

Recent Publications on Asian Elephants

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If you need additional information on any of the articles, please feel free to contact me. You can also let me know about new (2012) publications on Asian elephants.

M.A. Ahlering, S. Hedges, A. Johnson, M. Tyson, S.G. Schuttler & L.S. Eggert

Genetic diversity, social structure, and conservation value of the elephants of the Nakai Plateau, Lao PDR, based on non-invasive sampling

Conservation Genetics 12 (2011) 413-422

Abstract. The Lao People's Democratic Republic (PDR) may have the largest Asian elephant population in Indochina. However, elephants on Lao PDR's Nakai Plateau are potentially threatened by the construction of a hydropower dam that will flood important habitat. We conducted a non-invasive genetic study of elephants in this region to provide baseline data on genetic diversity and social structure prior to dam construction. For the 102 elephants we detected, values of observed heterozygosity (0.711) and allelic diversity (8.0 alleles/locus) at microsatellite loci were higher than those found in elephant populations in India and Vietnam, while mitochondrial diversity (haplotype diversity 0.741; nucleotide diversity 0.011) was similar to that reported for the Lao/Vietnam region. Six mitochondrial haplotypes were detected, representing both major clades previously reported in this species. Relatedness estimates between females and young detected near each other are consistent with familial relationships, and relatedness estimates between adult males and females suggest male locational dispersal. Since family group structure appears to be intact in the Nakai region, these elephants will likely move as relatively large family groups in response to habitat disturbance. These results

have positive implications for the viability of the elephant population in this region, demonstrate its conservation significance, and will be valuable for predicting and monitoring the effects of the hydropower dam over time.

R. Alfred, A.H. Ahmad, J. Payne, C. Williams, L.N. Ambu, P.M. How & B. Goossens

Home range and ranging behaviour of Bornean elephant (*Elephas maximus borneensis*) females

PLoS ONE 7 (2012) e31400

Abstract. Background: Home range is defined as the extent and location of the area covered annually by a wild animal in its natural habitat. Studies of African and Indian elephants in landscapes of largely open habitats have indicated that the sizes of the home range are determined not only by the food supplies and seasonal changes, but also by numerous other factors including availability of water sources, habitat loss and the existence of man-made barriers. The home range size for the Bornean elephant had never been investigated before. Methodology/Principal Findings: The first satellite tracking program to investigate the movement of wild Bornean elephants in Sabah was initiated in 2005. Five adult female elephants were immobilized and neck collars were fitted with tracking devices. The sizes of their home range and movement patterns were determined using location data gathered from a satellite tracking system and analyzed by using the Minimum Convex Polygon and Harmonic Mean methods. Home range size was estimated to be 250 to 400 km² in a non-fragmented forest and 600 km² in a fragmented forest. The ranging behavior was influenced by the size of the natural forest habitat and the availability of permanent water sources. The movement pattern was influenced by human disturbance and the need to move from one

feeding site to another. Conclusions/Significance: Home range and movement rate were influenced by the degree of habitat fragmentation. Once habitat was cleared or converted, the availability of food plants and water sources were reduced, forcing the elephants to travel to adjacent forest areas. Therefore movement rate in fragmented forest was higher than in the non-fragmented forest. Finally, in fragmented habitat human and elephant conflict occurrences were likely to be higher, due to increased movement bringing elephants into contact more often with humans. © 2012 Alfred et al.

G. Areendran, K. Raj, S. Mazumdar, M. Munsri, H. Govil & P.K. Sen

Geospatial modeling to assess elephant habitat suitability and corridors in northern Chhattisgarh, India

Tropical Ecology 52 (2011) 275-283

Abstract. We used remote sensing data and geospatial modeling techniques to assess the elephant habitat suitability and dispersal corridor in northern parts of Chhattisgarh, Central India. This region is frequently visited by elephants from the neighboring states of Orissa and Jharkhand in search of better habitat and often enter human habitations and agricultural fields resulting in conflicts with humans. Satellite images and ground information were used for land use/ land cover mapping and identification of conflict zones. Analytic Hierarchy Process (AHP) was used to assign weights to the three factors, viz., type of vegetation cover, proximity to water body and proximity to human habitation. Based on the analysis a corridor for elephant movement and migration has been identified which could be notified and managed by the state government in order to minimize human - elephant conflicts in the region. © 2011 International Society for Tropical Ecology.

J. Arvidsson, M. Amundin & M. Laska

Successful acquisition of an olfactory discrimination test by Asian elephants, *Elephas maximus*

Physiology & Behavior 105 (2012) 809–814

Abstract. The present study demonstrates that Asian elephants, *Elephas maximus*, can successfully be trained to cooperate in an olfactory

discrimination test based on a food-rewarded two-alternative instrumental conditioning procedure. The animals learned the basic principle of the test within only 60 trials and readily mastered intramodal stimulus transfer tasks. Further, they were capable of distinguishing between structurally related odor stimuli and remembered the reward value of previously learned odor stimuli after 2, 4, 8, and 16 weeks of recess without any signs of forgetting. The precision and consistency of the elephants' performance in tests of odor discrimination ability and long-term odor memory demonstrate the suitability of this method for assessing olfactory function in this proboscoid species. An across-species comparison of several measures of olfactory learning capabilities such as speed of initial task acquisition and ability to master intramodal stimulus transfer tasks shows that Asian elephants are at least as good in their performance as mice, rats, and dogs, and clearly superior to nonhuman primates and fur seals. The results support the notion that Asian elephants may use olfactory cues for social communication and food selection and that the sense of smell may play an important role in the control of their behavior. © 2012 reprinted with permission from Elsevier.

B. Arzi, V.P. Willard, D.J. Huey, F.J.M. Verstraete, N. Vapniarsky-Arzi & K.A. Athanasiou

The temporomandibular joint disc of Asian elephant (*Elephas maximus*) and African elephant (*Loxodonta africana*)

European J. of Wildlife Res. 58 (2012) 451-459

Abstract. The temporomandibular joint (TMJ) is a synovial articulation between the mandibular head of the condylar process of the mandible and the mandibular fossa of the squamous temporal bone. Extensions of the fibrous capsule into the joint space form a biconcave disc that functions as an articulating surface and divides the joint into dorsal and ventral compartments. The TMJ disc plays a crucial role in normal functioning of the joint, and differences in cranial morphology, mastication patterns, and diet are reflected in the material and biochemical properties of the disc. The purpose of the present case study was to compare the regional histologic differences between two elephant genera and quantify the biochemical and biomechanical properties of

the African elephant disc. This study provides a unique insight into the elephant TMJ disc and also provides a comparison between the African and the Asian elephant genera. The results demonstrate several remarkable findings. First, structure–function relationships exist within the elephant TMJ disc. Second, regional variations exist in the elephant TMJ disc, and these are likely to correlate with its functional requirement. Additionally, it is apparent that some properties of the disc vary with the specific anatomy, diet requirement, and jaw motion. Finally, in comparison with the TMJ disc of other species, it is clear that, although the elephant disc is unique, it has properties that transcend and are preserved among the species. © 2011 Springer-Verlag.

D. Bowman

Bring elephants to Australia?

Nature 482 (2012) 30

Abstract. none

M. Buckley, N. Larkin & M. Collins

Mammoth and Mastodon collagen sequences; survival and utility

Geochimica et Cosmochimica Acta 75 (2011) 2007–2016

Abstract. Near-complete collagen (I) sequences are proposed for elephantid and mammutid taxa, based upon available African elephant genomic data and supported with LC–MALDI-MS/MS and LC–ESI-MS/MS analyses of collagen digests from proboscidean bone. Collagen sequence coverage was investigated from several specimens of two extinct mammoths (*Mammuthus trogontherii* and *Mammuthus primigenius*), the extinct American mastodon (*Mammot americanum*), the extinct straight-tusked elephant (*Elephas (Palaeoloxodon) antiquus*) and extant Asian (*Elephas maximus*) and African (*Loxodonta africana*) elephants and compared between the two ionization techniques used. Two suspected mammoth fossils from the British Middle Pleistocene (Cromerian) deposits of the West Runton Forest Bed were analysed to investigate the potential use of peptide mass spectrometry for fossil identification. Despite the age of the fossils, sufficient peptides were obtained to identify these as elephantid, and sufficient sequence variation to discriminate elephantid

and mammutid collagen (I). In-depth LC–MS analyses further failed to identify a peptide that could be used to reliably distinguish between the three genera of elephantids (*Elephas*, *Loxodonta* and *Mammuthus*), an observation consistent with predicted amino acid substitution rates between these species. © 2011 reprinted with permission from Elsevier.

R.W. Burn, F.M. Underwood & J. Blanc

Global trends and factors associated with the illegal killing of elephants: A hierarchical Bayesian analysis of carcass encounter data

PLoS ONE 6 (2011) e24165

Abstract. Elephant poaching and the ivory trade remain high on the agenda at meetings of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Well-informed debates require robust estimates of trends, the spatial distribution of poaching, and drivers of poaching. We present an analysis of trends and drivers of an indicator of elephant poaching of all elephant species. The site-based monitoring system known as Monitoring the Illegal Killing of Elephants (MIKE), set up by the 10th Conference of the Parties of CITES in 1997, produces carcass encounter data reported mainly by anti-poaching patrols. Data analyzed were site by year totals of 6337 carcasses from 66 sites in Africa and Asia from 2002 – 2009. Analysis of these observational data is a serious challenge to traditional statistical methods because of the opportunistic and non-random nature of patrols, and the heterogeneity across sites. Adopting a Bayesian hierarchical modeling approach, we used the proportion of carcasses



Babies having fun (Lolugas Wewa, Sri Lanka)

that were illegally killed (PIKE) as a poaching index, to estimate the trend and the effects of site- and country-level factors associated with poaching. Important drivers of illegal killing that emerged at country level were poor governance and low levels of human development, and at site level, forest cover and area of the site in regions where human population density is low. After a drop from 2002, PIKE remained fairly constant from 2003 until 2006, after which it increased until 2008. The results for 2009 indicate a decline. Sites with PIKE ranging from the lowest to the highest were identified. The results of the analysis provide a sound information base for scientific evidence-based decision making in the CITES process. © 2011 Burn et al.

