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 (2013) publications on Asian elephants.

F.N. Abbondanza, M.L. Power, M.A. Dickson, J. Brown & O.T. Oftedal
Variation in the composition of milk of Asian elephants (*Elephas maximus*) throughout lactation
Zoo Biology 32 (2013) 291-298
Abstract. We investigated milk nutrient composition from three Asian elephant cows over the first 3 years of lactation, including two consecutive lactations in one cow. Body mass gain is presented for three calves during the first year. Milk samples (n = 74) were analyzed for dry matter (DM), fat, crude protein (CP), sugar, ash, calcium (Ca), phosphorus (P), and potassium (K); gross energy (GE) was calculated. Concentrations of most nutrients changed over lactation: DM, fat, CP, Ca, P, and GE were positively correlated to calf age; sugar was negatively correlated to calf age. GE doubled between birth (1 kcal/g) and 2 years of age (2 kcal/g). After accounting for calf age, GE, fat, Ca, and P concentrations differed among the cows. Milk composition also differed between two lactations from the same cow. When milk nutrients were expressed on a mg per kcal basis, the pattern changes: CP, Ca, and P remained relatively constant over lactation on a per energy basis. Calf mass quadrupled over the first year of life; mass gain was linear at 0.9 kg/day. Asian elephant milk composition is variable, both across lactations and between cows, complicating efforts to determine representative values for comparative studies and for the formulation of elephant milk formulas. The fact that CP, Ca, and P were all relatively constant when expressed on a per energy basis may be of biological significance. The increase in nutrient density over lactation undoubtedly limits maternal water loss, reducing the volume of milk necessary to support the calf. © 2012 Reproduced with permission of John Wiley & Sons, Inc.

E. Albayrak & A.M. Lister
Dental remains of fossil elephants from Turkey
Quaternary Internat. 276-277 (2012) 198-211
Abstract. Turkey is at the crossroads of Africa, Asia and Europe, and occupies an important position for the migration of mammals such as elephantids. Nonetheless, there has been no detailed study of fossil elephants from Turkey. In this study, elephant remains from five localities were examined. *Mammuthus meridionalis*, *Mammuthus trogontherii*, *Elephas maximus* and probably *Palaeoloxodon antiquus* were identified. *M. meridionalis* remains from Yukarısöğütönü have some primitive features compared to typical meridionalis of the Upper Valdarno, which is consistent with the age of the locality. *M. trogontherii* was identified from Suluova and Dursunlu. Most of the mammoth remains from Dursunlu have features of typical trogontherii, but some have 'primitive' features evoking meridionalis. *E. maximus* was identified from Gavur Lake Swamp, but these remains were collected from agricultural areas by local people so there is no information about their exact location. However, new radiocarbon dates indicate that at approximately 3500 BP, the range of Asian elephant extended as far west as south-east Turkey. The *E. maximus* remains are mostly similar to recent Asian elephant in appearance and metrics, but some specimens show unexpected characters that might signal a distinct, now extinct population. Although remains of *E. maximus* include isolated teeth, skulls, mandibles and post-cranial bones, this study focused on only teeth.

L. Atkins, J.-C. Zong, J. Tan, A. Mejia, S.Y. Heaggans, S.A. Nofs, J.J. Stanton, J.P. Flanagan, L. Howard, E. Latimer, M.R. Stevens, D.S. Hoffman, G.S. Hayward & P.D. Ling

Elephant endotheliotropic herpesvirus 5, a newly recognized elephant herpesvirus associated with clinical and subclinical infections in captive Asian elephants (*Elephas maximus*)

