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 (2015) publications on Asian elephants.

M. Barua
Circulating elephants: unpacking the geographies of a cosmopolitan animal
Transactions of the Institute of British Geographers 39 (2014) 559-573
Abstract. Cosmopolitanism has emerged as an important concept in geography and the social sciences. The rise of mobility, circulation and transnational networks has been paralleled by academic scholarship on un-parochial others: diasporas, travellers and itinerant social groups. However, the role of nonhumans as participants in and subjects of cosmopolitanism has received scant attention. This paper seeks to develop a 'more-than-human' cosmopolitanism that accounts for the presence of nonhuman animals and entities in stories of circulation and contact. Through a multi-sited ethnography of elephant conservation in India and the UK, the paper illustrates how animals become participants in forging connections across difference. Through their circulation, elephants become cosmopolitan, present in diverse cultures and serving banal global consumption. The paper then illustrates how cosmopolitan elephants may be coercive, giving rise to political frictions and new inequalities when mobilised by powerful, transnational environmental actors. It concludes by discussing the methodological and conceptual implications of a more-than-human cosmopolitanism. © 2013 Royal Geographical Society.

B. Bouchard, B. Xaymountry, N. Thongtip, P. Lertwatcharasarakul & W. Wajjwalku
First reported case of elephant endotheliotropic herpes virus infection in Laos
Journal of Zoo and Wildlife Medicine 45 (2014) 704-707
Abstract. The elephant endotheliotropic herpesvirus (EEHV) is now recognized as one of the main causes of death of young Asian elephants (*Elephas maximus*) in North American zoos. Its impact in wild and domestic elephant populations in Asia is not clearly understood. This article describes the first case of EEHV infection in Lao People's Democratic Republic of a 2.5-yr-old domestic male Asian elephant. Clinical signs and pathological findings reported here are consistent with previous infections in Asian elephant calves. Phylogenetic analyses showed 100% homology with other EEHV-1A strains identified in Asia, Europe, and North America. Contamination of the molecular assays was ruled out, because the DNA polymerase sequence identified in this study differed from the positive control by two base pairs. © 2014 by American Association of Zoo Veterinarians.

A.P. Brock, R. Isaza, E.F. Egelund, R.P. Hunter & C.A. Peloquin
The pharmacokinetics of a single oral or rectal dose of concurrently administered isoniazid, rifampin, pyrazinamide, and ethambutol in Asian elephants (*Elephas maximus*)
Journal of Veterinary Pharmacology and Therapeutics 37 (2014) 472-479
Abstract. Tuberculosis, caused by *Mycobacterium tuberculosis*, is a disease of concern in captive Asian elephants (*Elephas maximus*). Treatment for tuberculosis in elephants utilizes multidrug protocols combining isoniazid, rifampin, pyrazinamide, and/or ethambutol. In this study, a single, coformulated dose of isoniazid 5 mg/kg, rifampin 10 mg/kg, pyrazinamide 30 mg/kg, and

ethambutol 30 mg/kg was administered orally to six Asian elephants, and rectally to five elephants using a cross-over design. Blood samples were collected serially over 24 h. Pyrazinamide and ethambutol concentrations were determined using validated gas chromatography assays. Isoniazid and rifampin concentrations were determined using validated high-performance liquid chromatography assays. Rectal isoniazid produced an earlier T_{max} compared with oral administration. Oral isoniazid resulted in a comparatively lower Cmax, but higher AUC values compared with rectal isoniazid. Oral rifampin and oral ethambutol were well absorbed while rectal rifampin was not. Oral pyrazinamide produced comparatively higher C_{max} and AUC values compared with rectal pyrazinamide. Results of this study indicate that currently recommended therapeutic monitoring sample collection times for rectal isoniazid and oral rifampin do not provide an accurate assessment of exposure for these drugs. This study demonstrates notable individual variability, indicating that dosing of these medications requires individual monitoring and provides additional information to guide the clinician when treating elephants. © 2014 John Wiley & Sons Ltd.

S. Chakraborty, D. Boominathan, A.A. Desai & T.N.C. Vidya

Using genetic analysis to estimate population size, sex ratio, and social organization in an Asian elephant population in conflict with humans in Alur, southern India

Conservation Genetics 15 (2014) 897-907

Abstract. With growing human and, possibly, elephant populations and a drastic increase in anthropogenic activities, human–elephant conflict in Asia has been on the rise. The Alur area in Karnataka state, southern India, is one such case in point, which has witnessed increasing levels of human–elephant conflict over the last two decades. The tiny, moderately protected habitat available for elephants in this human-dominated landscape does not appear to be able to support elephants over the long term. Options to deal with the escalating conflict include translocation of elephants, bringing elephants into captivity, and culling. We carried out a molecular genetic study of elephants in the Alur area to estimate the minimum number of elephants using the area, the sex ratio, genetic relatedness between individuals, and genetic structure with regard to the larger population in the landscape, so that informed management decisions could be made. Fresh dung samples were collected from the field and genotyped using 12 microsatellite loci. We found 29 unique individuals in the population, comprising 17 females and 12 males of different age classes. Relatedness between females suggested independent colonisations by discrete, small groups rather than by one cohesive clan of related females. This obviates the need for a single solution for dealing with all the females in the area in order to maintain social integrity, and has implications in terms how these elephants can be dealt with. We demonstrate how social organization inferred through molecular data from non-invasive sampling can inform management decisions. © 2014 With kind permission from Springer Science+Business Media.

M.Y. Chew, K. Hymeir, R. Nosrat & M.A. Shahfiz

Relation between grasses and large herbivores at the Ulu Muda salt licks, Peninsular Malaysia

J. of Tropical Forest Science 26 (2014) 554-559

Abstract. Ulu Muda Forest Reserve is known for its salt licks and grassy floodplains. Previous studies largely overlooked the floristic component of Gramineae in this herbivore-rich forest. This paper reports on the dominant grass species present at Sira Bongor, Sira Keladi and Sira Air Hangat salt licks, namely, *Hymenachne amplexicaulis*, *Centotheca lappacea* and *Oryza ridleyi* and describes the niches occupied by grasses at the three sites in relation to signs of large herbivore activities. Preliminary evidence indicated that the salt licks and adjacent *H. amplexicaulis* swamps were dynamic habitats, plausibly created and maintained by large-bodied herbivores including elephants. The presence of grasses that extended the role of salt licks as places for both minerals and nutritive food intake for large herbivores was discussed. © 2014 Forest Research Institute Malaysia.

A. Dastjerdi, C. Robert & M. Watson

Low coverage sequencing of two Asian elephant (*Elephas maximus*) genomes

GigaScience 3 (2014) e12

Abstract. There are three species of elephant that exist, the Asian elephant (*Elephas maximus*) and two species of African elephant (*Loxodonta africana* and *L. cyclotis*). The populations of all three species are dwindling, and are under threat due to factors, such as habitat destruction and ivory hunting. The species differ in many respects, including in their morphology and response to disease. The availability of elephant genome sequence data from all three elephant species will complement studies of behaviour, genetic diversity, evolution and disease resistance. We present low-coverage Illumina sequence data from two Asian elephants, representing approximately 5X and 2.5X coverage respectively. Both raw and aligned data are available, using the African elephant (*L. africana*) genome as a reference. The data presented here are an important addition to the available genetic and genomic information on Asian and African elephants. © 2014 The Authors.