L. Chartier, A. Zimmermann & R.J. Ladle

Habitat loss and human–elephant conflict in Assam, India: does a critical threshold exist?

Oryx 45 (2011) 528–533

Abstract. Human–elephant conflict in India, driven by habitat loss and an expanding human population, is a complex challenge for biodiversity conservation. Determining if, how and why this conflict has changed over time will be an important step towards managing landscapes where people and elephants *Elephas maximus* coexist. This study combines social surveys and remote sensing data to analyse patterns in human–elephant conflict and land-use change over time. The reported experience of conflict increased dramatically in the early 1980s, with 85% of those surveyed indicating that conflict began after 1980. The expansion of conflict showed a significant southward trend and was associated with forest cover dropping below 30–40%. Based on our results we propose that a critical habitat threshold for human–elephant conflict may exist at 30–40% forest cover. Below this level, conflict expanded across the landscape. The existence of such a deforestation threshold may have important implications for landscape management in elephant range states that seek to avoid or mitigate further conflict. Maintenance of remaining forest areas, reforestation, and the creation of habitat corridors are strategies that could help prevent further expansion of conflict. © 2011 Fauna & Flora International.

T.E. Davies, S. Wilson, N. Hazarika, J. Chakrabarty, D. Das, D.J. Hodgson & A. Zimmermann
Effectiveness of intervention methods against crop-raiding elephants

Conservation Letters 4 (2011) 346–354

Abstract. The raiding of crops by elephants is one of the major components of human–elephant conflict, causing loss of livelihood and retaliation against elephants. To mitigate this conflict, various intervention methods are in use by farmers across Africa and Asia; yet there have been few rigorous assessments of their effectiveness. We provide an assessment of the efficacy of interventions in use by communities in Assam from a 3-year survey dataset using Generalized Linear Mixed Modeling. We found spotlights, chili fences, and electric fences to be highly effective at preventing crop damage by elephants when used in isolation, but when used in combination with noise their efficacy was compromised. Our study highlights the importance of evaluating intervention methods to determine their effectiveness. We propose the use of fences and spotlights be promoted in Assam, in conjunction with long-term habitat protection and restoration strategies. © 2011 Wiley Periodicals, Inc.

M. Doube, M.M. Kłosowski, A.M. Wiktorowicz-Conroy, J.R. Hutchinson & S.J. Shefelbine

Trabecular bone scales allometrically in mammals and birds

Proc. of the Royal Society B 278 (2011) 3067–73

Abstract. Many bones are supported internally by a latticework of trabeculae. Scaling of whole bone length and diameter has been extensively investigated, but scaling of the trabecular network is not well characterized. We analysed trabecular geometry in the femora of 90 terrestrial mammalian and avian species with body masses ranging from 3 to 3400 kg. We found that bone volume fraction does not scale substantially with animal size, while trabeculae in larger animals' femora are thicker, further apart and fewer per unit volume than in smaller animals. Finite element modelling indicates that trabecular scaling does not alter the bulk stiffness of trabecular bone, but does alter strain within trabeculae under equal applied loads. Allometry of bone's trabecular tissue may contribute to

the skeleton's ability to withstand load, without incurring the physiological or mechanical costs of increasing bone mass. © 2011 The Royal Society.

T.L. Dow, I. Holásková & J.L. Brown

Results of the third reproductive assessment survey of north American Asian (*Elephas maximus*) and African (*Loxodonta africana*) female elephants

Zoo Biology 30 (2011) 699–711

Abstract. A written survey assessed reproductive status of female Asian and African elephants in AZA/SSP facilities in 2008, and data were compared to surveys conducted in 2002 and 2005. Results showed that ovarian acyclicity rates across the surveys remained unchanged for Asian (13.3, 10.9 and 11.1%) and African (22.1, 31.2 and 30.5%) elephants, respectively ($P>0.05$), but were higher overall for African compared to Asian elephants ($P<0.05$). In 2008, the percentages of Asian and African elephants with irregular cycles (14.3 and 15.8%) and irregular + no cycles (25.4 and 46.4%) was similar to 2005 (7.6 and 11.8%; 18.5 and 43.0%), but were increased compared to 2002 (2.6 and 5.2%; 16.0 and 27.3%), respectively ($P<0.05$). For both species, ovarian acyclicity increased with age ($P<0.05$). Reproductive tract pathologies did not account for the majority of acyclicity, although rates were higher in noncycling females ($P<0.05$). Bull presence was associated with increased cyclicity rates

($P<0.05$) for Asian (92.5 vs. 58.3%) and African (64.9 vs. 57.8%) elephants compared to females at facilities with no male, respectively. Cyclicity rates were higher for Asian (86.8 vs. 65.2%) and African (67.9 vs. 56.7%) elephants managed in free compared to protected contact programs ($P<0.05$), respectively. Geographical facility location had no effect on cyclicity ($P>0.05$). In summary, incidence of ovarian cycle problems continues to predominantly affect African elephants. Although percentages of acyclicity did not increase between 2005 and 2008, 42.2% Asian and 30.2% African females were no longer being hormonally monitored; thus, reproductive cycle abnormalities could be worse than current data suggest. © 2011 Wiley-Liss, Inc.

G.A. Dumonceaux, J. St. Leger, J.H. Olsen, M.S. Burton, D. Ashkin & J.N. Maslow

Genitourinary and pulmonary multidrug resistant *Mycobacterium tuberculosis* infection in an Asian elephant (*Elephas maximus*)

J. of Zoo and Wildlife Med. 42 (2011) 709-712

Abstract. A female Asian elephant (*Elephas maximus*) developed vaginal and trunk discharge. Cultures were positive for pan-susceptible *Mycobacterium tuberculosis*. Isoniazid and pyrazinamide were given rectally and monitored by serum levels. After being trained at 10 mo to accept oral dosing, treatment was changed and rifampin was added. Oral medications were administered for another 10 mo. A year after completion of therapy, the vaginal discharge increased and cultures yielded *M. tuberculosis*, resistant to isoniazid and rifampin. Treatment with oral ethambutol, pyrazinamide, and enrofloxacin and intramuscular amikacin was initiated. Although follow-up cultures became negative, adverse reactions to medications precluded treatment completion. Due to public health concerns related to multidrug resistant *M. tuberculosis* (MDR-TB), the elephant was euthanized. Postmortem smears from the lung, peribronchial, and abdominal lymph nodes yielded acid-fast bacteria, although cultures were negative. This case highlights important considerations in the treatment of *M. tuberculosis* in animals and the need for a consistent approach to diagnosis, treatment, and follow-up. © 2011 American Association of Zoo Veterinarians.



Tusker at Kaudulla National Park (Sri Lanka)

Ø. Flagstad, N.M.B. Pradhan, L.G. Kvernstuen & P. Wegge

Conserving small and fragmented populations of large mammals: Non-invasive genetic sampling in an isolated population of Asian elephants in Nepal

J. for Nature Conservation 20 (2012) 181–190

Abstract. The Terai is one of the world's most spectacular landscapes, encompassing parts of Nepal and northern India. This area used to harbour large and continuous populations of charismatic species like elephants, tigers and rhinoceros. However, recent habitat fragmentation reduced these populations into small, partially or completely isolated remnants. The largest of these fragments in Nepal is the Bardia National Park. Here, the elephant population was functionally extinct in the early 1970s and -80s, but was rescued by a considerable number of immigrants in 1994. In order to assess population size, sex ratio, age structure, and levels of genetic variation, we carried out non-invasive genetic sampling, using elephant dung as the source of DNA. A capture-mark-recapture estimate of population size suggested that there were 57 individuals in the study area, which agrees well with field observations. Notably, a strongly male-biased sex ratio was evident among sub-adult individuals. This observation suggests the presence of sub-adult immigrants in the population, which was supported by formal migrant detection analysis. Genetic variation was quite high and the evidence for male immigrants suggests that there are good prospects for maintenance of genetic diversity. A decade ago a large-scale project was initiated in the Terai region to link remaining populations of large mammals through dispersal corridors. The program is basically founded on the assumption that habitat fragments are isolated with little or no migration between them. Our results indicate that this may not be the case, at least not for the Asian elephant in western Nepal, which therefore reduces the alleged extinction risk from genetic erosion and stochastic demographic events. © 2012 reprinted with permission from Elsevier.

R. Ghosal, N. Kalaiivanan, R. Sukumar & Polani B. Seshagiri

Assessment of estrus cyclicity in the Asian elephant (*Elephas maximus*) by measurement

of fecal progesterone metabolite 5 α -P-3OH, using a non-invasive assay

General and Comparative Endocrinology 175 (2012) 100-108

Abstract. Reproductive management of the Asian elephant (*Elephas maximus*) is important for its conservation. To monitor its estrous cyclicity, we earlier used an indirect ELISA to show that levels of fecal progesterone (P₄)-metabolite (allopregnanolone: 5 α -P-3OH) in semi-captive females sampled randomly positively correlated with serum P₄ levels. In this longitudinal study (51 weeks), we measured levels of fecal 5 α -P-3OH and serum P₄ in seven semi-captive female elephants. Females exhibited three types of hormonal profiles. Four females showed cyclical patterns of fecal 5 α -P-3OH and serum P₄ typical of normal estrous cycles, two showed acyclic pattern while one showed high values indicative of a pregnant animal. Values for anestrus or follicular phases were 60.3 lg/g (5 α -P-3OH) and 60.3 ng/mL (P₄); for luteal phase 0.32–11.09 μ g/g (5 α -P-3OH) and 0.32–1.48 ng/mL (P₄); for pregnancy 1.41–7.38 μ g/g (5 α -P-3OH) and 0.39–1.6 ng/mL (P₄). A positive correlation ($t = 8.8$, $p < 0.01$, $n = 321$) between levels of fecal 5 α -P-3OH and serum P₄ was observed. A random sample of 30 free-ranging female elephants showed fecal 5 α -P-3OH values of 0.06–23.4 μ g/g, indicating them to be in different stages of estrous cyclicity. This study is the first to assess the reproductive phases of female Asian elephants based on the correlative-patterns of both the fecal 5 α -P-3OH and serum P₄ values over multiple estrous cycles. This has a potential application in the reproductive management and conservation of Asian elephants. © 2011 reprinted with permission from Elsevier.

