagnosis, and management and control of EEHV1. © 2012 with permission from Elsevier.

A.H.M.R. Sarker & E. Røskaft

Farmer characteristics and their perception of Asian elephants (*Elephas maximus*) as an agricultural pest in Bangladesh

International Journal of Biodiversity and Conservation 4 (2012) 560-572

Abstract. We explored the degree to which Bangladeshi farmers perceive Asian elephants (*Elephas maximus*) as agricultural pests, as related to the type of farming and other characteristics of the farmers. We analysed the size and cropping

patterns of farms raided by wild elephants, the extent and nature of crop loss, the months and timing of crop raiding, and the size of the crop-raiding elephants' herds. The average loss for all crops increased with distance from the park up to 300 m and then decreased with greater distance. The greatest loss due to crop raiding was associated with specific crops. Farmers incurred the greatest mean losses in terms of cost from rice, vegetables, banana, and teak. The highest proportion of small losses occurred during the early evening, while the greatest financial losses occurred during late evening. Wild elephants raided crops throughout most of the year, but the greatest loss and cost were incurred during the monsoon season. The proportion of crops lost varied with the size of the crop-raiding elephant's herd and the duration of crop-raiding. Differences were found in the views of farmers regarding the perceptions towards elephant as pest. © 2012 Academic Journals.

R. Sharma, B. Goossens, C. Kun-Rodrigues, T. Teixeira, N. Othman, J.Q. Boone, N.K. Jue, C. Oberfell, R.J. O'Neill & L. Chikhi

Two different high throughput sequencing approaches identify thousands of de novo genomic markers for the genetically depleted Bornean elephant

PLoS ONE 7 (2012) e49533

Abstract. High throughput sequencing technologies are being applied to an increasing number of model species with a high-quality reference genome. The application and analyses of whole-genome sequence data in non-model species with no prior genomic information are currently under way. Recent sequencing technologies provide new opportunities for gathering genomic data in natural populations, laying the empirical foundation for future research in the field of conservation and population genomics. Here we present the case study of the Bornean elephant, which is the most endangered subspecies of Asian elephant and exhibits very low genetic diversity. We used two different sequencing platforms, the Roche 454 FLX (shotgun) and Illumina, GAIIX (Restriction site associated DNA, RAD) to evaluate the feasibility of the two methodologies for the discovery of de novo markers (single nucleotide

polymorphism, SNPs and microsatellites) using low coverage data. Approximately, 6683 (shotgun) and 14,724 (RAD) SNPs were detected within our elephant sequence dataset. Genotyping of a representative sample of 194 SNPs resulted in a SNP validation rate of ~ 83-94% and 17% of the loci were polymorphic with a low diversity ($H_o = 0.057$). Different numbers of microsatellites were identified through shotgun (27,226) and RAD (868) techniques. Out of all di-, tri-, and tetra-microsatellite loci, 1706 loci had sufficient flanking regions (shotgun) while only 7 were found with RAD. All microsatellites were monomorphic in the Bornean but polymorphic in another elephant subspecies. Despite using different sample sizes, and the well known differences in the two platforms used regarding sequence length and throughput, the two approaches showed high validation rate. The approaches used here for marker development demonstrate the utility of high throughput sequencing technologies as a starting point for the development of genomic tools in a non-model species and in particular for a species with low genetic diversity. © 2012 The Authors.

J.J. Stanton, S. Nofs, R. Peng, G.S. Hayward, & P.D. Ling

Development and validation of quantitative real-time polymerase chain reaction assays to detect elephant endotheliotropic herpesviruses-2, 3, 4, 5, and 6

Journal of Virological Methods 186 (2012) 73-77

Abstract. Elephant endotheliotropic herpesviruses (EEHVs) can cause lethal hemorrhagic disease in both African and Asian elephants. At least seven EEHV types have been described, and sensitive real-time PCR tests have been developed for EEHV1A and 1B, which are associated with the majority of characterized Asian elephant deaths. Despite growing knowledge of the different EEHV types, the prevalence of each type within African and Asian elephants remains to be determined and there is considerable need for diagnostic tests to detect and discriminate between each EEHV species for clinical management of African and Asian elephants that develop illness from one or more of these viruses. To begin to address these issues, we developed real-time PCR assays for EEHV2,

3, 4, 5, and 6. Overall, each assay had robust PCR efficiency, a dynamic linear range over 5 log₁₀ concentrations, a limit of detection of 10 copies/test reaction with 100% sensitivity, and low intra- and inter-assay variability. Each assay proved to be specific for the EEHV targets for which it was designed, with the exception of EEHV3 and EEHV4, which was expected because of greater DNA sequence similarity between these two EEHV species than the others. These new tools will be useful for conducting surveys of EEHV prevalence within captive and range country elephants, for diagnostic testing of elephants with suspected EEHV-associated disease, and for managing the treatment of elephants with EEHV-induced illness. © 2012 with permission from Elsevier.