R.K. de Mel, D.K. Weerakoon, W.D. Ratnasooriya & A. Dangolla

A comparative haematological analysis of Asian elephants *Elephas maximus* Linnaeus, 1758 (Mammalia: Proboscidea: Elephantidae) managed under different captive conditions in Sri Lanka

Journal of Threatened Taxa 6 (2014) 6148-6150

Abstract. Haematological parameters were assessed from elephants of three institutions in Sri Lanka with different captive conditions, in order to evaluate if different captive conditions influence the physiology of the animals. The institutions were: The National Zoological Gardens (NZG), where elephants live a comparatively sedentary lifestyle, Pinnawala Elephant Orphanage (PEO), where elephants are allowed to walk and engage in intra-specific behaviours, and Millennium Elephant Foundation (MEF), where the elephants are used for tourist rides. Four adult females were examined from the NZG, while only two males and two females could be examined from PEO and MEF respectively. All animals were sampled on four consecutive days. Blood glucose levels, total white blood cells (WBC), red blood cells (RBC), packed cell volume (PCV), mean corpuscular volume (MCV) and differential white blood cell counts were carried out. Certain blood parameters of the elephants from NZG differed significantly from the parameters of the elephants from PEO and MEF. These were, the total WBC counts (Kruskal-Wallis, H=21.92, 2 d.f., P=0.000), the lymphocyte count (Kruskal-Wallis, H=16.40, 2 d.f., P=0.00) and the Neutrophil: Lymphocyte ratios (Kruskal-Wallis , H=14.58, 2 d.f., P<0.05). PCV, blood glucose levels and monocyte counts were also shown to be significantly different among the three groups (Kruskal-Wallis P<0.000). We suggest that differences in the stress levels associated with the different management methods might influence these haematological values.

S. de Silva, U.S. Weerathunga & T.V. Pushpakumara

Morphometrics and behavior of a wild Asian elephant exhibiting disproportionate dwarfism

BMC Research Notes 7 (2014) 933

Abstract. Dwarfism is a condition characterized by shorter stature, at times accompanied by differential skeletal growth proportions relative to the species-typical physical conformation. Causes vary and are well documented in humans as well as certain mammalian species in captive or laboratory conditions, but rarely observed in the wild. We report on a single case of apparent dwarfism in a free-ranging adult male Asian elephant in Sri Lanka, comparing physical dimensions to those of other males in the population as well as in previous literature. The subject M459 was found to have a shoulder height of approximately 195 cm, is shorter than the average height of typical mature males, with a body length of 218 cm. This ratio of body length to height deviates from what is typically observed, which is approximately 1:1, but was similar to the attributes of a dwarf elephant in captivity documented in 1955. We report on behaviour including the surprising observation that M459 appears to have a competitive advantage in intrasexual contests. We discuss how this phenotype compares to cases of dwarfism in other non-human animals. M459 exemplifies a rare occurrence of disproportionate dwarfism in a free-ranging wild mammal that has survived to reproductive maturity and appears otherwise healthy. © 2014 The Authors.

M. English, M. Ancrenaz, G. Gillespie, B. Goossens, S. Nathan & W. Linklater

Foraging site recursion by forest elephants *Elephas maximus borneensis*

Current Zoology 60 (2014) 551-559

Abstract. Recursion by herbivores is the repeated use of the same site or plants. Recursion by wild animals is rarely investigated but may be ubiquitous. Optimal foraging theory predicts site recursion as a function of the quality of the site, extent of its last use, and time since its last use because these influence site resource status and recovery. We used GPS collars, behaviour and site sampling to investigate recursion to foraging sites for two elephant *Elephas maximus borneensis* herds in the Lower Kinabatangan Wildlife Sanctuary, Borneo, over a 12-month period. Recursion occurred to 48 out of 87 foraging sites and was most common within 48 hours or between 151–250 days, indicating two different types of recursion. Recursion was more likely to occur if the site had previously been occupied for longer. Moreover, the time spent at a site at recursion was the same as the time spent at the site on the first occasion. The number of days that had passed between the first visit and recursion was also positively correlated with how much time was spent at the site at recursion. Habitat type also influenced the intensity of site-use, with more time spent at recursion within riverine/open grass areas along forest margins compared to other habitat types. Recursion is a common behaviour used by the elephants and its pattern suggests it may be a foraging strategy for revisiting areas of greater value. The qualities of recursion sites might usefully be incorporated into landscape management strategies for elephant conservation in the area. © 2014 Current Zoology.

M. English, G. Gillespie, M. Ancrenaz, S. Ismail, B. Goossens, S. Nathan & W. Linklater

Plant selection and avoidance by the Bornean elephant (*Elephas maximus borneensis*) in tropical forest: does plant recovery rate after herbivory influence food choices?

Journal of Tropical Ecology 30 (2014) 371-379

Abstract. The plant vigour hypothesis proposes that herbivores should favour feeding on more vigorously growing plants or plant modules. Similarly, we would expect herbivores to favour plants that regrow vigorously after herbivory. Larger animals, like elephants, may also select plant species relative to their availability and prefer species with larger growth forms in order to meet their intake requirements. The food preferences of the Bornean elephant (*Elephas maximus borneensis*) in the Lower Kinabatangan Wildlife Sanctuary, Sabah, Malaysia, were investigated along 12 transects in areas where elephants were recently sighted feeding. One hundred and eighty-two plants were eaten and 185 plants were measured for species availability along transects. Species vigour was determined by the monthly regrowth in new shoot length after elephant feeding and the number of new shoots produced on each plant. Measurements were carried out on each plant for 9 mo or until the new shoot was eaten. Plant sizes were determined from their basal diameter. The Bornean elephant did not prefer more vigorous species or species with larger growth forms. New shoots did not grow longer on preferred than avoided species. Additionally, unlike other elephants that live in a forest environment, the Bornean elephant preferred species from the Poaceae (specifically *Phragmites karka* and *Dinochloa scabrida*) over other plant types including gingers, palms, lianas and woody trees. © 2014 Cambridge Univ. Press.

M. English, G. Kaplan & L.J. Rogers

Is painting by elephants in zoos as enriching as we are led to believe?

PeerJ 2 (2014) e471

Abstract. The relationship between the activity of painting and performance of stereotyped and other stress-related behaviour was investigated in four captive Asian elephants at Melbourne Zoo, Australia. The activity involved the elephant being instructed to paint on a canvas by its keeper in front of an audience. Painting by elephants in zoos is commonly believed to be a form of enrichment, but this assumption had not been based on any systematic research. If an activity is enriching we would expect stress-related behaviour to be reduced but we found no evidence of the elephants anticipating the painting activity and no effect on the performance of stereotyped or other stress-related behaviour either before or after the painting session. This

indicates that the activity does not fulfil one of the main aims of enrichment. However, if an elephant was not selected to paint on a given day this was associated with higher levels of non-interactive behaviour, a possible indicator of stress. Behavioural observations associated with ear, eye and trunk positions during the painting session showed that the elephant's attentiveness to the painting activity or to the keeper giving instruction varied between individuals. Apart from positive reinforcement from the keeper, the results indicated that elephants gain little enrichment from the activity of painting. Hence, the benefits of this activity appear to be limited to the aesthetic appeal of these paintings to the people viewing them. © 2014 The Authors.