Journal of Zoo and Wildlife Medicine 44 (2013) 136-143

Abstract. Elephant endotheliotropic herpesviruses (EEHVs) can cause acute hemorrhagic disease with high mortality rates in Asian elephants (*Elephas maximus*). Recently, a new EEHV type known as EEHV5 has been described, but its prevalence and clinical significance remain unknown. In this report, an outbreak of EEHV5 infection in a herd of captive Asian elephants in a zoo was characterized. In February 2011, a 42-yr-old wild-born female Asian elephant presented with bilaterally swollen temporal glands, oral mucosal hyperemia, vesicles on the tongue, and generalized lethargy. The elephant had a leukopenia and thrombocytopenia. She was treated with flunixin meglumine, famciclovir, and fluids. Clinical signs of illness resolved gradually over 2 wk, and the white blood cell count and platelets rebounded to higher-than-normal values. EEHV5 viremia was detectable starting 1 wk before presentation and peaked at the onset of clinical illness. EEHV5 shedding in trunk secretions peaked after viremia resolved and continued for more than 2 mo. EEHV5 trunk shedding from a female herd mate without any detectable viremia was detected prior to onset of clinical disease in the 42-yr-old elephant, indicating reactivation rather than primary infection in this elephant. Subsequent EEHV5 viremia and trunk shedding was documented in the other five elephants in the herd, who remained asymptomatic, except for 1 day of temporal gland swelling in an otherwise-healthy 1-yr-old calf. Unexpectedly, the two elephants most recently introduced into the herd 40 mo previously shed a distinctive EEHV5 strain from that seen in the other five elephants. This is the first report to document the kinetics of EEHV5 infection in captive Asian elephants and to provide evidence that this virus can cause illness in some animals.

K.K. Bonia & B. Dutta

Comparative serum biological constituents of captive Asian elephants (*Elephas maximus*)

Indian J. of Animal Sciences 82 (2012) 715-717

Abstract. none.

A.L. Brandt, Y. Ishida, N.J. Georgiadis & A.L. Roca

Forest elephant mitochondrial genomes reveal that elephantid diversification in Africa tracked climate transitions

Molecular Ecology 21 (2012) 1175–1189

Abstract. Among elephants, the phylogeographic patterns of mitochondrial (mt) and nuclear markers are often incongruent. One hypothesis attributes this to sex differences in dispersal and in the variance of reproductive success. We tested this hypothesis by examining the coalescent dates of genetic markers within elephantid lineages, predicting that lower dispersal and lower variance in reproductive success among females would have increased mtDNA relative to nuclear coalescent dates. We sequenced the mitochondrial genomes of two forest elephants, aligning them to mitogenomes of African savanna and Asian elephants, and of woolly mammoths, including the most divergent mitogenomes within each lineage. Using fossil calibrations, the divergence between African elephant F and S clade mitochondrial genomes (originating in forest and savanna elephant lineages, respectively) was estimated as 5.5 Ma. We estimated that the (African) ancestor of the mammoth and Asian elephant lineages diverged 6.0 Ma, indicating that four elephantid lineages had differentiated in Africa by the Miocene–Pliocene transition, concurrent with drier climates. The coalescent date for forest elephant mtDNAs was c. 2.4 Ma, suggesting that the decrease in tropical forest cover during the Pleistocene isolated distinct African forest elephant lineages. For all elephantid lineages, the ratio of mtDNA to nuclear coalescent dates was much greater than 0.25. This is consistent with the expectation that sex differences in dispersal and in variance of reproductive success would have increased the effective population size of mtDNA relative to nuclear markers in elephantids, contributing to the persistence of incongruent mtDNA phylogeographic patterns.

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K. Buranaamnuay, S. Mahasawangkul & K. Saikhuna

The in vitro quality of frozen-thawed Asian elephant (*Elephas maximus*) spermatozoa in semen supplemented with Equex STM paste and oxytocin during and after cryopreservation

Reproductive Biology 13 (2013) 169–171

Abstract. The effects of Equex STM paste (Equex) and oxytocin (OT) on the in vitro quality of frozen-thawed Asian elephant sperm were investigated in the study. The viability of frozen-thawed sperm was significantly higher in the Equex-treated (1 and 2%) groups than in the control group. There were no differences in the examined sperm parameters among the control and OT-treated (0.05–5 IU) groups. © 2013 Reprinted with permission from Elsevier.