R. Ghosal, P.B. Seshagiri & R. Sukumar

Dung as a potential medium for inter-sexual chemical signaling in Asian elephants (*Elephas maximus*)

Behavioural Processes 91 (2012) 15-21

Abstract. Chemical signaling is a prominent mode of male–female communication among elephants, especially during their sexually active periods. Studies on the Asian elephant in zoos have shown the significance of a urinary pheromone (Z7-12:Ac) in conveying the reproductive

status of a female toward the opposite sex. We investigated the additional possibility of an inter-sexual chemical signal being conveyed through dung. Sixteen semi-captive adult male elephants were presented with dung samples of three female elephants in different reproductive phases. Each male was tested in 3 separate trials, within an interval of 1–3 days. The trials followed a double-blind pattern as the male and female elephants used in the trials were strangers, and the observer was not aware of the reproductive status of females during the period of bioassays. Males responded preferentially ($P < 0.005$), in terms of higher frequency of sniff, check and place behavior toward the dung of females close to pre-ovulatory period (follicular-phase) as compared to those in post-ovulatory period (luteal-phase). The response toward the follicular phase samples declined over repeated trials though was still significantly higher than the corresponding response toward the non-ovulatory phase in each of the trials performed. This is the first study to show that male Asian elephants were able to distinguish the reproductive phase of the female by possibly detecting a pre-ovulatory pheromone released in dung. © 2012 reprinted with permission from Elsevier.

S.S. Glaeser, K.E. Hunt, M.S. Martin, M. Finnegan & J.L. Brown

Investigation of individual and group variability in estrous cycle characteristics in female Asian elephants (*Elephas maximus*) at the Oregon Zoo

Theriogenology 78 (2012) 285–296

Abstract. Evaluating ovarian cycle activity through longitudinal progesterone monitoring is important for optimizing breeding management of captive elephants and understanding impact of life events (births, deaths, and transfers) on reproductive function. This study summarized serum progesterone profiles for eight Asian mainland elephants (*Elephas maximus indicus*) and one Bornean elephant (*E. maximus borneensis*) at the Oregon Zoo over a 20-yr interval, and represents the longest longitudinal dataset evaluated to date. Estrous cycle characteristics were more varied than previously reported for this species, with an overall duration of 12 to 19 wk, luteal phase duration of 4 to 15

wk, and follicular phase duration of 2 to 12 wk. In general, there was more cycle variability across than within individual elephants. Compared with other elephants in the group, the Borneo female exhibited consistently longer cycle lengths, higher progesterone concentrations, and greater cycle variability; however, it is not known if this represents a subspecies or an individual difference. Cycle durations did not appear to change over time or with age, and the first pubertal cycle was similar to subsequent cycles. Variability in duration of the follicular phase was greater than that of the luteal phase. In addition, there was a significant negative relationship between luteal and follicular phase durations, suggesting a possible regulatory role of the follicular phase in maintaining a relatively consistent cycle duration within individuals. Overall, we found these elephants to be highly resilient in that major life events (births, deaths, and changes in herd structure) had minimal effect on cycle dynamics over time. In conclusion, the higher range in cycle phase characteristics is likely because of the larger number of elephants studied and longer duration of longitudinal monitoring, and may be more representative of the captive population as a whole. Furthermore, identification of significant inter-animal variability suggests that understanding the complexities of herd reproductive characteristics could facilitate development of more effective institution-specific breeding management strategies. © 2012 reprinted with permission from Elsevier.

T.E. Goodwin, L.J. Broederdorf, B.A. Burkert, I.H. Hirwa, D.B. Mark, Z.J. Waldrip, R.A. Kopper, M.V. Sutherland, E.W. Freeman, J.A. Hollister-Smith & B.A. Schulte

Chemical signals of elephant musth: Temporal aspects of microbially-mediated modifications
Journal of Chemical Ecology 38 (2012) 81–87

Abstract. Mature male African (*Loxodonta africana*) and Asian (*Elephas maximus*) elephants exhibit periodic episodes of musth, a state in which serum androgens are elevated, food intake typically decreases, aggressiveness often increases, and breeding success is enhanced. Urine is a common source of chemical signals in a variety of mammals. Elephants in musth dribble urine almost continuously for lengthy

periods, suggesting that the chemicals in their urine may reveal their physiological condition to conspecifics. We investigated the volatile urinary chemicals in captive male elephants using automated solid phase dynamic extraction (SPDE) and gas chromatography–mass spectrometry (GC-MS). We found higher levels of alkan-2-ones, alkan-2-ols, and some aromatic compounds in urine from males in musth than in urine from non-musth males or from females. Levels of ketones and alcohols increased as the urine aged, likely due to microbial metabolism of fatty acids. Protein- derived aromatic metabolites also increased in abundance after urination, likely due to microbial hydrolysis of hydrophilic conjugates. We suggest that microbes may play an important role in timed release of urinary semiochemicals during elephant musth. © 2012 Springer Science+Business Media.

V.R. Goswami, M.V. Lauretta, M.D. Madhusudan & K.U. Karanth

Optimizing individual identification and survey effort for photographic capture–recapture sampling of species with temporally variable morphological traits

Animal Conservation 15 (2012) 174–183

Abstract. Endangered, wide-ranging megafauna have many threats to contend with during their struggle for survival in an ever-increasing human dominance of the environment. Reliable monitoring of endangered large mammal populations is therefore a critical conservation requirement. Photographic capture–recapture (CR) techniques have opened up avenues for population monitoring of individually recognizable large mammal species. The efficient application of these techniques, however, can be constrained by challenges in reliably identifying individuals arising from the use of multiple, and potentially variable traits, as well as issues of temporal sampling of populations in the field. We address these key problems by describing an automated process of rapidly identifying individual Asian elephants (*Elephas maximus*) from photographs, and comparing resultant CR-based population parameter estimates with those obtained using supervised visual identification of individuals. In addition, we assess the temporal effort necessary for robust estimation of

demographic parameters in our study population. Morphological traits that maintain constancy over time, including variations in tusk characteristics, and ear fold and lobe shape, proved the most reliable for individual identification and subsequent estimation of population parameters. The use of temporally variable traits contributed to high probabilities of misidentification and biased estimates of population size. We found a minimum of seven sampling occasions necessary for reliable population estimation. Our study contributes to design issues for CR studies by providing insights into optimality of sampling effort such that precision of parameter estimates are not compromised while minimizing survey costs. We demonstrate the importance of accurate individual identification in the context of such studies and recommend the use of fixed morphological traits as the optimal individual identification strategy for species where animals are distinguished on the basis of multiple attributes, including some that may be variable over time. © 2011 Zoological Society of London.

T.N.E. Gray & C. Phan

Habitat preferences and activity patterns of the larger mammal community in Phnom Prich Wildlife Sanctuary, Cambodia

Raffles Bulletin of Zoology 59 (2011) 311–318

Abstract. The northern and eastern plains of Cambodia support one of the largest extents of lowland deciduous forest in South-east Asia and are globally significant for mammal conservation. Between Dec.2008 and Aug.2009 intensive camera-trapping was conducted within mosaic deciduous dipterocarp and mixed- deciduous/ semi-evergreen forest in the east of Phnom Prich Wildlife Sanctuary, Mondulhiri province, Cambodia. Forty camera-trap locations were set up for >2700 camera-trap nights producing 707 independent encounters of 23 mammal species. Eight globally threatened species of mammals were recorded including the Asian elephant (*Elephas maximus*), banteng (*Bos javanicus*) and dhole (*Cuon alpinus*). Two species, the gaur (*Bos gaurus*) and pig-tailed macaque (*Macaca nemestrina*), showed significant preference for forest type (higher Relative Abundance Index of both species in mixed-deciduous/semi-evergreen forest). The mix of drier deciduous

dipterocarp forest and wetter mixed-deciduous and semi-evergreen forest appears important for maintaining the conservation value of the site. Camera trap encounter rates were lower in areas within a day's walk from villages at the periphery of the protected area whilst cathemeral species displayed higher proportions of nocturnal activity than in similar studies from elsewhere in South-east Asia. We suggest disturbance and hunting may therefore be affecting the distribution and activity patterns of key species. Managing the Non Timber Forest Product (NTFP) collectors as well as finalising, and enforcing, zonation within the protected area are recommended conservation measures for the mammal community. © 2011 National University of Singapore.

S. Gubbi

Patterns and correlates of human–elephant conflict around a south Indian reserve

Biological Conservation 148 (2012) 88-95

Abstract. Success stories in Indian conservation also carry opportunity costs in the form of human–wildlife conflicts, especially to people living in close proximity with wildlife. In India, human–wildlife conflict is a serious challenge to wildlife conservation, which needs a much-improved scientific and social understanding. In this study, I assess the patterns and correlates of human–elephant conflicts around Nagarhole National Park, southern India. I hypothesised that human and livestock demographic variables, and factors such as cropping patterns, availability of irrigated land around the national park, and protected area frontage to be the underlying correlates of conflict. Using applications and documents filed with the wildlife department by affected farmers during the period 2006–2009, I analysed crops affected, compensation payments made by the Government, spatio-temporal patterns of conflict and identified the key correlates of human–elephant conflict. 98.8% of the conflict incidences occurred in villages that lie within 6 km from the national park boundary. Of the 26 crop types affected by elephants, finger millet, maize, cotton, paddy and sugarcane formed 86.34% of the total crop losses. Conflict frequencies were highest during August–November, a period when there was a decrease in rainfall and important crops such as

finger millet, maize and paddy were ripening. Multiple linear regression results suggest that villages with higher protected area frontage and unirrigated land were key variables underlying conflict frequency. However, results from this study suggests that there are other probable factors such as elephant behaviour, movement patterns and/or maintenance of physical barriers which could be more important determinants of conflict. © 2012 printed with permission from Elsevier.