J.M. Enk, A.M. Devault, M. Kuch, Y.E. Murgha, J.-M. Rouillard & H.N. Poinar

Ancient whole genome enrichment using baits built from modern DNA

Molecular Biology and Evolution 31 (2014) 1292-1294

Abstract. We report metrics from complete genome capture of nuclear DNA from extinct mammoths using biotinylated RNAs transcribed from an Asian elephant DNA extract. Enrichment of the nuclear genome ranged from 1.06- to 18.65-fold, to an apparent maximum threshold of ~80% on-target. This projects an order of magnitude less costly complete genome sequencing from long-dead organisms, even when a reference genome is unavailable for bait design. © 2014 The Authors. By permission of the Society for Molecular Biology and Evolution.

A. Fagen, N. Acharya & G.E. Kaufman

Positive reinforcement training for a trunk wash in Nepal's working elephants: Demonstrating alternatives to traditional elephant training techniques

Journal of Applied Animal Welfare Science 17 (2014) 83-97

Abstract. Many trainers of animals in the zoo now rely on positive reinforcement training to teach animals to voluntarily participate in husbandry and veterinary procedures in an effort to improve behavioral reliability, captive management, and welfare. However, captive elephant handlers in Nepal still rely heavily on punishment- and aversion-based methods. The aim of this project was to determine the effectiveness of secondary positive reinforcement (SPR) in training free-contact elephants in Nepal to voluntarily participate in a trunk wash for the purpose of tuberculosis testing. Five female elephants, 4 juveniles and 1 adult, were enrolled in the project. Data were collected in the form of minutes of training, number of offers made for each training task, and success rate for each task in performance tests. Four out of 5 elephants, all juveniles, successfully learned the trunk wash in 35 sessions or fewer, with each session lasting a mean duration of 12 min. The elephants' performance improved from a mean success rate of 39.0% to 89.3% during the course of the training. This study proves that it is feasible to efficiently train juvenile, free-contact, traditionally trained elephants in Nepal to voluntarily and reliably participate in a trunk wash using only SPR techniques. © Taylor & Francis Group, LLC.

F. Galis, D.R. Carrier, J. van Alphen, S.D. van der Mije, T.J.M. Van Dooren, J.A.J. Metz & C.M.A. ten Broek

Fast running restricts evolutionary change of the vertebral column in mammals

PNAS 111 (2014) 11401-11406

Abstract. The mammalian vertebral column is highly variable, reflecting adaptations to a wide range of lifestyles, from burrowing in moles to flying in bats. However, in many taxa, the number of trunk vertebrae is surprisingly constant. We argue that this constancy results from strong selection against initial changes of these numbers in fast running and agile mammals, whereas such selection is weak in slower-running, sturdier mammals. The rationale is that changes of the number of trunk vertebrae require homeotic transformations from trunk into sacral vertebrae, or vice versa, and mutations toward such transformations generally produce transitional lumbosacral vertebrae that are incompletely fused to the sacrum. We hypothesize that such incomplete homeotic transformations impair flexibility of the lumbosacral joint and thereby threaten survival in species that depend on axial mobility for speed and agility. Such transformations will only marginally affect

performance in slow, sturdy species, so that sufficient individuals with transitional vertebrae survive to allow eventual evolutionary changes of trunk vertebral numbers. We present data on fast and slow carnivores and artiodactyls and on slow afrotherians and monotremes that strongly support this hypothesis. The conclusion is that the selective constraints on the count of trunk vertebrae stem from a combination of developmental and biomechanical constraints.

A. Gentry, A.M. Lister, and A.M. Roos, M.T.P. Gilbert & E. Cappellini

The lectotype for the Asian elephant, *Elephas maximus* Linnaeus, 1758 (Mammalia, Proboscidea) and comments on 'primary, secondary and tertiary syntypes' and 'virtual lectotype designation'

Bulletin of Zoological Nomenclature 71 (2014) 208-213

Abstract. Last November a group of colleagues and ourselves designated a lectotype for the Asian elephant, *Elephas maximus* Linnaeus, 1758, having used morphology and genetic and proteomic sequencing to confirm that Linnaeus's syntypes included both Asian and African elephants. The article was published (Cappellini *et al*., 2013) online in the Zoological Journal of the Linnean Society, together with eight items of Supplementary Information, and appeared on paper in the ZJLS in January 2014. The paper and SI items are available online at DOI:10.1111/zoj.12084. The lectotype is a very nearly complete mounted skeleton on display in the Natural History Museum of the University of Florence. John Ray described the specimen in 1673 and 1693 and Linnaeus cited Ray's 1693 publication. The lectotype designation is available and valid. Dubois, Nemésio & Bour, however, have criticised our choice of selected specimen (published in Bionomina, June 2014; a preview is available online at http://mapress.com/bionomina/content.htm). We are concerned because they have demonstrated misunderstanding or ignorance of a number of aspects of the International Code of Zoological Nomenclature.

V.R. Goswami, S. Sridhara, K. Medhi, A.C. Williams, R. Chellam, J.D. Nichols & M.K. Oli

Community-managed forests and wildlife-friendly agriculture play a subsidiary but not substitutive role to protected areas for the endangered Asian elephant

Biological Conservation 177 (2014) 74-81

Abstract. Global conservation policy is increasingly debating the feasibility of reconciling wildlife conservation and human resource requirements in land uses outside protected areas (PAs). However, there are few quantitative assessments of whether or to what extent these 'wildlife-friendly' land uses fulfill a fundamental function of PAs—to separate biodiversity from anthropogenic threats. We distinguish the role of wildlife-friendly land uses as being (a) subsidiary, whereby they augment PAs with secondary habitat, or (b) substitutive, wherein they provide comparable habitat to PAs. We tested our hypotheses by investigating the influence of land use and human presence on space-use intensity of the endangered Asian elephant (*Elephas maximus*) in a fragmented landscape comprising PAs and wildlife-friendly land uses. We applied multistate occupancy models to spatial data on elephant occurrence to estimate and model the overall probability of elephants using a site, and the conditional probability of high-intensity use given that elephants use a site. The probability of elephants using a site regardless of intensity did not vary between PAs and wildlife-friendly land uses. However, high-intensity use declined with distance to PAs, and this effect was accentuated by an increase in village density. Therefore, while wildlife-friendly land uses did play a subsidiary conservation role, their potential to substitute for PAs was offset by a strong human presence. Our findings demonstrate the need to evaluate the role of wildlife-friendly land uses in landscape-scale conservation; for species that have conflicting resource requirements with people, PAs are likely to provide crucial refuge from growing anthropogenic threats. © 2014 Elsevier Ltd.

V.R. Goswami, D. Vasudev & M.K. Oli

The importance of conflict-induced mortality for conservation planning in areas of human–elephant co-occurrence

Biological Conservation 176 (2014) 191-198

Abstract. Multiple-use zones around protected areas are designed to balance human resource

needs with wildlife conservation, but conflicts between wildlife and people in these areas of co-occurrence (CA) can seriously undermine their conservation potential. We evaluated this issue by assessing the effects of conflict-induced mortality in CAs around an inviolate core, on long-term population viability of the endangered, wide-ranging, and conflict-prone Asian elephant (*Elephas maximus*). Using a single-sex, age-structured density-dependent matrix population model to simulate elephant population dynamics over a period of 500 years, we: (1) assessed the existence of extinction thresholds arising from the interaction of mortality due to human–elephant conflict (HEC) and habitat degradation, and (2) evaluated whether and to what extent habitat supplementation by the CA is devalued by detrimental effects of conflict-induced mortality. We parameterized our model using published survival and fecundity rates. We considered different scenarios of core to CA configurations, and simulated the population under HEC-induced mortality rates (HECm) ranging from 0 to 0.1. Population persistence was adversely affected by HECm, and its detrimental effects were magnified as the proportion of core habitat declined. Under moderate HECm, small increments in mortality rates necessitated disproportionately large increases in core area availability to avoid quasi-extinction. Furthermore, benefits of CA supplementation were driven more by CA quality than size, and these benefits declined as HECm increased. We emphasize the need to minimize conflict-induced mortality, or to maintain adequate refugia from such anthropogenic threats, to successfully conserve conflict-prone species in human-dominated landscapes. © 2014 Elsevier Ltd.