A.S. Stoeger, D. Mietchen, S. Oh, S. de Silva, C.T. Herbst, S. Kwon & W.T. Fitch

An Asian elephant imitates human speech

Current Biology 22 (2012) 2144-2148

Abstract. Vocal imitation has convergently evolved in many species, allowing learning and cultural transmission of complex, conspecific sounds, as in birdsong. Scattered instances also exist of vocal imitation across species, including mockingbirds imitating other species or parrots and mynahs producing human speech. Here, we document a male Asian elephant (*Elephas maximus*) that imitates human speech, matching Korean formants and fundamental frequency in such detail that Korean native speakers can readily understand and transcribe the imitations. To create these very accurate imitations of speech formant frequencies, this elephant (named Koshik) places his trunk inside his mouth, modulating the shape of the vocal tract during controlled phonation. This represents a wholly novel method of vocal production and formant control in this or any other species. One hypothesized role for vocal imitation is to facilitate vocal recognition by heightening the similarity between related or socially affiliated individuals. The social circumstances under which Koshik's speech imitations developed suggest that one function of vocal learning might be to cement social bonds and, in unusual cases, social bonds across species. © 2012 with permission from Elsevier.

S. Tangyuenyong, N. Viriyakhasem, S. Aungsu-chawan, S. Peansukmanee, C. Thitaram, P. Kongtawelert & S. Ongchai

Catabolism of Asian elephant cartilage matrix biomolecules in explant culture

KKU Veterinary Journal 22 (2012) 107-123

Abstract. OBJECTIVE—To attempt to culture and study articular cartilage biomolecules in Asian elephant. MATERIALS AND METHODS—Elephant articular cartilages were dissected from knee joint. The explants were then incubated in culture medium containing antibiotics in a humidified incubator with 5% CO₂ at 37°C for 3-28 days, under condition of 10 ng/ml IL-1b-induced cartilage degradation, compare to left untreated as control. At the end of incubation, the conditioned media were collected to measure the quantity of hyaluronan (HA), sulfated glycosaminoglycan (s-GAG) and the matrix metalloproteinase-2 (MMP-2) activity by competitive inhibition-based-ELISA, colorimetric dye binding assay and gelatin zymography respectively. The remaining of collagen and uronic acid content in cartilage tissue were investigated by colorimetric dye binding assays. RESULTS—IL-1b treated group showed 74% higher HA release than control (P<0.05) but there was no statistical difference in s-GAG release. MMP-2 activity was found to be 71% lower in IL-1b treated group than in control. The remaining of collagen and uronic acid in the explant tissues tended to be greater in the IL-1b treated group when compared to the control. The explant tissue section stained with Hematoxylin-Eosin and Safranin-O showed no significant difference in chondrocyte number and matrix profile; however, cell size in IL-1b treated group was likely to be bigger than that in the control. CONCLUSION—The achievement on cartilage explants culture and monitoring the marker substance of articular cartilage degradation provides the academic significance for further investigation of osteoarthritis in elephants. [Figures in English, text in Thai.]

V. Thuppil & R.G. Coss

Using threatening sounds as a conservation tool: Evolutionary bases for managing human–elephant conflict in India

Journal of International Wildlife Law & Policy

15 (2012) 167-185

Abstract. none.