K. Chakraborty & J. Mondal

Perceptions and patterns of human–elephant conflict at Barjora block of Bankura district in West Bengal, India: insights for mitigation and management

Environment, Development and Sustainability 15 (2013) 547-565

Abstract. Human–elephant conflict is an issue of great concern regarding the growing competition between people and wildlife for food and shelter throughout Asia and Africa. The situation the Asian elephant faces is much critical. According to IUCN (Big hopes for endangered Asian Elephants, News Release, Gland, 2006), one of the prime factors to the decline of elephant population in India is the increasing trend in human–elephant conflict. Barjora block of Bankura district in West Bengal is one of the severe conflict prone zones in West Bengal, where elephant raid in every year has now become an inevitable phenomenon. As a result, crop damage, infrastructural damages, disturbances of daily activities, occurrence of human death and injuries have no doubt annihilated and frustrated the social fabric of life. This paper is an empirical attempt to address various consequences of human–elephant encounters which have an adverse impact on social, economic as well as the cultural life of the people. Instead of pursuing some traditional mitigation techniques, we argued much on understanding peoples' perception to explore some sustainable mitigation measures to ensure the interest of both human and elephant and also to safeguard ecological integrity. © 2012 Springer Science+Business Media Dordrecht.

K. Chelliah, H. Bukka & R. Sukumar

Modeling harvest rates and numbers from age and sex ratios: A demonstration for elephant populations

Biological Conservation 165 (2013) 54–61

Abstract. Illegal harvest rates of wildlife populations are often unknown or difficult to estimate from field data due to under-reporting or incomplete detection of carcasses. This is especially true for elephants that are killed for ivory or in conflicts with people. We describe a method to infer harvest rates from coarse field data of three population parameters, namely, adult female to male ratio, male old-adult to young-adult ratio, and proportion of adult males in the population using Jensen's (2000) 2-sex, density-dependent Leslie matrix model. The specific combination of male and female harvest rates and numbers can be determined from the history of harvest and estimate of population size. We applied this technique to two populations of elephants for which data on age structure and records of mortality were available— a forest-dwelling population of the Asian elephant (at Nagarahole, India) and an African savannah elephant population (at Samburu, Kenya) that had experienced male-biased harvest regimes over 2–3 decades. For the Nagarahole population, the recorded numbers of male and female elephants killed illegally during 1981–2000 were 64% and 88% of the values predicted by the model, respectively, implying some non-detection or incomplete reporting while for the Samburu population the recorded and modeled numbers of harvest during 1990–1999 closely matched. This technique, applicable to any animal population following logistic growth model, can be especially useful for inferring illegal harvest numbers of forest elephants in Africa and Asia. © 2013 Reprinted with permission from Elsevier.

E.R.C. Davidar, P. Davidar, P. Davidar & J.-P. Puyravaud

Elephant *Elephas maximus* Linnaeus (Proboscidea: Elephantidae) migration paths in the Nilgiri Hills, India in the late 1970s

Journal of Threatened Taxa 4 (2012) 3284-3293

Abstract. The study presented was carried out in 1978 with the support of the Asian Elephant Specialist Group (AsESG) of the International Union for the Conservation of Nature (IUCN) Species Survival Commission (SSC). Its objective was to investigate the impediments to elephant movement in the Nilgiri Hills, in the Western Ghats of India, in an attempt to suggest positive steps to encourage movement through the provision of corridors. The report was left unpublished, but given its importance as a reference document for the conservation of the Asian elephant in the Nilgiris, in 2011 the last two authors decided to publish it. The process of habitat fragmentation has been going on ever since man started agriculture. But this problem has, of late, become much more acute due to mounting pressure on land. The corridor concept applied to wildlife is the provision of a free and, as far as possible, unimpeded way for the passage of wild animals between two wildlife zones. A corridor's more important function is to prevent wild animals from getting isolated in small pocket-like islands. Maintaining elephant habitat connectivity in and around the Nilgiris rests upon the understanding that elephant populations of the several protected areas of the now Nilgiri Biosphere Reserve must remain active. The first author surveyed the Nilgiris on foot and on elephant back for several months in 1978. It was concluded that four areas (the Nilgiri north slopes and Deccan Plateau, the south and southeastern slopes, the Gudalur Plateau, and the upper plateau) harboured together 10 corridors that needed to be maintained, or restored, or even partially restored. © 2012 The Authors.