T.N.E. Gray, T.N.C. Vidya, S. Potdar, D.K. Bharti & P. Sovanna

Population size estimation of an Asian elephant population in eastern Cambodia through non-invasive mark-recapture sampling

Conservation Genetics 15 (2014) 803-810

Abstract. The Asian elephant is a flagship species for conservation in tropical Asia, but reliable population estimates are available only from a few populations. This is because the species can be elusive and occurs at low densities in dense habitat over a large part of its range. Phnom Prich Wildlife Sanctuary in the Eastern Plains, Cambodia, which is part of one of the largest protected area complexes in South-East Asia, is one such habitat that had not been systematically censused for elephants. We, therefore, used faecal-DNA based capture-mark-recapture sampling to estimate the population size for establishing a monitoring baseline. Five sampling sessions targeted all areas in and adjacent to Phnom Prich Wildlife Sanctuary believed to be used by elephants. Fresh dung was collected as the source of DNA and genotyping was carried out based on nine microsatellite loci. The 224 samples collected yielded 78 unique genotypes. Using model averaging of closed population capture-mark-recapture models, the elephant population in Phnom Prich Wildlife Sanctuary was estimated to number 136 ± 18 (SE) individuals. Our results suggest that eastern Cambodia supports a regionally important Asian elephant population. © 2014 With kind permission from Springer Science+Business Media.

N. Ilmberger, S. Güllert, J. Dannenberg, U. Rabausch, J. Torres, B. Wemheuer, M. Alawi, A. Poehlein, J. Chow, D. Turaev, T. Rattei, C. Schmeisser, J. Salomon, P.B. Olsen, R. Daniel, A. Grundhoff, M.S. Borchert & W.R. Streit

A comparative metagenome survey of the fecal microbiota of a breast- and a plant-fed Asian elephant reveals an unexpectedly high diversity of glycoside hydrolase family enzymes

PLoS ONE 9 (2014) e106707

Abstract. A phylogenetic and metagenomic study of elephant feces samples (derived from a three-weeks-old and a six-years-old Asian elephant) was conducted in order to describe the microbiota inhabiting this large land-living animal. The microbial diversity was examined via 16S rRNA gene analysis. We generated more than 44,000 GS-FLX+454 reads for each animal. For the baby elephant, 380 operational taxonomic units (OTUs) were identified at 97% sequence identity level; in the six-years-old animal, close to 3000 OTUs were identified, suggesting high microbial diversity in the older animal. In both animals most OTUs belonged to Bacteroidetes

and Firmicutes. Additionally, for the baby elephant a high number of Proteobacteria was detected. A metagenomic sequencing approach using Illumina technology resulted in the generation of 1.1 Gbp assembled DNA in contigs with a maximum size of 0.6 Mbp. A KEGG pathway analysis suggested high metabolic diversity regarding the use of polymers and aromatic and non-aromatic compounds. In line with the high phylogenetic diversity, a surprising and not previously described biodiversity of glycoside hydrolase (GH) genes was found. Enzymes of 84 GH families were detected. Polysaccharide utilization loci (PULs), which are found in Bacteroidetes, were highly abundant in the dataset; some of these comprised cellulase genes. Furthermore the highest coverage for GH5 and GH9 family enzymes was detected for Bacteroidetes, suggesting that bacteria of this phylum are mainly responsible for the degradation of cellulose in the Asian elephant. Altogether, this study delivers insight into the biomass conversion by one of the largest plant-fed and land-living animals. © 2014 The Authors.

R. Isaza, E. Wiedner, S. Hiser & C. Cray

Reference intervals for acute phase protein and serum protein electrophoresis values in captive Asian elephants (*Elephas maximus*)

Journal of Veterinary Diagnostic Investigation 26 (2014) 616–621

Abstract. Acute phase protein (APP) immunoassays and serum protein electrophoresis (SPEP) are assays for evaluating the inflammatory response and have use as diagnostic tools in a variety of species. Acute phase proteins are markers of inflammation that are highly conserved across different species while SPEP separates and quantifies serum protein fractions based on their physical properties. In the current study, serum samples from 35 clinically healthy Asian elephants (*Elephas maximus*) were analyzed using automated assays for C-reactive protein, serum amyloid A, and haptoglobin and SPEP. Robust methods were used to generate reference intervals for the APPs: C-reactive protein (1.3–12.8 mg/l), serum amyloid A (0–47.5 mg/l), and haptoglobin (0–1.10 mg/ml). In addition, SPEP was performed on these samples to establish reference intervals for each protein fraction. A combination of APPs and SPEP measurements are valuable adjunctive diagnostic tools in elephant health care. © 2014 The Authors.

R.-D. Kahlke

The origin of Eurasian mammoth faunas (Mammuthus–Coelodonta faunal complex)

Quaternary Science Reviews 96 (2014) 32-49

Abstract. Pleistocene Mammoth Faunas were the most successful, cold-adapted large mammal assemblages in the history of the Earth. However, the causes for their emergence can not be attributed only to the global trend of climate cooling which occurred during the Neogene/Quaternary period. The formation of the Eurasian Mammuthus–Coelodonta Faunal Complex was a result of interacting tectonic, geographical, climatic, ecological and phylogenetic processes. The key environmental factors controlling the origin and evolution of Palaearctic cold-adapted large mammal faunas were successive aridification of major parts of Eurasia, rhythmic global climatic cooling with prolonged and intensified cold stages, and increasing continentality. Between 2.6 Ma and around 700 ka BP, largely independent mammal faunas became established in continental Asian steppe regions as well as in the circumpolar tundra. Both faunal complexes were adapted to open environmental conditions but were largely separated from each other. The principal requirements in order for species to evolve into members of Mammoth Faunas are progressing adaptation to aridity, decreasing temperatures and rapid temperature fluctuations. Eurasian Mammoth Faunas were mainly composed of the descendants of either Central Asian steppe or Arctic tundra faunal elements. The majority of species of Central Asian origin emerged in regions north of the Himalayan–Tibetan uplift. Between 640 and 480 ka BP, saiga, musk-ox and reindeer occasionally spread far beyond the limits of their respective traditional areas, thus anticipating the subsequent merge of steppe and tundra originated species in Eurasian Mammoth Faunas. During the pronounced cold period of MIS 12, tundra species regularly expanded south- and southwestward into a newly formed type of biome, the so-called tundra-steppe. In parallel, species originating from the Asian steppe

dispersed into new habitats north and northwest of their ancestral distribution areas. This drastic faunal turnover led to the formation of the earliest pan-Eurasian Mammoth Fauna at around 460 ka BP. The sister taxa of several species involved in Mammoth Faunas underwent separate evolution in Central Asia, thus indicating ecological differences between the Asian core steppe and Eurasian tundra-steppe habitats. During temperate and humid stages of the late Middle to Late Pleistocene periods the transcontinental reach of the steppe-tundra biome collapsed. As a result, the majority of the characteristic mammal species were forced back to continental steppe or Arctic tundra refugia, only returning during subsequent cold stages when the formation of a new and more evolved Mammoth Fauna began. The maximum geographic extension of the Palaearctic Mammuthus–Coelodonta Faunal Complex occurred during the Late Pleistocene, when it covered an area of up to 190 degrees of longitude and 40 degrees of latitude. © 2014 Reprinted with permission from Elsevier.