S.K. Gupta, K. Thangaraj & L. Singh

Identification of the source of ivory idol by DNA analysis

J. of Forensic Sciences 56 (2011) 1343-1345

Abstract. In this study, we describe a forensic case dealing with the identification of the source of the processed ivory object by DNA analysis. Two pieces of Lord Krishna's idols from a shop were confiscated by an investigating agency of the Indian government and forwarded to us to identify the source of its origin. We succeeded in isolating DNA from both processed ivory idols by using the phenol/chloroform DNA extraction method. The extracted DNA was subjected to PCR amplification using an elephant-specific mitochondrial DNA (mtDNA) D-loop marker. DNA sequence analysis of the amplified fragment of mtDNA D-loop region confirmed that the idols were consistent with Asian elephant with 99% similarity. © 2011 American Academy of Forensic Sciences.

N.H. Hall, R. Isaza, J.S. Hall, E. Wiedner, B.L. Conrad & H.L. Wamsley

Serum osmolality and effects of water deprivation in captive Asian elephants (*Elephas maximus*)

Journal of Veterinary Diagnostic Investigation 24 (2012) 688-695

Abstract. Serum from 21 healthy, captive Asian elephants (*Elephas maximus*) was evaluated by measured and calculated osmolality. Serum osmolality results for this population of Asian elephants had a median of 261 mOsm/kg and an interquartile interval of 258–269 mOsm/kg when measured by freezing point osmometry and a median of 264 mOsm/kg and an interquartile interval of 257–269 mOsm/kg when measured

by vapor pressure osmometry. These values are significantly lower than values reported in other mammalian species and have important diagnostic and therapeutic implications. Calculated osmolality produced unreliable results and needs further study to determine an appropriate formula and its clinical application in this species. A 16-hr water deprivation test in 16 Asian elephants induced a small, subclinical, but statistically significant increase in measured serum osmolality. Serum osmolality, blood urea nitrogen, and total protein by refractometer were sensitive indicators of hydration status. Serum osmolality measurement by freezing point or vapor pressure osmometry is a useful adjunct to routine clinical tests in the diagnostic evaluation of elephants. © 2012 The Authors.

K. Hardman, A. Dastjerdi, R. Gurralla, A. Routh, M. Banks, F. Steinbach & T. Bouts

Detection of elephant endotheliotropic herpesvirus type 1 in asymptomatic elephants using TaqMan real-time PCR

Veterinary Record 170 (2012) e205

Abstract. This study assessed the feasibility of identifying asymptomatic viral shedders using a novel TaqMan real-time PCR on trunk washes and swabs from the conjunctiva, palate and vulva of elephants. Six elephants from a UK collection were sampled weekly over a period of 11 weeks for this study. The herd prevalence of elephant endotheliotropic herpesvirus-1 (EEHV-1) was 100% by PCR. The virus DNA was detected in all the sampling sites; however, the prevalence of



Elephant in Bandipur National Park (India)

virus DNA in the conjunctiva swabs was higher. In addition, Asian elephants from two continental European collections were sampled once and one animal tested positive on a trunk wash. The virus from this animal was phylogenetically typed as EEHV-1A based on 231 nucleotides of the terminase gene.

G.S. Hayward

Conservation: clarifying the risk from herpesvirus to captive Asian elephants

Veterinary Record 170 (2012) 202-203

Abstract. none.

Q. He, Z. Wu, W. Zhou & R. Dong

Perception and attitudes of local communities towards wild elephant-related problems and conservation in Xishuangbanna, Southwestern China

Chinese Geograph. Science 21 (2011) 629-636

Abstract. The problem of wild elephants, or human-elephant conflict (HEC), influences the daily life of local communities and hinders the conservation of wild elephants. The perception and attitudes of local communities who inhabited the frontiers between human activities and wild elephant movement are important to the mitigation of the HEC and conservation of wild elephants. To analyze the perception and attitudes of local communities, the Participatory Rural Appraisal (PRA) was used in the investigation of 423 interviewees from 22 villages in Xishuangbanna from July 2009 to February 2010. The results indicated that local communities had their views on the elephant-related problems. In field survey, we found that 66.5% of interviewees were willing to support, participate in, and assist in the conservation of wild elephants; 33.5% of interviewees were opposed or indifferent to such conservation, because their livelihoods and even their lives were endangered by wild elephants. These views and attitudes were influenced by local communities' perception of HEC, education level, gender and self-interest. Therefore, it is necessary to analyze the diverse views among local communities and balance profits and costs in addressing HEC. © 2011 Science Press, Northeast Institute of Geography and Agroecology, CAS & Springer-Verlag.

J.R. Hutchinson, C. Delmer, C.E. Miller, T. Hildebrandt, A.A. Pitsillides & A. Boyde

From flat foot to fat foot: Structure, ontogeny, function, and evolution of elephant “sixth toes”

Science 334 (2011) 1699-1703

Abstract. Several groups of tetrapods have expanded sesamoid (small, tendon-anchoring) bones into digit-like structures (“predigits”), such as pandas’ “thumbs.” Elephants similarly have expanded structures in the fat pads of their fore- and hindfeet, but for three centuries these have been overlooked as mere cartilaginous curiosities. We show that these are indeed massive sesamoids that employ a patchy mode of ossification of a massive cartilaginous precursor and that the predigits act functionally like digits. Further, we reveal clear osteological correlates of predigit joint articulation with the carpals/tarsals that are visible in fossils. Our survey shows that basal proboscideans were relatively “flat-footed” (plantigrade), whereas early elephantiforms evolved the more derived “tip-toed” (subunguligrade) morphology, including the predigits and fat pad, of extant elephants. Thus, elephants co-opted sesamoid bones into a role as false digits and used them for support as they changed their foot posture. © 2011 reprinted with permission from AAAS.

P. Imrat, M. Hernandez, S. Rittm, N. Thongtip, S. Mahasawangkul, J. Gosaálvez & W.V. Holt

The dynamics of sperm DNA stability in Asian elephant (*Elephas maximus*) spermatozoa before and after cryopreservation

Theriogenology 77 (2012) 998–1007

Abstract. The purpose of this study was to investigate the occurrence of sperm DNA fragmentation in Asian elephant (*Elephas maximus*) spermatozoa at various processing stages before and after cryopreservation. Five semen samples from four elephants were assessed at four different stages during processing; after (1) collection and reextension in TEST-egg yolk; (2) cooling to 5°C; (3) equilibration for 1 h with glycerol; (4) thawing. An experimental approach was adopted that allowed comparisons of DNA fragmentation rates developed after the various processing stages. For this, spermatozoa were incubated in TEST-yolk media at 37°C for 0, 4,

8, 24 and 48 h, and sperm DNA fragmentation rates were estimated using an elephant-specific Halosperm procedure. Incubation at 37°C induced a rapid increase in DNA fragmentation, and significant differences between males were observed. The overall rate of increase over 4 h was estimated at about 5% per hour, and no significant changes to this rate were observed at the different processing stages, even, including the post-thaw samples. As semen quality of the five ejaculates was relatively poor, the basic semen parameter data were compared with nine different samples collected 11 mo earlier to see whether the tested samples were atypical or representative of the population. As there was no significant difference between the two sets of samples, it is believed that the samples tested for DNA stability were not unusually sensitive. These results suggest that Asian elephant spermatozoa are more susceptible to DNA fragmentation than spermatozoa of other mammals. © 2012 reprinted with permission from Elsevier Inc.

N. Irie & T. Hasegawa

Summation by Asian elephants (*Elephas maximus*)

Behavioral Sciences 2 (2012) 50-56

Abstract. Recent empirical evidence for complex cognition in elephants suggests that greater attention to comparative studies between non-human primates and other animals is warranted. We have previously shown that elephants possess the ability to judge the difference between two discrete quantities, and unlike other animals, their choice does not appear to be affected by distance or overall quantity. In this study, we investigated Asian elephants’ ability to perform summation, as exemplified by the ability to combine four quantities into two sums and subsequently compare them. We presented two discrete sums (3–7) to the elephants by baiting two buckets; they were loaded sequentially with two discrete quantities (1–5 pieces) of food per bucket. All three elephants selected the larger grand sum significantly more often than the smaller grand sum. Moreover, their performance was not affected by either distance to the bait or the overall quantity evaluated. Studies report that the performance of other animal species on similar tasks declines as distance to the bait

decreases and as the overall quantities evaluated increase. These results suggest that the numerical cognition of Asian elephants may be different from that of other animals, but further study is required to elucidate the differences precisely. © 2012 by the authors.

A. Ito, T. Mishima, K. Nataami, K. Ikek & S. Imai

Infraciliature of eight *Triplumaria* species (Ciliophora, Entodiniomorpha) from Asian elephants with the description of six new species

European J. of Protistology 47 (2011) 256–273

Abstract. Intestinal ciliates excreted in the feces of Asian elephants were surveyed. Fourteen species in the order Entodiniomorpha were detected. Nine *Triplumaria* species in the family Cycloposthiidae were found. Using the silver impregnation, two known species, *T. antis* and *T. dvoinosi*, were redescribed and six new species, *T. sukuna* n. sp., *T. zuze* n. sp., *T. solea* n. sp., *T. suwako* n. sp., *T. fulgora* n. sp., and *T. harpagonis* n. sp., were described. *T. sukuna*, *T. zuze*, *T. solea*, and *T. suwako* have the perivestibular polybrachykinety along the vestibular opening. The buccal infraciliary bands of *T. suwako* are similar to those of *T. selenica* found from elephants and the buccal infraciliary bands of *T. sukuna*, *T. zuze*, and *T. solea* are similar to those of *T. grypoclunis* described from rhinoceroses. *T. antis*, *T. dvoinosi*, *T. fulgora*, and *T. harpagonis* have the vestibular polybrachykinety extending down inside the vestibulum as found in rumen ciliates in the family Ophryoscolecidae. The caudal ciliary zones of *T. dvoinosi* and *T. fulgora* were retractable as found in rumen ophryoscolecids. *Raabena bella* and *Pseudoentodinium elephantis* showed high composition values over 30%. Ciliate densities in the three fecal samples were 0.15, 1.09, and 2.07×10^4 /ml. © 2011 reprinted with permission from Elsevier.