R. Duffy

The international political economy of tourism and the neoliberalisation of nature: Challenges posed by selling close interactions with animals

Review of International Political Economy 20 (2013) 605-626

Abstract. This paper examines the inter-relationships between neoliberalism, tourism and nature. It argues that scholars of international political economy (IPE) need to engage more fully with the role of nature in driving forward the logics of neoliberalism. Most scholars view nature as a source of accumulation or as an object of governance, but this paper uses the neoliberalisation of nature debate to extend our understandings of neoliberalism. In particular, global tourism has targeted and opened up new frontiers in nature, which serves to expand and deepen neoliberalism to a wider range of biophysical phenomena. This paper uses the case of elephant tourism to demonstrate how tourism is not just reflective of neoliberalism, but is in fact a key driver of it, acting as an environmental fix for capitalism. Further, this paper takes up the challenge of research on 'actually existing neoliberalisms' via engagement with locally specific contexts and emerging forms of socio-nature in the Thai tourism industry. It reveals how neoliberalism redraws the boundaries of access to nature, thereby shifting the distribution of costs and benefits. Hence, nature is one of the primary ways in which neoliberalism is constituted, albeit in a highly differentiated way. This reminds us not to reify neoliberalism and accord it a greater degree of power and coherence than it really has. © 2013 Taylor & Francis.

R.C. Dunkin, D. Wilson, N. Way, K. Johnson & T.M. Williams

Climate influences thermal balance and water use in African and Asian elephants: physiology can predict drivers of elephant distribution

Journal of Experimental Biology 216 (2013) 2939-2952

Abstract. Elephant movement patterns in relation to surface water demonstrate that they are a water-dependent species. Thus, there has been interest in using surface water management to mitigate problems associated with localized elephant overabundance. However, the physiological mechanisms underlying the elephant's water dependence remain unclear. Although thermoregulation is likely an important driver, the relationship between thermoregulation, water use and climate has not been quantified. We measured skin surface temperature of and cutaneous water loss from 13 elephants (seven African, 3768±642 kg; six Asian, 3834±498 kg)

and determined the contribution of evaporative cooling to their thermal and water budgets across a range of air temperatures (8–33°C). We also measured respiratory evaporative water loss and resting metabolic heat production on a subset of elephants (N=7). The rate of cutaneous evaporative water loss ranged between 0.31 and 8.9 g min^{-1} m^{-2} for Asian elephants and 0.26 and 6.5 g min^{-1} m^{-2} for African elephants. Simulated thermal and water budgets using climate data from Port Elizabeth, South Africa, and Okaukuejo, Namibia, suggested that the 24-h evaporative cooling water debt incurred in warm climates can be more than 4.5 times that incurred in mesic climates. This study confirms elephants are obligate evaporative coolers but suggests that classification of elephants as water dependent is insufficient given the importance of climate in determining the magnitude of this dependence. These data highlight the potential for a physiological modeling approach to predicting the utility of surface water management for specific populations. © 2013 The Company of Biologists Ltd.

P.L. Falkingham

Acquisition of high resolution three-dimensional models using free, open-source, photogrammetric software

Palaeontologia Electronica 15 (2012) 15.1.1T

Abstract. The 3D digitisation of palaeontological resources is of tremendous use to the field, providing the means to archive, analyse, and visualise specimens that would otherwise be too large to handle, too valuable to destructively sample, or simply in a different geographic location. Digitisation of a specimen to produce a 3D digital model often requires the use of expensive laser scanning equipment or proprietary digital reconstruction software, making the technique inaccessible to many workers. Presented here is a guide for producing high resolution 3D models from photographs, using freely available open-source software. To demonstrate the accuracy and flexibility of the approach, a number of examples are given, including a small trilobite (~0.04 m), a large mounted elephant skeleton (~3 m), and a very large fossil tree root system (~6 m), illustrating that the method is equally applicable to specimens or even outcrops of all sizes. The digital files of the models produced in this paper are included. The results demonstrate that production of digital models from specimens for research or archival purposes is available to anyone, and it is hoped that an increased use of digitisation techniques will facilitate research and encourage collaboration and dissemination of digital data. © 2012 Palaeontological Association.