R. Kansky & A.T. Knight

Key factors driving attitudes towards large mammals in conflict with humans

Biological Conservation 179 (2014) 93-105

Abstract. Biodiversity conflicts, and human–wildlife conflicts (HWC) in particular, are predicted to increase. Understanding drivers of these conflicts is a prerequisite for developing strategies to achieve conservation goals. People are a part of all HWC problems meaning social research methods are essential for finding solutions. We conducted a meta-analysis of the variables predicted to drive attitudes of people living in areas with damage causing carnivores, ungulates, elephants and primates so as to determine if common patterns of variables are present across a wide range of contexts. We categorized variables reported in publications into main and sub-categories and developed three indexes to describe relative frequency of category use, relative significance of categories and degree of accuracy between use and significance. From 45 suitable publications, 16 main categories and 17 sub-categories were identified. The majority of publications measured variables with a low likelihood of explaining drivers of HWC, or did not quantify variables of generally high utility. For example, only four categories (25%) were applied in over 50% of publications, and two thirds were mostly not significant in explaining attitudes. Tangible costs and tangible benefits thought to be the main drivers of attitudes were respectively, two and three times more non-significant than significant. Intangible costs however were the most important category to explain attitudes but was under represented in publications. Intangible benefits were mostly not important in explaining attitudes. Costs were more significant than benefits suggesting negative perceptions more strongly determine attitudes. Other important categories were exposure and experience with a species, stakeholder types and legal status of land. Socio-demographic variables commonly used in published studies such as gender, education and wealth, poorly explained attitudes. We conclude that greater conceptual clarity is urgently required to guide future attitude studies so that research can reliably inform the development of species management plans and policies. © 2014 Reprinted with permission from Elsevier.

Herd near Galgamuwa (Sri Lanka)

S. Katole, A. Das, N. Agarwal, B. Prakash, S.K. Saha, M. Saini & A.K. Sharma

Influence of work on nutrient utilisation in semicaptive Asian elephants (*Elephas maximus*)

Journal of Applied Animal Research 42 (2014)

Abstract. Two feeding trials were conducted to evaluate the feed consumption, nutrient utilisation, blood biochemical and faecal microbial profile of working and nonworking semicaptive Asian elephant. During each trial, six captive elephants were placed in two groups

of three each. Elephants in one group performed the scheduled work at the park, i.e., 4-h safari with tourists, while the other group performed no work. During night time, all the elephants were kept in respective individual enclosure so that feed consumption and faeces voided could be measured accurately. During day time, all the elephants were allowed to forage in nearby forest. Intake (kg/d) of sugarcane (*Saccharum officinarum*) and sugarcane leaves was more ($P < 0.01$) in nonworking elephants as compared to working elephants. Working elephants consumed more ($P < 0.01$) forages during foraging than nonworking elephants. Average daily dry matter intake (DMI) and DMI (% body weight, BW) were comparable between the groups. Apparent digestibility (%) of DM, OM, crude protein (CP), neutral detergent fibre (NDF), acid detergent fibre (ADF), hemicellulose, cellulose and gross energy (GE) were higher ($P < 0.01$) in working than nonworking elephants. Activity of ALT (IU/l) was higher in working as compared to non-working elephants. The relative population of *Fibrobacter succinogenes* and *Ruminococcus flavefaciens* and total fungi were numerically increased in working elephants as compared to nonworking elephants. It was concluded that 4 h of work has no adverse impact on food consumption and blood metabolite profile of semicaptive Asian elephants; rather it improved the digestibility of nutrients. Work showed positive effect in restricting the calorie supply closer to requirement. © 2014 Taylor & Francis.

M. Lahdenperä, K. U Mar & V. Lummaa

Reproductive cessation and post-reproductive lifespan in Asian elephants and pre-industrial humans

Frontiers in Zoology 11 (2014) e54

Abstract. Short post-reproductive lifespan is widespread across species, but prolonged post-reproductive life-stages of potential adaptive significance have been reported only in few mammals with extreme longevity. Long post-reproductive lifespan contradicts classical evolutionary predictions of simultaneous senescence in survival and reproduction, and raises the question of whether extreme longevity in mammals promotes such a life history. Among terrestrial mammals, elephants share the features with great apes and humans, of having long lifespan and offspring with long dependency. However, little data exists on the frequency of post-reproductive lifespan in elephants. Here we use extensive demographic records on semi-captive Asian elephants (n = 1040) and genealogical data on pre-industrial women (n = 5336) to provide the first comparisons of age-specific reproduction, survival and post-reproductive lifespan in both of these long-lived species. We found that fertility decreased after age 50 in elephants, but the pattern differed from a total loss of fertility in menopausal women with many elephants continuing to reproduce at least until the age of 65 years. The probability of entering a non-reproductive state increased steadily in elephants from the earliest age of reproduction until age 65, with the longer living elephants continuing to reproduce until older ages, in contrast to humans whose termination probability increased rapidly after age 35 and reached 1 at 56 years, but did not depend on longevity. Post-reproductive lifespan reached 11–17 years in elephants and 26–27 years in humans living until old age (depending on method), but whereas half of human adult lifespan (of those reproductive females surviving to the age of 5% fecundity) was spent as post-reproductive, only one eighth was in elephants. Consequently, although some elephants have long post-reproductive lifespans, relatively few individuals reach such a phase and the decline in fertility generally parallels declines in survivorship in contrast to humans with a decoupling of senescence in somatic and reproductive functions. Our results show that the reproductive and survival patterns of Asian elephants differ from other long-lived animals exhibiting menopause, such as humans, and extreme longevity alone does not promote the evolution of menopause or post-reproductive lifespan, adding weight to the unusual kin-selected benefits suggested to favour such traits in humans and killer whales.© 2014 The Authors.

J.A. Landolfi, M. Miller, C. Maddox, F. Zuckermann & K.A. Terioa

Differences in immune cell function between tuberculosis positive and negative Asian elephants

Tuberculosis 94 (2014) 374-382

Abstract. Tuberculosis is an important health concern for Asian elephant (*Elephas maximus*) populations worldwide, however, mechanisms underlying susceptibility to Mycobacterium tuberculosis are unknown. Proliferative responses assessed via brominated uridine incorporation and cytokine expression measured by real-time RT-PCR were evaluated in peripheral blood mononuclear cell (PBMC) cultures from 8 tuberculosis negative and 8 positive Asian elephants. Cultures were stimulated with Mycobacterium bovis purified protein derivative (PPD-B), M. tuberculosis culture filtrate protein (CFP)-10, and Mycobacterium avium PPD (PPD-A). Following stimulation with PPD-B, proliferation was higher ($\alpha = 0.005$) in positive samples; no significant differences were detected following CFP-10 or PPD-A stimulation. Tumor necrosis factor (TNF)-α, interleukin (IL)-12, and interferon (IFN)-γ expression was greater in samples from positive elephants following stimulation with PPD-B ($\alpha = 0.025$) and CFP-10 ($\alpha = 0.025$ TNF-α and IL-12; $\alpha = 0.005$ IFN-γ). Stimulation with PPD-A also produced enhanced IL-12 expression in positive samples ($\alpha = 0.025$). Findings suggested that differences in immune cell function exist between tuberculosis positive and negative elephants. Proliferative responses and expression of TNF-α, IL-12, and IFN-γ in response to stimulation with PPD-B and CFP-10 differ between tuberculosis positive and negative elephants, suggesting these parameters may be important to tuberculosis immunopathogenesis in this species. © 2014 Elsevier Ltd.