Y. Trisurat, N. Bhumpakphan, D.H. Reed & B. Kanchanasaka

Using species distribution modeling to set management priorities for mammals in northern Thailand

J. for Nature Conservation 20 (2012) 264–273

Abstract. Rapid deforestation has occurred in northern Thailand and is expected to continue. Thus, identification and protection of sufficient amounts of the highest quality habitat is urgent. Wildlife occurrence data were gathered along wildlife trails and patrolling routes in protected areas and forest patches outside of protected areas. Geographic Information Systems, biophysical and anthropogenic variables were used to generate suitable habitats for 17 mammal species using maximum entropy theory (MAXENT). Suitable habitats for all species were aggregated, and used to set priorities for wildlife conservation in northern Thailand. In addition, predicted deforestation was overlaid on moderate and high priority areas to determine future wildlife threats and aid decision-making concerning which areas to protect. The results revealed that the total extent of suitable habitats for the studied species covers approximately 37% of the region. Nearly 70% of the total habitat for endangered and vulnerable species is predicted in large and contiguous protected areas. Threatened areas with high biodiversity encompass approximately 1.9% of the region, and 66% of this figure is predicted to occur in existing protected areas. Based on the model outcomes, we recommend reducing human pressures, enhancing the density of prey species and conservation outside protected areas, as well as increasing connectivity of suitable habitats among protected areas that are too small to maintain viable populations in isolation. © 2012 with permission from Elsevier.

S. Verma-Kumar, D. Abraham, N. Dendukuri, J.V. Cheeran, R. Sukumar & K.N. Balaji

Serodiagnosis of tuberculosis in Asian elephants (*Elephas maximus*) in Southern India: A latent class analysis

PLoS ONE 7 (2012) e49548

Abstract. Background: *Mycobacterium tuber-*

culosis, a causative agent of chronic tuberculosis disease, is widespread among some animal species too. There is paucity of information on the distribution, prevalence and true disease status of tuberculosis in Asian elephants (*Elephas maximus*). The aim of this study was to estimate the sensitivity and specificity of serological tests to diagnose *M. tuberculosis* infection in captive elephants in southern India while simultaneously estimating sero-prevalence. Methodology/Principal Findings: Health assessment of 600 elephants was carried out and their sera screened with a commercially available rapid serum test. Trunk wash culture of select rapid serum test positive animals yielded no animal positive for *M. tuberculosis* isolation. Under Indian field conditions where the true disease status is unknown, we used a latent class model to estimate the diagnostic characteristics of an existing (rapid serum test) and new (four in-house ELISA) tests. One hundred and seventy nine sera were randomly selected for screening in the five tests. Diagnostic sensitivities of the four ELISAs were 91.3–97.6% (95% Credible Interval (CI): 74.8–99.9) and diagnostic specificity were 89.6–98.5% (95% CI: 79.4–99.9) based on the model we assumed. We estimate that 53.6% (95% CI: 44.6–62.8) of the samples tested were free from infection with *M. tuberculosis* and 15.9% (97.5% CI: 9.8 - to 24.0) tested positive on all five tests. Conclusions/Significance: Our results provide evidence for high prevalence of asymptomatic *M. tuberculosis* infection in Asian elephants in a captive Indian setting. Further validation of these tests would be important in formulating area-specific effective surveillance and control measures. © 2012 The Authors.

J. Whilde & N. Marples

Effect of a birth on the behavior of a family group of Asian elephants (*Elephas maximus*) at Dublin Zoo

Zoo Biology 31 (2012) 442-452

Abstract. Elephants in the wild live in herds of related females from several generations. Zoos, therefore, tend to house elephants in female groups, consisting where possible of related individuals. This type of group structure is very beneficial as it allows group members to experience events such as births in the group, and

means that natural social interactions can take place between the group members. The behavior of four related female Asian elephants (*Elephas maximus*) at Dublin Zoo was recorded before and after the birth of a calf, to examine what effects it would have on the behavior and associations in the elephant group. The mother of the calf significantly decreased the amount of time she spent walking after the birth and the aunt of the calf showed significant decreases in both walking and standing. The mother spent the majority of her time closest to her calf after the birth, but the proportion of time she spent with each of the other individuals in the group did not change. The associations of the aunt also did not change after the birth. The older sister of the newborn calf increased the proportion of time she spent nearest to her mother after the calf was born, and reduced the time she spent close to another young elephant in the group. The new calf seems to have been successfully assimilated into the elephant group. © 2011 Wiley Periodicals, Inc.