P. Jepson, M. Barua, R.J. Ladle & K. Buckingham
Towards an intradisciplinary bio-geography: a response to Lorimer's 'lively biogeographies' of Asian elephant conservation

Transactions of the Institute of British Geographers 36 (2011) 170–174

Abstract. none.

P. Jepson, M. Barua & K. Buckingham

What is a conservation actor?

Conservation & Society 9 (2011) 229-235

Abstract. As a crisis-oriented discipline, conservation biology needs actions to understand the state of nature and thwart declines in biodiversity. Actors-traditionally individuals, institutions, and collectives-have been central to delivering such goals in practice. However, the definition of actors within the discipline has been narrow and their role in influencing conservation outcomes inadequately conceptualised. In this paper, we examine the question 'What is a conservation actor?' Who or what creates the capacity to influence conservation values and actions? Drawing from theoretical developments in Actor-Network Theory and collective governance, we argue that the concept of an actor in conservation biology should be broadened to include non-humans, such as species and devices, because they have the agency and ability to influence project goals and outcomes. We illustrate this through four examples: the Asian elephant, International Union for Conservation of Nature red lists, the High Conservation Value approach, and an Integrated Conservation and Development Project. We argue that a broader conceptualisation of actors in conservation biology will produce new forms of understanding that could open up new areas of conservation research, enhance practice and draw attention to spheres of conservation activity that might require stronger oversight and governance. © 2011 the Authors.

J.J. Kilburn, K.E. Velguth & K.A. Backues

Suspected seminal vesiculitis in an Asian elephant (*Elephas maximus*)

J. of Zoo and Wildlife Med. 42 (2011) 485-489

Abstract. A 32-year-old male Asian elephant (*Elephas maximus*) underwent routine transrectal stimulation for semen collection as part of an artificial insemination program. The procedure consisted of a preinsemination semen collection followed by two consecutive days of semen collections for artificial insemination. The second day's sample contained large numbers of inflammatory cells, intracellular bacteria, and phagocytized sperm. Semen was submitted for culture and sensitivity. Culture

revealed *Acinetobacter lwoffii*, *Staphylococcus intermedius*, *Kocuria roseus*, and an unidentified gram-positive organism. Empirical antibiotic therapy with trimethoprim sulfa was initiated and then changed to enrofloxacin based on sensitivity panel results for a total of 28 days of treatment. Diagnostic semen collections were performed during treatment and 2 wk posttreatment to determine the success of therapy. Posttreatment collections revealed resolution of the inflammation. The origin of the infection was suspected to be the seminal vesicles. © 2011 American Association of Zoo Veterinarians.

W.K. Kiso, J.L. Brown, F. Siewerdt, D.L. Schmitt, D. Olson, E.G. Crichton & B.S. Pukazhenth

Liquid semen storage in elephants (*Elephas maximus* and *Loxodonta africana*): Species differences and storage optimization

Journal of Andrology 32 (2011) 420-431

Abstract. Artificial insemination plays a key role in the genetic management of elephants in zoos. Because freshly extended semen is typically used for artificial insemination in elephants, it has become imperative to optimize conditions for liquid storage and semen transport. The objectives of this study were to examine the interactions between different extenders and storage temperatures on sperm total motility, progressive motility, and acrosomal integrity in Asian (*Elephas maximus*) and African (*Loxodonta africana*) elephants. Ejaculates were collected by rectal massage, diluted using a split-sample technique in 5 semen extenders: TL-Hepes (HEP), Modena (MOD), Biladyl (BIL), TEST refrigeration medium (TES), and INRA96 (INR), maintained at 35°C, 22°C, or 4°C. At 0, 4, 6, 12, and 24 hours, aliquots were removed and assessed for sperm total motility, progressive motility, and acrosomal integrity. After 24 hours of storage, African elephant spermatozoa exhibited greater longevity and higher values in sperm quality parameters compared with those of Asian elephants. In both species, semen storage at 35°C resulted in a sharp decline in all sperm quality parameters after 4 hours of storage, whereas storage at 22°C and 4°C facilitated sperm survival. In Asian elephants, MOD and HEP were most detrimental, whereas BIL, TES, and INR maintained motility up to 12 hours

when spermatozoa were cooled to 22°C or 4°C. In African elephants, there were no differences among extenders. All media maintained good sperm quality parameters at 22°C or 4°C. However, although MOD, BIL, and INR were most effective at lower temperatures, HEP and TES maintained sperm motility at all storage temperatures. This study demonstrated sperm sensitivity to components of various semen extenders and storage temperatures and offers recommendations for semen extender choices for liquid semen storage for both Asian and African elephants. © 2011 American Society of Andrology.

H.N. Kumara, S. Rathnakumar, M.A. Kumar & M. Singh

Estimating Asian elephant, *Elephas maximus*, density through distance sampling in the tropical forests of Biligiri Rangaswamy Temple Tiger Reserve, India

Tropical Conservation Science 5 (2012) 163-172

Abstract. To determine abundance, density and distribution of wild animals, it is crucial to estimate populations using reliable sampling techniques. In most earlier studies, elephant populations were estimated employing block counts or dung counts, which provide biased estimates due to limitations of the methods. We estimated an Asian elephant population using distance sampling, a quantitatively robust technique, in Biligiri Rangaswamy Temple Tiger Reserve, a critical elephant conservation area in the Nilgiri Biosphere Reserve in south India. We laid 33 transects with a total length of 93 km. We walked these transects five to 11 times amounting to a total of 795.5 km of walks. We collected data on location, number and age-sex classes through direct elephant sightings, using rangefinders, global positioning systems and compass. We used DISTANCE software for analysis. We estimated per km² cluster density as 0.69 elephant herds, mean cluster size as 2.44, and elephant density as 1.7 animals. This amounts to a total of 713 elephants in 610 km² of the sanctuary. A high percentage of males less than 30 years old and a low immature:adult female ratio indicated the severity of poaching in the recent past in the study region. © 2012 The Authors.

V.A. Langman, M.F. Rowe, T.J. Roberts, N.V. Langman & C.R. Taylor

Minimum cost of transport in Asian elephants: do we really need a bigger elephant?

J. of Experimental Biology 215 (2012) 1509-14

Abstract. Body mass is the primary determinant of an animal's energy requirements. At their optimum walking speed, large animals have lower mass-specific energy requirements for locomotion than small ones. In animals ranging in size from 0.8 g (roach) to 260 kg (zebu steer), the minimum cost of transport (COT_{min}) decreases with increasing body size roughly as COT_{min} body mass (M_b)^{-0.316±0.023} (95% CI). Typically, the variation of COT_{min} with body mass is weaker at the intraspecific level as a result of physiological and geometric similarity within closely related species. The interspecific relationship estimates that an adult elephant, with twice the body mass of a mid-sized elephant, should be able to move its body approximately 23% cheaper than the smaller elephant. We sought to determine whether adult Asian and sub-adult African elephants follow a single quasi-intraspecific relationship, and extend the interspecific relationship between COT_{min} and body mass to 12-fold larger animals. Physiological and possibly geometric similarity between adult Asian elephants and sub-adult African elephants caused body mass to have a no effect on COT_{min} ($COT_{min} M_b^{0.007±0.455}$). The COT_{min} in elephants occurred at walking speeds between 1.3 and ~1.5 m/s, and at Froude numbers between 0.10 and 0.24. The addition of adult Asian elephants to the interspecific relationship resulted in $COT_{min} M_b^{-0.277±0.046}$. The quasi-intraspecific relationship between body mass and COT_{min} among elephants caused the interspecific relationship to underestimate COT_{min} in larger elephants. © 2012 The Company of Biologists.

R. Lei, R.A. Brenneman, D.L. Schmitt & E.E. Louis Jr.

Genetic diversity in North American captive Asian elephants

Journal of Zoology 286 (2012) 38-47

Abstract. To assess genetic diversity in North American captive Asian elephants *Elephas maximus*, one mitochondrial DNA (mtDNA) segment was sequenced in combination with multilocus genotypes generated from 20

nuclear microsatellite loci for 201 individuals. The analysis of 627 bp of the C-terminal of cyt b and the hypervariable left domain of the noncoding control region (labeled as MDL fragment) sequences revealed the existence of two mtDNA lineages (α and β clade). Analysis of the MDL confirmed that North American captive Asian elephants belong to either the previously characterized α or β clade. An average nucleotide diversity of 0.017 was observed for the Asian elephant mtDNA MDL fragment sequences. Regardless whether an individual possessed mtDNA α or β clade haplotype, all individuals belonged to one nuclear gene lineage for the two X-linked (BGN and PHKA2) and one Y-linked (AMELY) genes sequenced. Analysis of multilocus genotypes indicated an average observed and expected heterozygosities were 0.543 and 0.539 in wild-sourced and 0.579 and 0.547 in the captive-born Asian elephants, respectively. No subdivision among the sampled individuals was detected, including data partitioned by mtDNA clades. Aside from parent-offspring dyads, no further relationships were detected among wild-sourced and captive-born Asian elephants (average relatedness value <0.000). © 2011 Zoological Society of London.

R. Makecha, O. Fad & S.A. Kuczaj II

The role of touch in the social interactions of Asian elephants (*Elephas maximus*)

International Journal of Comparative Psychology 25 (2012) 60-82

Abstract. In order to successfully engage in social interactions, it is necessary to recognize and respond to the communicative cues provided by the other participants in these interactions. Communicative signals can occur in a variety of sensory modalities, including vision, sound, olfaction, and touch. In this study, we focus on the role of touch in the social interactions of elephants. Both aggressive and nonaggressive tactile behaviors were examined. In all cases, the body parts used to initiate tactile behaviors as well as the body parts that received these tactile behaviors were analyzed. Significant differences were seen in the overall frequency of tactile behaviors initiated and received by each elephant, as well as in the frequency of aggressive and nonaggressive tactile behaviors initiated

and received by each elephant. The trunk was the body part most commonly used to initiate and receive tactile behaviors. The influence of several factors on the observed tactile behavior patterns are discussed, including the influence of social rank and movement in the social hierarchy. © 2012 International Society for Comparative Psychology.