J. Louys, R.T. Corlett, G.J. Price, S. Hawkins & P.J. Piper

Rewilding the tropics, and other conservation translocations strategies in the tropical Asia-Pacific region

Ecology and Evolution 4 (2014) 4380-4398

Abstract. Alarm over the prospects for survival of species in a rapidly changing world has encouraged discussion of translocation conservation strategies that move beyond the focus of 'at-risk' species. These approaches consider larger spatial and temporal scales than customary, with the aim of recreating functioning ecosystems through a combination of large-scale ecological restoration and species introductions. The term 'rewilding' has come to apply to this large-scale ecosystem restoration program. While reintroductions of species within their historical ranges have become standard conservation tools, introductions within known paleontological ranges—but outside historical ranges—are more controversial, as is the use of taxon substitutions for extinct species. Here, we consider possible conservation translocations for nine large-bodied taxa in tropical Asia-Pacific. We consider the entire spectrum of conservation translocation strategies as defined by the IUCN in addition to rewilding. The taxa considered are spread across diverse taxonomic and ecological spectra and all are listed as 'endangered' or 'critically endangered' by the IUCN in our region of study. They all have a written and fossil record that is sufficient to assess past changes in range, as well as ecological and environmental preferences, and the reasons for their decline, and they have all suffered massive range restrictions since the late Pleistocene. General principles, problems, and benefits of translocation strategies are reviewed as case studies. These allowed us to develop a conservation translocation matrix, with taxa scored for risk, benefit, and feasibility. Comparisons between taxa across this matrix indicated that orangutans, tapirs, Tasmanian devils, and perhaps tortoises are the most viable taxa for translocations. However, overall the case studies revealed a need for more data and research for all taxa, and their ecological and environmental needs. Rewilding the Asian-Pacific tropics remains a controversial conservation strategy, and would be difficult in what is largely a highly fragmented area geographically. © 2014 The Authors.

I. Lueders, T.B. Hildebrandt, C. Gray, S. Botha, P. Rich & C. Niemuller

Supression of testicular function in a male Asian elephant (*Elephas maximus*) treated with gonadotropin-releasing hormone vaccines

J. of Zoo and Wildlife Med. 45 (2014) 611-619

Abstract. The ability to control testosterone concentrations and sperm production is of great interest in both Asian (*Elephas maximus*) and African (*Loxodonta africana*) elephants. GnRH vaccination may pose an alternative to surgical castration. This is a case report of a male Asian

elephant treated with two commercial GnRH vaccines (Equity® and Improvac®). Beginning at the age of 7 yr, the male was vaccinated monthly for 6 consecutive months, then every 6 mo and, finally, every 12 to 24 mo over a period of 6 yr. In order to evaluate the GnRH vaccine as a potential method of immunologic castration, behavioural observations, testosterone level analysis, body weights, ultrasound examinations, and semen collection were part of the routine monitoring of this bull (no. 1) and a half-brother (bull 2) who remained untreated and served as control. The results showed a decrease in serum testosterone concentrations after the second booster. Levels stayed continuously below 5.0 ng/ml within the study period. The combined testicle diameter of 9.03 ± 0.3 cm prior to treatment had decreased to a size of 6.93 ± 0.19 cm ($P < 0.001$) when measured 2 yr later. Accessory sex gland fluid content disappeared and penile atrophy was observed. Semen collections yielded no spermatozoa 1 yr after the initial treatment. Bull 1 showed slowed weight gain as compared to bull 2 and, due to its friendly temperament and the absence of musth, remained in free contact. This report documents the GnRH vaccine as a possible noninvasive and inexpensive method for immunecastration. © 2014 by American Association of Zoo Veterinarians.

S. Mariati, H. Kusnoputranto, J. Supriatna & R.H. Koestoer

Habitat loss of Sumatran elephants (*Elephas maximus sumatranus*) in Tesso Nilo Forest, Riau, Indonesia

Australian Journal of Basic and Applied Sciences 8 (2014) 248-255

Abstract. Sumatran elephants (*Elephas maximus sumatranus*) are morphologically, anatomically and genetically different from other sub-species of the Asian elephant is distributed only in Sumatra. Riau province has been one of the largest population pockets of elephants together with Aceh, Lampung and Jambi provinces. One of the remaining forest left in Riau province is Tesso Nilo Forest (377,387 hectares). This forest block consists of Tesso Nilo National Park, Production Forest areas belong to two companies, and a small recreation Park. This forest block contains one of the most important mixed peat swamp forests. It is home to endemic and charismatic wildlife species include Sumatran elephants (*Elephas maximus sumatranus*), Sumatran tigers (*Panthera tigris sumatrae*), and many other mammals, birds and reptiles. The forest block has been degraded by frequent burning during the dry season. The smoke from forest fires in Tesso Nilo has spread into several countries such as Malaysia and Singapore on a yearly base. For that reason, the Indonesia Government has been trying to manage this forest block to eliminate, or at least minimize, forest destruction, encroachment of settlement and consequent forest fires.. The objectives of this study are to identify impact open access of roads to deforestation in Tesso Nilo Forest as Sumatran Elephant Habitat. We predict that forest cover lost will increase before and after road construction by using GIS and remote sensing imagery. Deforestation rates have increased from 1.5% per year before road construction to 9.3% per year after road construction, which means that the area of forest has decreased by an annual average of 8156 ha. Our predictions on the forest left in 2018 is only 28,017 ha. As consequences Sumatran elephants habitat will be reduced to 72% of its original area. As human populations increase and more and more forest is converted to estates and agricultural lands, and roads are built across Sumatran forest, elephants-human conflicts are on the rise. © 2014 AENSI Publisher.

J.L. McGee, E. Wiedner & R. Isaza

Prenatal passive transfer of *Mycobacterium tuberculosis* antibodies in Asian elephant (*Elephas maximus*) calves

Journal of Zoo and Wildlife Medicine 45 (2014) 955-957

Abstract. Asian elephant (*Elephas maximus*) dams and their newborn calves were tested for *Mycobacterium tuberculosis* antibodies in serum. Blood was drawn from dams prior to calving and from calves on their day of birth. All six calves born to tuberculosis-reactive dams were also tuberculosis reactive, suggesting prenatal passive placental transfer of tuberculosis antibodies. In contrast, all three calves born to tuberculosis-nonreactive dams lacked detectable tuberculosis antibodies in pre-suckling or day-of-birth blood samples. Of the living tuberculosis-reactive

calves observed from 1 to 11 yr of age, none exhibited clinical signs of tuberculosis infection or became tuberculosis culture positive. This is the first report of prenatal passive placental transfer of tuberculosis antibodies in elephants and demonstrates that detectible tuberculosis antibodies in newborn elephant calves should not be assumed to correlate with clinical tuberculosis. © 2014 by American Association of Zoo Veterinarians.