M. Wierer, A.K. Schrey, R. Kühne, S.E. Ulbrich & H.H.D. Meyer

Alanine exchange directs ligand specificity of the elephant progesterin receptor

PLoS ONE 7 (2012) e50350

Abstract. The primary gestagen of elephants is 5 α -dihydroprogesterone (DHP), which is unlike all other mammals studied until now. The level of DHP in elephants equals that of progesterone in other mammals, and elephants are able to bind DHP with similar affinity to progesterone indicating a unique ligand-binding specificity of the elephant progesterin receptor (PR). Using site-directed mutagenesis in combination with in vitro binding studies we here report that this change in specificity is due to a single glycine to alanine exchange at position 722 (G722A) of PR, which specifically increases DHP affinity while not affecting binding of progesterone. By conducting molecular dynamics simulations comparing human and elephant PR ligand-binding domains (LBD), we observed that the alanine methyl group at position 722 is able to push the DHP A-ring into a position similar to progesterone. In the human PR, the DHP A-ring position is twisted towards helix 3 of PR thereby disturbing the hydrogen bond pattern around the C3-keto

group, resulting in a lower binding affinity. Furthermore, we observed that the elephant PR ligand-binding pocket is more rigid than the human analogue, which probably explains the higher affinity towards both progesterone and DHP. Interestingly, the G722A substitution is not elephant-specific, rather it is also present in five independent lineages of mammalian evolution, suggesting a special role of the substitution for the development of distinct mammalian gestagen systems. © 2012 The Authors.

M.A. Wong, R. Isaza, J.K. Cuthbert, D.E. Brooks & D.A. Samuelson

Periocular anterior adnexal anatomy and clinical adnexal examination of the adult Asian elephant (*Elephas maximus*)

Journal of Zoo and Wildlife Medicine 43 (2012) 793-801

Abstract. Formalin preserved ocular-associated anterior adnexa tissues from five necropsied Asian elephants (*Elephas maximus*) were dissected with attention to the palpebrae, conjunctiva, nictitating membranes, nasolacrimal ducts, and periocular glandular tissues. Gross and histologic examination revealed that lacrimal and tarsal glands were not present. Evidence of the lacrimal drainage apparatus, including lacrimal punctae or any remnant of lacrimal sacs, was also absent. In contrast, well-developed sebaceous glands associated with accessory hairs along the palpebrae were exceptionally abundant. Mixed-secreting accessory lacrimal glands were noted in the deep stroma posterior to the tarsus of both palpebrae and the gland of the nictitating



Yala National Park (Sri Lanka)

membrane. Apparently, the Asian elephant has developed a novel tear system in the absence of lacrimal and tarsal (meibomian) glands. Clinical examinations and bacterial cultures of the visible periocular tissues were performed on eight living adult Asian elephants to confirm the postmortem anatomic findings and provide guidance to the clinician during examination of the elephant conjunctiva. © 2012 American Association of Zoo Veterinarians.

Y. Yamamoto, N. Yuto, T. Yamamoto, S. Kaewmanee, O. Shiina, Y. Mouri, E. Narushima, M. Katayanagi, K. Sugimura, K. Nagaoka, G. Watanabe & K. Taya

Secretory pattern of inhibin during estrous cycle and pregnancy in African (*Loxodonta africana*) and Asian (*Elephas maximus*) elephants

Zoo Biology 31 (2012) 511-522

Abstract. The ovary of female elephants has multiple corpora lutea (CL) during the estrous cycle and gestation. The previous reports clearly demonstrated that inhibin was secreted from lutein cells as well as granulosa cells of antral follicles in cyclic Asian elephants. The aim of this study is to investigate the inhibin secretion during the pregnancy in African and Asian elephants. Two African elephants and two Asian elephants were subjected to this study. Circulating levels of immunoreactive (ir-) inhibin and progesterone were measured by radioimmunoassay. Four pregnant periods of an African elephant and three pregnant periods of an Asian elephant were analyzed in this study. Circulating levels of ir-inhibin started to increase at 1 or 2 week before the ovulation and reached the peak level 3 or 4 weeks earlier than progesterone during the estrous cycle in both African and Asian elephants. After last luteal phase, the serum levels of ir-inhibin remained low throughout pregnancy in both an African and an Asian elephant. The mean levels of ir-inhibin during the pregnancy were lower than the luteal phase in the estrous cycle despite high progesterone levels were maintained throughout the pregnancy. These results strongly suggest that CL secrete a large amount of progesterone but not inhibin during the pregnancy in elephants. © 2011 Wiley-Liss, Inc.