K.U. Mar, M. Lahdenperä & V. Lummaa
Causes and correlates of calf mortality in captive Asian elephants (*Elephas maximus*)
PLoS ONE 7 (2012) e32335

Abstract. Juvenile mortality is a key factor influencing population growth rate in density-independent, predation-free, well-managed captive populations. Currently at least a quarter of all Asian elephants live in captivity, but both the wild and captive populations are unsustainable with the present fertility and calf mortality rates. Despite the need for detailed data on calf mortality to manage effectively populations and to minimize the need for capture from the wild, very little is known of the causes and correlates of calf mortality in Asian elephants. Here we use the world's largest multigenerational demographic dataset on a semi-captive population of Asian elephants compiled from timber camps in Myanmar to investigate the survival of calves ($n = 1020$) to age five born to captive-born mothers ($n = 391$) between 1960 and 1999. Mortality risk varied significantly across different ages and was higher for males at any age. Maternal reproductive history was associated with large differences in both stillbirth and liveborn mortality risk: first-time mothers had a higher risk of calf loss as did mothers producing another calf soon (<3.7 years) after a previous birth, and when giving birth at older age. Stillbirth (4%) and pre-weaning mortality (25.6%) were considerably lower than those reported for zoo elephants and used in published population viability analyses. A large proportion of deaths were caused by accidents and lack of maternal milk/calf weakness which both might be partly preventable by supplementary feeding of mothers and calves and work reduction of high-risk mothers. Our results on Myanmar timber elephants with an extensive keeping system provide an important comparison

to compromised survivorship reported in zoo elephants. They have implications for improving captive working elephant management systems in range countries and for refining population viability analyses with realistic parameter values in order to predict future population size of the Asian elephant. © 2012 Mar et al.

N. J. Masters, M.F. Stidworthy, D.J. Everest, A. Dastjerdi & S. Bäumler

Detection of EGHV-5 in a self-limiting papilloma-like lesion in the trunk of an Asian elephant (*Elephas maximus*)

Veterinary Record 169 (2011) e209

Abstract. none.

A. Menargues Marcilla, V. Urios & R. Limiñana
Seasonal rhythms of salivary cortisol secretion in captive Asian elephants (*Elephas maximus*)
General and Comparative Endocrinology 176 (2012) 259–264

Abstract. Salivary cortisol has been recently used to assess welfare of captive and free-ranging animals. However, rhythms of cortisol secretion may vary annually and thus, it is necessary to take into account these rhythms when evaluating the physiological significance of fluctuations of this hormone throughout the year as stress indicator in animals. Here, we analyze monthly differences in cortisol secretion in Asian elephants (*Elephas maximus*) during a year. Saliva samples of eight adult female Asian elephants were collected and analyzed using Radioimmunoassay. Results revealed an overall seasonal pattern of salivary cortisol secretion and significant differences in cortisol concentration among months were found. Overall, the highest cortisol levels were recorded in October, and then decreased until reaching the lowest concentration in April. However, some individual variations were found respect this annual overall trend. The occurrence of this annual pattern of cortisol secretion should be taken into account when using cortisol as a tool to assess animal welfare in captive animal at zoological parks, as well as it opens new questions to further analyze this pattern and its variations, as well as the endogenous mechanisms controlling it. © 2012 reprinted with permission from Elsevier.

K. Müller & I. Reiche

Differentiation of archaeological ivory and bone materials by micro-PIXE/PIGE with emphasis on two Upper Palaeolithic key sites: Abri Pataud and Isturitz, France

J. of Archaeological Science 38 (2011) 3234-43

Abstract. The exact identification of the raw material used for ancient bone objects is the basis to understand the manner in which humans in ancient times chose the medium for the manufacture of objects. The material identification is not trivial in the case of highly modified surfaces worked by man or degraded by diagenesis. Even if bone materials are morphologically quite different, they show in general a very similar chemical composition. Nevertheless, slight differences can be observed in their chemical composition on minor and trace level. These variations may be used as a marker of their exact nature, when other means such as morphological observations are limited. A large data base was built up by analysing different modern and archaeological osseous materials in order to define chemical markers for the identification of the raw materials used to manufacture objects. Micro-Proton Induced X-ray and Gamma-ray Emission (micro-PIXE/PIGE) was chosen to analyse the different bone materials as a non-invasive method is generally required for the study of ancient worked osseous objects. These analyses were performed at the particle accelerator AGLAE installed at the laboratory of the C2RMF, Paris. This paper presents the results obtained on about 150 objects made of different bone materials dating from the Palaeolithic to



Enjoying a bath in Yala National Park (Sri Lanka)

today and coming from various archaeological sites, mainly in France. Some chemical markers seem to be characteristic, such as the magnesium to calcium ratio for well preserved ivory on one hand and the fluorine content versus strontium to calcium ratio for bones of marine mammals on the other hand. The limits of this approach and the different parameters to consider for an identification of ancient bone and ivory material based on this method are particularly discussed in the case of Palaeolithic material from Abri Pataud and Isturitz, France. © 2011 reprinted with permission from Elsevier.

O. Panagiotopoulou, T.C. Pataky, Z. Hill & J.R. Hutchinson

Statistical parametric mapping of the regional distribution and ontogenetic scaling of foot pressures during walking in Asian elephants (*Elephas maximus*)

J. of Experimental Biology 215 (2012) 1584-93

Abstract. Foot pressure distributions during locomotion have causal links with the anatomical and structural configurations of the foot tissues and the mechanics of locomotion. Elephant feet have five toes bound in a flexible pad of fibrous tissue (digital cushion). Does this specialized foot design control peak foot pressures in such giant animals? And how does body size, such as during ontogenetic growth, influence foot pressures? We addressed these questions by studying foot pressure distributions in elephant feet and their correlation with body mass and centre of pressure trajectories, using statistical parametric mapping (SPM), a neuro-imaging technology. Our results show a positive correlation between body mass and peak pressures, with the highest pressures dominated by the distal ends of the lateral toes (digits 3, 4 and 5). We also demonstrate that pressure reduction in the elephant digital cushion is a complex interaction of its viscoelastic tissue structure and its centre of pressure trajectories, because there is a tendency to avoid rear 'heel' contact as an elephant grows. Using SPM, we present a complete map of pressure distributions in elephant feet during ontogeny by performing statistical analysis at the pixel level across the entire plantar/palmar surface. We hope that our study will build confidence in the potential clinical and scaling applications of mammalian

foot pressures, given our findings in support of a link between regional peak pressures and pathogenesis in elephant feet. © 2012 The Company of Biologists.

O. Panagiotopoulou, S.D. Wilshin, E.J. Rayfield, S.J. Shefelbine & J.R. Hutchinson

What makes an accurate and reliable subject-specific finite element model? A case study of an elephant femur

J. of the Royal Soc. Interface 9 (2012) 351-361

Abstract. Finite element modelling is well entrenched in comparative vertebrate biomechanics as a tool to assess the mechanical design of skeletal structures and to better comprehend the complex interaction of their form–function relationships. But what makes a reliable subject-specific finite element model? To approach this question, we here present a set of convergence and sensitivity analyses and a validation study as an example, for finite element analysis (FEA) in general, of ways to ensure a reliable model. We detail how choices of element size, type and material properties in FEA influence the results of simulations. We also present an empirical model for estimating heterogeneous material properties throughout an elephant femur (but of broad applicability to FEA). We then use an *ex vivo* experimental validation test of a cadaveric femur to check our FEA results and find that the heterogeneous model matches the experimental results extremely well, and far better than the homogeneous model. We emphasize how considering heterogeneous material properties in FEA may be critical, so this should become standard practice in comparative FEA studies along with convergence analyses, consideration of element size, type and experimental validation. These steps may be required to obtain accurate models and derive reliable conclusions from them. © 2012 The Royal Society.

S. Prasad, A. Witt, A. C. Williams & A. Sitompul
Invasive plant species in Asian elephant habitats

Aliens: Invasive Species Bulletin 31 (2011) 30-35

Abstract. Although it has been recognized that invasive plants pose a major threat to native flora and fauna, invasive plants are very poorly documented in Tropical Asia compared to other

regions. Results from a preliminary survey which covered respondents working in nine countries with Asian elephants indicate that invasive plants are ubiquitous and, one or more invasive plant species are frequently encountered in most Asian elephant habitats. Findings from this preliminary survey suggests that quantitative assessment of invasive plants in Asian elephant habitat should be taken up without further delay to assess impacts of invasive plants on Asian elephants and also to help forest managers deal with invasive plants in a scientific manner.

T. Ramesh, K. Sankar, Q. Qureshi & R. Kalle
Group size and population structure of megaherbivores (gaur *Bos gaurus* and Asian elephant *Elephas maximus*) in a deciduous habitat of Western Ghats, India

Mammal Study 37 (2012) 47-54

Abstract. none

T. Ramesh, R. Kalle, K. Sankar & Q. Qureshi
Assessment of wild Asiatic elephant (*Elephas maximus indicus*) body condition by simple scoring method in a tropical deciduous forest of Western Ghats, Southern India

Wildlife Biology in Practice 7 (2011) 47-54

Abstract. The individual based body condition assessment is the most meaningful method when applied as an early indicator of the impact of management actions and health status of wild elephants. The body condition evaluation of wild Asiatic elephant (*Elephas maximus*) was studied within 107 km² area covering deciduous forest of Mudumalai Tiger Reserve, Western Ghats from February 2008 to December 2009. Overall vehicle drive of 3740 km yielded 1622 body condition assessments. A higher percentage of adult male and female were either in poor or medium condition during the dry season compared to the wet season. The proportion of adult female body condition was found to be poor compared to adult males. This might be due to less availability of nutritional food during the dry season and since elephant calving occurred throughout the year in Mudumalai, nutritional stress in lactating females could have resulted in their poor body condition. The aging factor could also be one of the reasons where either medium/poor condition was noticed mainly in

adult elephants. It is suggested that long-term monitoring of body condition evaluation should be carried out not only in Asiatic elephant but even for several other wild ungulates.