V. Nijman & C.R. Shepherd
Emergence of Mong La on the Myanmar–China border as a global hub for the international trade in ivory and elephant parts
Biological Conservation 179 (2014) 17-22
Abstract. We report on the illegal trade in ivory and elephant parts in the Special Development Zone of Mong La, Shan State, Myanmar, on the border with China. Mong La caters exclusively for the Chinese market and is best described as a Chinese enclave in Myanmar. We surveyed the morning market, shops and hotels in February 2006, February 2009 and December 2013–January 2014. Trade in body parts primarily concerned dried elephant skin (4 pieces in 2006, 278 in 2009 and 1238 in 2013–2014), and to a lesser extent molars and bones. We found 3494 pieces of carved ivory (none in 2006, 200 in 2009 and 3294 in 2013–2014) and 49 whole tusks (all in 2013–2014) openly for sale, suggesting Mong La has recently emerged as a significant hub of the ivory trade. The origin of the ivory may constitute a combination of Asian elephant ivory from Myanmar and African ivory imported via China. According to local sources the carving was done by Chinese craftsmen, in Mong La as well as across the border in China, and was largely, if not exclusively, intended for the internal Chinese market. Based on asking prices of the most commonly offered items the retail value of the ivory on display in Mong La during the 2013–2014 survey totals an estimated US$1.2 million. Trade in elephant parts and elephant ivory is illegal in Myanmar and CITES I listing of elephants preclude international trade in them. Mong La is governed largely autonomously by an overlord and policed by an Eastern Shan State army. We urge both the Myanmar and Chinese governments to liaise with the Mong La rulers to curb the trade in ivory (and other high profile species), and recommend that the Myanmar and Chinese CITES authorities come together urgently as to resolve the illicit trade of ivory and elephant parts across their borders. © 2014 Reprinted with permission from Elsevier.

P.E. Pellett
Trunkloads of viruses
Journal of Virology 88 (2014) 13520-13522
Abstract. Elephant populations are under intense pressure internationally from habitat destruction and poaching for ivory and meat. They also face pressure from infectious agents, including elephant endotheliotropic herpesvirus 1 (EEHV1), which kills ~20% of Asian elephants (*Elephas maximus*) born in zoos and causes disease in the wild. EEHV1 is one of at least six distinct EEHV in a phylogenetic lineage that appears to represent an ancient but newly recognized subfamily (the Deltaherpesvirinae) in the family Herpesviridae. © 2014 American Society for Microbiology.

N.C. Palei, H.S. Palei, B.P. Ratha & C.S. Kara
Mortality of the endangered Asian elephant *Elephas maximus* by electrocution in Odisha, India
Oryx 48 (2014) 602-604
Abstract. Elephants are threatened globally by habitat loss, poaching and accelerating levels of human–elephant conflict. In the state of Odisha, east India, electrocution by domestic electric power lines is causing mortality of the Asian elephant *Elephas maximus*. We collated data on elephant mortality from such electrocution in the villages surrounding elephant habitat for a period of 12 years (2001–2012). During this period 118 elephants were killed in 91 incidences. Most deaths (73.68%) were a result of accidental contact with electric power lines whilst elephants were moving into agricultural areas for crop raiding. The increasing human population, poor electrical infrastructure and ivory poaching pose serious threats to the continued survival of these elephants. To reduce elephant mortality from electrocution and to ensure the long-term survival of this population we recommend strengthening of the electrical infrastructure, minimizing habitat destruction, increasing public awareness

of the problem, and stronger law enforcement. © 2014 Fauna & Flora International.

J.M. Plotnik & F.B.M. de Waal
Asian elephants (*Elephas maximus*) reassure others in distress
PeerJ 2 (2014) e278
Abstract. Contact directed by uninvolved bystanders toward others in distress, often termed consolation, is uncommon in the animal kingdom, thus far only demonstrated in the great apes, canines, and corvids. Whereas the typical agonistic context of such contact is relatively rare within natural elephant families, other causes of distress may trigger similar, other-regarding responses. In a study carried out at an elephant camp in Thailand, we found that elephants affiliated significantly more with other individuals through directed, physical contact and vocal communication following a distress event than in control periods. In addition, bystanders affiliated with each other, and matched the behaviour and emotional state of the first distressed individual, suggesting emotional contagion. The initial distress responses were overwhelmingly directed toward ambiguous stimuli, thus making it difficult to determine if bystanders reacted to the distressed individual or showed a delayed response to the same stimulus. Nonetheless, the directionality of the contacts and their nature strongly suggest attention toward the emotional states of conspecifics. The elephants' behaviour is therefore best classified with similar consolation responses by apes, possibly based on convergent evolution of empathic capacities. © 2014 The Authors.

U. Rabausch, N. Ilmberger & W.R. Streit
The metagenome-derived enzyme RhaB opens a new subclass of bacterial B type α-l-rhamnosidases
Journal of Biotechnology 191 (2014) 38-45
Abstract. A combined sequence- and function-based analysis of a metagenomic library DNA derived from elephant feces led to the identification of a novel bacterial α-l-rhamnosidase belonging to glycoside hydrolase family 78 (GH78). The gene was designated *rhaB* (4095 bp) and encoded for a putative protein of 1364 amino acids. The C-terminal part of the enzyme revealed an amino acid (AA) sequence identity of 58% to a predicted bacterial α-l-rhamnosidase from *Bacteroides nordii*. Interestingly, the N-terminal region of the deduced enzyme *RhaB* contained a GDSL-like lipase motif and an acetyl-xylan esterase (DAP2) motif. While heterologous expression of the complete rhaB failed, subcloning of the gene identified the most active open reading frame (ORF) to be of 3081 bp, which we designated rhaB1. The enzyme RhaB1 was overexpressed in *Escherichia coli* BL21 (DE3) and was purified to an amount of 75 mg/L of culture medium. In accordance to the intestinal origin, RhaB1 showed a preference for mesophilic conditions with an optimum activity at a temperature T_{Opt} of 40 °C and a pH_{Opt} of 6.5, respectively. The recombinant protein had a K_m value of 0.79 mM and a specific activity v_{max} of 18.4 U for pNP-α-l-rhamnose, a calculated K_m of 6.36 mM and v_{max} of 2.9×10^{-3} U for naringin, and a K_m of 6.75 mM and specific activity v_{max} of 8.63×10^{-2} U for rutin, respectively. Phylogenetic analysis and amino acid domain architecture comparison revealed that RhaB1 belongs to a new subclass of bacterial B type α-l-rhamnosidases of GH 78. To our knowledge RhaB1 is the first biochemically-characterized enzyme of this subclass. © 2014 Reprinted with permission from Elsevier.

L.K. Richman, J.-C. Zong, E.M. Latimer, J. Lock, R.C. Fleischer, S.Y. Heaggans & G.S. Hayward
Elephant endotheliotropic herpesviruses EEHV1A, EEHV1B, and EEHV2 from cases of hemorrhagic disease are highly diverged from other mMammalian herpesviruses and may form a new subfamily
Journal of Virology 88 (2014) 13523-13546
Abstract. A family of novel endotheliotropic herpesviruses (EEHVs) assigned to the genus Proboscivirus have been identified as the cause of fatal hemorrhagic disease in 70 young Asian elephants worldwide. Although EEHV cannot be grown in cell culture, we have determined a total of 378 kb of viral genomic DNA sequence directly from clinical tissue samples from six lethal cases and two survivors. Overall, the data obtained encompass 57 genes, including orthologues of 32 core genes common to all herpesviruses, 14 genes found in some other herpesviruses, plus 10 novel genes, including a

single large putative transcriptional regulatory protein (ORF-L). On the basis of differences in gene content and organization plus phylogenetic analyses of conserved core proteins that have just 20% to 50% or less identity to orthologues in other herpesviruses, we propose that EEHV1A, EEHV1B, and EEHV2 could be considered a new Deltaherpesvirinae subfamily of mammalian herpesviruses that evolved as an intermediate branch between the Betaherpesvirinae and Gammaherpesvirinae. Unlike cytomegaloviruses, EEHV genomes encode ribonucleotide kinase B subunit (RRB), thymidine kinase (TK), and UL9-like origin binding protein (OBP) proteins and have an alphaherpesvirus-like dyad symmetry Ori-Lyt domain. They also differ from all known betaherpesviruses by having a 40-kb large-scale inversion of core gene blocks I, II, and III. EEHV1 and EEHV2 DNA differ uniformly by more than 25%, but EEHV1 clusters into two major subgroups designated EEHV1A and EEHV1B with ancient partially chimeric features. Whereas large segments are nearly identical, three nonadjacent loci totaling 15 kb diverge by between 21 and 37%. One strain of EEHV1B analyzed is interpreted to be a modern partial recombinant with EEHV1A. © 2014 American Society for Microbiology.