M.R. Robinson, K.U. Mar & V. Lummaa

Senescence and age-specific trade-offs between reproduction and survival in female Asian elephants

Ecology Letters 15 (2012) 260–266

Abstract. Although studies on laboratory species and natural populations of vertebrates have shown reproduction to impair later performance, little is known of the age-specific associations between reproduction and survival, and how such findings apply to the ageing of large, long-lived species. Herein we develop a framework to examine population-level patterns of reproduction and survival across lifespan in long-lived organisms, and decompose those changes into individual-level effects, and the effects of age-specific trade-offs between fitness components. We apply this to an extensive longitudinal dataset on female semi-captive Asian timber elephants (*Elephas maximus*) and report the first evidence of age-specific fitness declines that are driven by age-specific associations between fitness components in a long-lived mammal. Associations between reproduction and survival are positive in early life, but negative in later life with up to 71% of later-life survival declines associated with investing in the production of offspring within this population of this critically endangered species. © 2012 Blackwell Publishing Ltd/CNRS.

N.M. Srinivasaiah, V.D. Anand, S. Vaidyanathan & A. Sinha

Usual populations, unusual individuals: Insights into the behavior and management of Asian elephants in fragmented landscapes

PLoS ONE 7 (2012) e42571

Abstract. Background: A dearth in understanding the behavior of Asian elephants (*Elephas maximus*) at the scale of populations and individuals has left important management issues, particularly related to human-elephant conflict (HEC), unresolved. Evaluation of differences in behavior and decision-making among individual elephants across groups in response to changing local ecological settings is essential to fill this

gap in knowledge and to improve our approaches towards the management and conservation of elephants. Methodology/Principal Findings: We hypothesized certain behavioral decisions that would be made by Asian elephants as reflected in their residence time and movement rates, time-activity budgets, social interactions and group dynamics in response to resource availability and human disturbance in their habitat. This study is based on 200 h of behavioral observations on 60 individually identified elephants and a 184-km² grid-based survey of their natural and anthropogenic habitats within and outside the Bannerghatta National Park, southern India during the dry season. At a general population level, the behavioral decisions appeared to be guided by the gender, age and group-type of the elephants. At the individual level, the observed variation could be explained only by the idiosyncratic behaviors of individuals and that of their associating conspecific individuals. Recursive partitioning classification trees for residence time of individual elephants indicated that the primary decisions were taken by individuals, independently of their above-mentioned biological and ecological attributes. Conclusions/Significance: Decision-making by Asian elephants thus appears to be determined at two levels, that of the population and, more importantly, the individual. Models based on decision-making by individual elephants have the potential to predict conflict in fragmented landscapes that, in turn, could aid in mitigating HEC. Thus, we must target individuals, in addition to populations, in our efforts to manage and conserve this threatened species, particularly in human-dominated landscapes. © 2012 The Authors.

N. Sthitmatee, P. Mahatnirunkul, P. Keawmong, A. Sirimalaisuwan, P. Boontong, S. Rojanasthien & S. Boonmar

Observation of *Ruminococcus* strains in captive Asian elephant (*Elephas maximus*)

Thai Journal of Vet. Medicine 41 (2011) 267-272

Abstract. Asian elephant is indigenous to many countries including Thailand, but fermenter microorganisms in gastrointestinal tract of the elephant have not fully been investigated. Therefore, this study aimed to observe the

cellulolytic bacteria in genus *Ruminococcus* in large intestines of captive Asian elephants (*Elephas maximus*). Fecal samples were collected from male and female sucklings, young and adult captive Asian elephants. Forty-four elephants were divided into 3 groups as followed: A) > 18 years old (n=24); B) 2-18 years old (n=17) and C) < 2 years old (n=3). The results revealed that there were 214 (42.8%) isolates of *R. flavefaciens*, 105 (21.0%) isolates of *R. bromii*, 90 (18.0%) isolates of *R. obeum*, 54 (10.8%) isolates of *R. callidus* and 37 (7.4%) isolates of *R. albus* from all fecal samples examined. Interestingly, *Ruminococcus* strains could be isolated from the weaned elephants, but were not found in the sucklings ($p < 0.05$). In conclusion, cellulolytic bacteria in genus *Ruminococcus* were isolated from the large intestines of captive Asian elephants. Moreover, the highest prevalence of the bacteria was found in the elephants aged more than 18 years old.

S. Thongtipsiridech, P. Imrat, T. Srihawong, S. Mahasawangkul, C. Tirawattanawanich & K. Saikhun

Seminal plasma MDA concentrations correlating negatively with semen quality in Asian elephants

Thai Journal of Vet. Medicine 41 (2011) 199-204

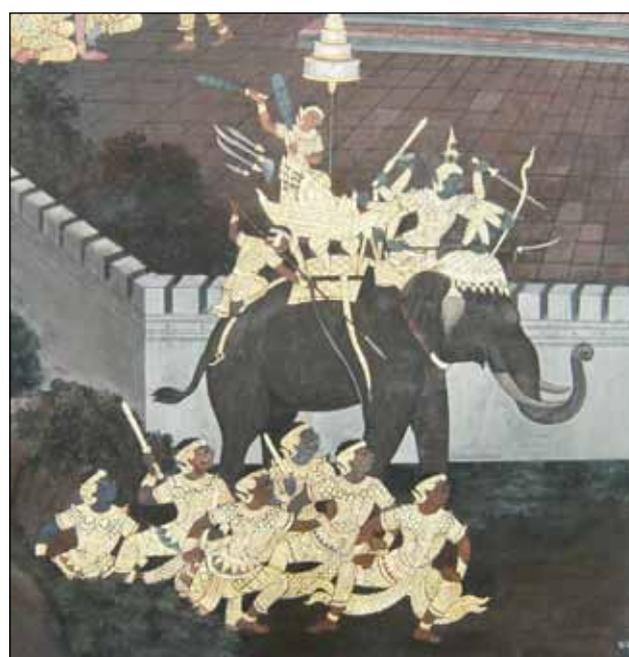
Abstract. The aim of this study was to determine whether lipid peroxidation is correlated with semen quality in Asian elephant bulls. Malondialdehyde (MDA) in seminal plasma from ejaculates with varying percentages of progressive motility was measured using Thiobarbituric Acid method. Correlation between the MDA levels and percentages of progressive motility and normal morphology were performed. Results revealed that the MDA levels were significantly negative, which correlated ($p < 0.05$) with the percentages of progressive motility and normal morphology ($R = 0.2131$ and 0.1685 , respectively). The results also showed that the MDA levels were significantly difference between each bull ($p < 0.01$). Furthermore, when the ejaculates were grouped according to motility scores into two groups; low- (<40%) and high- percentage of progressive motility (>40%), a significant difference was detected between the MDA means (\pm SD) of the low- (20.7 ± 11.4 nmol/ml) and high-percentages of progressive

motility (14.4 ± 7.8 nmol/ml) groups. The results obtained from this study suggested that MDA could be a potential parameter applicable for the assessment of elephant semen quality. It could as well be deduced from this study that oxidative stress might play a key role in low fertility due to poor semen quality in captive male elephants. This data provides beneficial information to better understanding of elephant reproduction in captivity.

E. Tsoukala, D. Mol, S. Pappa, E. Vlachos, W. van Logchem, M. Vaxevanopoulos & J. Reumer
***Elephas antiquus* in Greece: New finds and a reappraisal of older material (Mammalia, Proboscidea, Elephantidae)**

Quaternary International 245 (2011) 339-349

Abstract. This paper briefly describes some recently discovered remains of the straight-tusked elephant, *Elephas antiquus*, from Greece. Material of this extinct proboscidean was found in four localities in Northern Greece: Kaloneri and Sotiras in Western Macedonia, Xerias in Eastern Macedonia, and Larissa in Thessaly. In addition, published elephant remains from Ambelia, Petres and Perdikas, also from Northern Greece, are reinterpreted and also attributed to *E. antiquus*. Of all these, the Kaloneri elephant shows an interesting paleopathology: it was disabled by a broken right tusk. © 2010 Elsevier Ltd and INQUA.



Grand Palace in Bangkok, Thailand.

C.E. Webber, T. Sereivathana, M.P. Maltby & P.C. Lee

Elephant crop-raiding and human–elephant conflict in Cambodia: crop selection and seasonal timings of raids

Oryx 45 (2011) 243–251

Abstract. Elephants are threatened globally by habitat loss, poaching and accelerating levels of human–elephant conflict. For *Elephas maximus* in Cambodia, crop raiding underlies this conflict. Understanding the timing of raids and selection of crops can help design locally appropriate mitigation and management strategies. This study, using a 4-year database of events, investigated the most frequently raided crops and patterns of raids, over time and seasons and by location. Damage frequency varied significantly by crop, with rice, banana, cassava, sugar cane and papaya most frequently raided. Considering raid events per unit crop area, banana, sugar cane and pineapple were raided more than would be expected based on their availability. There were differences in both crop-raiding events and crop-damage frequencies over study years and there was a peak raiding season in October–December. Nationally, significant differences were found among provinces but not between years. Rates of damage decreased after mitigation strategies such as observation towers, deterrents and fences were implemented. We suggest further mechanisms to improve human–elephant conflict monitoring in relation to crop choice and availability. © 2011 Fauna & Flora International.

N.M. Weissenböck, W. Arnold & T. Ruf

Taking the heat: thermoregulation in Asian elephants under different climatic conditions

J. of Comparative Physiol. B 182 (2012) 311–319

Abstract. Some mammals indigenous to desert environments, such as camels, cope with high heat load by tolerating an increase in body temperature (T_b) during the hot day, and by dissipating excess heat during the cooler night hours, i.e., heterothermy. Because diurnal heat storage mechanisms should be favoured by large body size, we investigated whether this response also exists in Asian elephants when exposed to warm environmental conditions of their natural habitat. We compared daily cycles of intestinal T_b of 11 adult Asian elephants living under natural

ambient temperatures (T_a) in Thailand (mean $T_a \sim 30^\circ\text{C}$) and in 6 Asian elephants exposed to cooler conditions (mean $T_a \sim 21^\circ\text{C}$) in Germany. Elephants in Thailand had mean daily ranges of T_b oscillations (1.15°C) that were significantly larger than in animals kept in Germany (0.51°C). This was due to both increased maximum T_b during the day and decreased minimum T_b at late night. Elephant's minimum T_b lowered daily as T_a increased and hence entered the day with a thermal reserve for additional heat storage, very similar to arid-zone ungulates. We conclude that these responses show all characteristics of heterothermy, and that this thermoregulatory strategy is not restricted to desert mammals, but is also employed by Asian elephants. © 2011 <www.springerlink.com>.

E.B. Wiedner, J. Peddie, L. Reeve Peddie, N. Abou-Madi, G.V. Kollias, C. Doyle, W.A. Lindsay, R. Isaza, S. Terrell, T.M. Lynch, K. Johnson, G. Johnson, C. Sammut, B. Daft & F. Uzal

Strangulating intestinal obstructions in four captive elephants (*Elephas maximus* and *Loxodonta africana*)

J. of Zoo and Wildlife Med. 43 (2012) 125–130

Abstract. Three captive-born (5-day-old, 8-day-old, and 4-yr-old) Asian elephants (*Elephas maximus*) and one captive-born 22-yr-old African elephant (*Loxodonta africana*) from three private elephant facilities and one zoo in the United States presented with depression, anorexia, and tachycardia as well as gastrointestinal signs of disease including abdominal distention, decreased borborygmi, tenesmus, hematochezia, or diarrhea. All elephants showed some evidence of discomfort including agitation, vocalization, or postural changes. One animal had abnormal rectal findings. Nonmotile bowel loops were seen on transabdominal ultrasound in another case. Duration of signs ranged from 6 to 36 hr. All elephants received analgesics and were given oral or rectal fluids. Other treatments included warm-water enemas or walking. One elephant underwent exploratory celiotomy. Three animals died, and the elephant taken to surgery was euthanized prior to anesthetic recovery. At necropsy, all animals had severe, strangulating intestinal lesions. © 2012 American Association of Zoo Veterinarians.

S. Wijeyamohan, V. Sivakumar, B. Read, D. Schmitt, S. Krishnakumar & C. Santiapillai
A simple technique to estimate linear body measurements of elephants
Current Science 102 (2012) 26-28
Abstract. none

K.M. Wozney & P.J. Wilson
Real-time PCR detection and quantification of elephantid DNA: Species identification for highly processed samples associated with the ivory trade

Forensic Science Internat. 219 (2012) 106–112

Abstract. The ivory industry is the single most serious threat to global elephant populations. A highly sensitive, species-specific real-time PCR assay has been developed to detect and quantify African elephant (*Loxodonta africana*), Asian elephant (*Elephas maximus*) and Woolly Mammoth (*Mammuthus primigenius*) mitochondrial DNA from highly processed samples involved in the international ivory trade. This assay is especially useful for highly processed samples where there are no distinguishing morphological features to identify the species of origin. Using species-specific Taqman® probes targeting a region of the mitochondrial cytochrome b gene, we developed an assay that can be used to positively identify samples containing elephant or Woolly mammoth DNA faster and more cost-effectively than traditional sequencing methods. Furthermore, this assay provides a diagnostic result based on probe hybridization that eliminates ambiguities associated with traditional DNA sequence protocols involving low template DNA. The real-time method is highly sensitive, producing accurate and reproducible results in samples with as few as 100 copies of template DNA. This protocol can be applied to the enforcement of the Convention on the International Trade of Endangered Species (CITES), when positive identification of species from illegally traded products is required by conservation officers in wildlife forensic cases. © 2012 reprinted with permission from Elsevier.

Y. Yamamoto, T. Yamamoto, N. Yuto, T.B. Hildebrandt, I. Lueders, G. Wibbelt, O. Shiina, Y. Mouri, K. Sugimura, S. Sakamoto, S. Kaew-

manee, K. Nagaoka, G. Watanabe & K. Taya
The secretory pattern and source of immunoreactive prolactin in pregnant African (*Loxodonta africana*) and Asian (*Elephas maximus*) elephants
Journal of Reproduction and Development 58 (2012) 105-111

Abstract. The objective of the present study was to define the secretion of prolactin (PRL) in pregnant African and Asian elephants. Levels of immunoreactive (ir-) PRL in serum and placental homogenates were measured by a heterologous radioimmunoassay (RIA) based on an ovine and human RIA system, and the localization of ir-PRL in the placenta was detected by immunohistochemistry using anti-human PRL. Circulating ir-PRL clearly showed a biphasic pattern during pregnancy in African and Asian elephants. Serum levels of ir-PRL started to increase from the 4 – 6th month of gestation and reached the first peak level around the 11–14th month. A second peak of circulating ir-PRL levels was observed around the 18–20th month of gestation followed by an abrupt decline after parturition. In contrast, in a case of abortion of an African elephant, the second peak of ir-PRL was not observed, and the levels remained low for about four months until parturition. The weight of the fetus delivered at the 17th month of gestation was 23.5 kg, which was quite small compared with normal fetuses in previous reports. Ir-PRL was detected in placental homogenates, and immunolocalization was observed in trophoblasts in both the African and Asian elephants, indicating that the placenta is the source of ir-PRL during pregnancy in elephants. The present results clearly demonstrated that circulating ir-PRL shows a biphasic pattern during normal pregnancy and that the placenta appears to be an important source of circulating ir-PRL during pregnancy in both African and Asian elephants. © 2012 Society for Reproduction and Development.

H. Yong, G.-E. Choi, B.S. Lee, J. Whang & S.J. Shin

Disseminated infection due to *Mycobacterium avium* subsp. *avium* in an Asian elephant (*Elephas maximus*)

J. of Zoo and Wildlife Med. 42 (2011) 743-746

Abstract. A disseminated infection caused by *Mycobacterium avium* subspecies *avium* (MAA) was diagnosed in a 57-yr-old male Asian elephant (*Elephas maximus*) housed at the Seoul Zoo, Gyeonggi, Republic of Korea. An apparent granulomatous inflammation with central caseous necrosis was evident in the lung sections. To confirm mycobacterial infection, polymerase chain reaction–restriction enzyme polymorphism analysis (PCR-RFLP) of the *rpoB* and *hsp65* genes was performed from multiple organs and cultured bacteria. The PCR-RFLP revealed a *M. avium* subspecies. MAA was identified by multiplex PCR for detection of IS901 and IS1311. Thus, it is believed that MAA caused the disseminated infection in this case. Although the source of infection was not determined, the elephant may have become infected through contamination of soil and feed by free-living birds infected with MAA. This is the first reported case of disseminated infection due to MAA in a captive elephant in the Republic of Korea. © 2011 American Association of Zoo Veterinarians.

J. Yravedra, S. Rubio-Jara, J. Panera, D. Uribe Larrea & A. Pérez-González

Elephants and subsistence. Evidence of the human exploitation of extremely large mammal bones from the Middle Palaeolithic site of Preresá (Madrid, Spain)

J. of Archaeological Science 39 (2012) 1063-71

Abstract. The archaeological site at PRERESA (Madrid, Spain) has been dated to 84 ± 5.6 ka by optically stimulated luminescence (OSL) (MIS 5a). An area 255 m² was excavated and 754 lithic pieces were recovered, as well as a large amount of micro and macro vertebrate remains, including proboscidean bones. The aim of this paper is to outline the results of the taphonomic study of these remains. The identification of cut marks on a number of the bones recovered strengthens the theory that the exploitation of extremely large mammals was more than just a marginal practice before the Upper Palaeolithic. Additionally, the identification of green-bone fractures and percussion marks confirm for the

first time, that the bone marrow of these taxa was also consumed. Few other cases of this practice have been identified, firstly because obtaining this substance would not be an easy matter, and secondly because similar nutritional needs can also be met by the consumption of brain matter, which is easier to acquire. © 2011 Elsevier Ltd.

Y. Yuan, T.-J. Shen, P. Gupta, N.T. Ho, V. Simplaceanu, T.C.S. Tam, M. Hofreiter, A. Cooper, K.L. Campbell & C. Ho

A biochemical-biophysical study of hemoglobins from woolly mammoth, Asian elephant, and humans

Biochemistry 50 (2011) 7350-7360

Abstract. This study is aimed at investigating the molecular basis of environmental adaptation of woolly mammoth hemoglobin (Hb) to the harsh thermal conditions of the Pleistocene ice ages. To this end, we have carried out a comparative biochemical–biophysical characterization of the structural and functional properties of recombinant hemoglobins (rHb) from woolly mammoth (rHb WM) and Asian elephant (rHb AE) in relation to human hemoglobins Hb A and Hb A2 (a minor component of human blood). We have obtained oxygen equilibrium curves and calculated O₂ affinities, Bohr effects, and the apparent heat of oxygenation (ΔH) in the presence and absence of allosteric effectors [inorganic phosphate and inositol hexaphosphate (IHP)]. Here, we show that the four Hbs exhibit distinct structural properties and respond differently to allosteric effectors. In addition, the apparent heat of oxygenation (ΔH) for rHb WM is less negative than that of rHb AE, especially in phosphate buffer and the presence of IHP, suggesting that the oxygen affinity of mammoth blood was also less sensitive to temperature change. Finally, 1H NMR spectroscopy data indicates that both $\alpha 1(\beta/\delta)1$ and $\alpha 1(\beta/\delta)2$ interfaces in rHb WM and rHb AE are perturbed, whereas only the $\alpha 1\delta 1$ interface in Hb A2 is perturbed compared to that in Hb A. The distinct structural and functional features of rHb WM presumably facilitated woolly mammoth survival in the Arctic environment. © 2011 American Chemical Society.