S. Sapkota, A. Aryal, S.R. Baral, M.W. Hayward & D. Raubenheimer

Economic analysis of electric fencing for mitigating human-wildlife conflict in Nepal

J. of Resources and Ecology 5 (2014) 237-243

Abstract. Human-wildlife conflict is one of the biggest conservation challenges throughout the world. Various conservation strategies have been employed to limit these impacts, but often they are not adequately monitored and their effectiveness assessed. Recently, electric fencing has been constructed as a means to mitigate human-wildlife conflict surrounding many Nepalese protected areas. To date, there are no other studies analyzing the cost effectiveness and efficacy of fencing for conservation. This study aims to examine the cost effectiveness of electric fencing in the eastern sector of Chitwan National Park, Nepal, where the fencing has recently been constructed. Great Indian one-horned rhinoceros (*Rhinoceros unicornis*), wild boar (*Sus scrofa*), Asian elephant (*Elephas maximus*), and tiger (*Panthera tigris*) were the main wildlife species involved in human-wildlife conflict in the buffer zone area surrounding the park, where the fencing was deployed. Electric fencing was significantly effective in reducing crop damage by 78% and livestock depredation by 30%–60%. Human mortality was not reduced significantly in the study areas and continued at low levels. Our analysis suggested that total net present value of the cost of electric fence in Kagendramalli User Committee (KMUC) and Mrigakunja User Committee (MKUC) was 1,517,959 NPR (Nepalese Rupees, 21,685 USD) and 3,530,075 NPR (50,429 USD) respectively up to the fiscal year 2009/10. Net present benefit in KMUC and MKUC was 16,301,105 NPR (232,872 USD) and 38,304,602 NPR (547,208 USD) respectively up to 2009/10. The cost-benefit ratio of electric fence up to base fiscal year 2009/10 in KMUC is 10.73, whereas MKUC is 10.85. These results illustrate that the electric fencing program is economically and socially beneficial in reducing human-wildlife conflict (crop damage and livestock depredation) around the protected areas where large mammals occur.

A.S. Stoeger & P. Manger

Vocal learning in elephants: neural bases and adaptive context

Current Opinion in Neurobiol. 28 (2014) 101-7

Abstract. In the last decade clear evidence has accumulated that elephants are capable of vocal production learning. Examples of vocal imitation are documented in African (*Loxodonta africana*) and Asian (*Elephas maximus*) elephants, but little is known about the function of vocal learning within the natural communication systems of either species. We are also just starting to identify the neural basis of elephant vocalizations. The African elephant diencephalon and brainstem possess specializations related to aspects of neural information processing in the motor system (affecting the timing and learning of trunk movements) and the auditory and vocalization system. Comparative interdisciplinary (from behavioural to neuroanatomical) studies are strongly warranted to increase our understanding of both vocal learning and vocal behaviour in elephants. © 2014 The Authors.

G.S. Wilkie, A.J. Davison, K. Kerr, M.F. Stidworthy, S. Redrobe, F. Steinbach, A. Dastjerdi & D. Denk

First Fatality associated with elephant endotheliotropic herpesvirus 5 in an Asian elephant: Pathological findings and complete viral genome sequence

Scientific Reports 4 (2014) e6299

Abstract. Infections of Asian elephants (*Elephas maximus*) with elephant endotheliotropic herpesvirus (EEHV) can cause a rapid, highly lethal, hemorrhagic disease, which primarily affects juvenile animals up to the age of four years. So far, the majority of deaths have been attributed to infections with genotype EEHV1 or, more rarely, EEHV3 and EEHV4. Here, we report the pathological characteristics of the first fatality linked to EEHV5 infection, and describe the complete viral DNA sequence. Gross post-mortem and histological findings were indistinguishable from lethal cases previously attributed to other EEHV genotypes, and the presence of characteristic herpesviral inclusions in capillary endothelial cells at several sites was consistent with the diagnosis of acute EEHV infection. Molecular analysis confirmed the presence of EEHV5 DNA and was followed by sequencing of the viral genome directly from post-mortem material. The genome is 180,800 bp in size and contains 120 predicted protein-coding genes, five of which are fragmented and presumably nonfunctional. The seven families of paralogous genes recognized in EEHV1 are also represented in EEHV5. The overall degree of divergence (37%) between the EEHV5 and EEHV1 genomes, and phylogenetic analysis of eight conserved genes, support the proposed classification of EEHV5 into a new species (*Elephantid herpesvirus* 5). © 2014 Reprinted by permission from Macmillan Publishers Ltd.

J.-C. Zong, E.M. Latimer, S.Y. Long, L.K. Richman, S.Y. Heaggans & G.S. Haywarda

Comparative genome analysis of four elephant endotheliotropic herpesviruses, EEHV3, EEHV4, EEHV5, and EEHV6, from cases of hemorrhagic disease or viremia

Journal of Virology 88 (2014) 13547–13569

Abstract. The genomes of three types of novel endotheliotropic herpesviruses (elephant endotheliotropic herpesvirus 1A [EEHV1A], EEHV1B, and EEHV2) associated with lethal hemorrhagic disease in Asian elephants have been previously well characterized and assigned to a new *Proboscivirus* genus. Here we have generated 112 kb of DNA sequence data from segments of four more types of EEHV by direct targeted PCR from blood samples or necropsy tissue samples from six viremic elephants. Comparative phylogenetic analysis of nearly 30 protein-encoding genes of EEHV5 and EEHV6 show that they diverge uniformly by nearly 20% from their closest relatives, EEHV2 and EEHV1A, respectively, and are likely to have similar overall gene content and genome organization. In contrast, seven EEHV3 and EEHV4 genes analyzed differ from those of all other EEHVs by 37% and have a GC content of 63% compared to just 42% for the others. Three strains of EEHV5 analyzed clustered into two partially chimeric subgroups 5A and 5B that diverge by 19% within three small noncontiguous segments totaling 6.2 kb. We conclude that all six EEHV types should be designated as independent species within a proposed new fourth Deltaherpesvirinae subfamily of mammalian herpesviruses. These virus types likely initially diverged close to 100 million years ago when the ancestors of modern elephants split from all other placental mammals and then evolved into two major branches with high- or low-GC content about 35 million years ago. Later additional branching events subsequently generated three paired sister taxon lineages of which EEHV1 plus EEHV6, EEHV5 plus EEHV2, and EEHV4 plus EEHV3 may represent Asian and African elephant versions, respectively. © 2014 Am. Soc. for Microbiology.

"Jambu" in Yala National Park (Sri Lanka)