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

Cellulase enzyme production from lignocellulosic substrates by individual and consortium of new fungi isolated from Asian elephant (*Elephas maximus*) dung.

Journal of Enzyme Research 3 (2012) 34-38

Abstract. One of the major challenges of cellulosic bioethanol production is cellulase enzyme which is used in the hydrolysis of cellulose to sugars for fermentation to bioethanol. Commercial cellulase enzyme preparations are very expensive. Fungi are recognized for their ability to produce a large variety of extracellular enzymes. In this study, the potential of two new native fungi (*T. aureoviride* UPM 09 (JN811061) (UPMC 389) and *F. equiseti* strain UPM 09 (JN811063) (UPMC391) isolated from Asian elephant (*E. maximus*) dung to pro- duce cellulase enzymes from rice husk (RH), rubber wood saw dust (RW) and oil palm empty fruit bunch (EFB) using solid state cultivation (SSC) and submerged cultivation (SMC) was investigated. From the results of the statistical analysis, there is no significant difference ($P>0.05$) in cellulase production between the two methods for all the three substrates. However, there is significant difference ($P<0.05$) between the two fungi in cellulase enzyme production both SSC and SMC among the three substrates used. The result, therefore, indicates that any of the two fungi can be used for cellulase production. In addition, the type of substrate is influential in cellulase production by the fungi. The two new fungal strains may serve as good candidates for cellulase production in the cellulosic bioethanol industry. However, consortium of the two fungi produced relatively slightly higher cellulase enzyme in each of the methods than each when used alone. © 2012 The Authors.

M. Feldman, R. Isaza, C. Prins & J. Hernandez
Point prevalence and incidence of *Mycobacterium tuberculosis* complex in captive elephants in the United States of America
Veterinary Quarterly 33 (2013) 25-29
Abstract. Background: Captive elephants infected with tuberculosis are implicated as an occupational source of zoonotic tuberculosis. However, accurate estimates of prevalence and incidence of elephant tuberculosis from well-defined captive populations are lacking in the literature. Studies published in recent years contain a wide range of prevalence estimates calculated from summary data. Incidence estimates of elephant tuberculosis in captive elephants are not available. Objective: This study estimated the annual point prevalence, annual incidence, cumulative incidence, and incidence density of tuberculosis in captive elephants within the USA during the past 52 years. Animals and methods: We combined existing elephant census records from captive elephants in the USA with tuberculosis culture results obtained from trunk washes or at necropsy. This data set included 15 years where each elephant was screened annually. Results: Between 1960 and 1996, the annual point prevalence of tuberculosis complex mycobacteria for both species was 0. From 1997 through 2011, the median point prevalence within the Asian elephant population was 5.1%, with a range from 0.3% to 6.7%. The incidence density was 9.7 cases/1000 elephant years. In contrast, the annual point prevalence during the same time period within the African elephant population remained 0 and the incidence density was 1.5 cases/1000 elephant years. Conclusions: The apparent increase in new cases noted after 1996 resulted from a combination of both index cases and the initiation of mandatory annual tuberculosis screening in 1997 for all the elephants. This study found lower annual point prevalence estimates than previously reported in the literature. These discrepancies in prevalence estimates are primarily due to differences in terminology and calculation methods. Using the same intensive testing regime, the incidence of tuberculosis differed significantly between Asian and African elephants. Accurate and species specific knowledge of prevalence and incidence will inform our efforts to mitigate occupational risks associated with captive elephants in the USA. © 2013 Taylor & Francis.

A. Gall & A. Palser
An elephantine viral problem
Nature Reviews Microbiology 11 (2013) 512
Abstract. none.

A. Granados, R.B. Weladji & M.R. Loomis
Movement and occurrence of two elephant herds in a human-dominated landscape, the Bénoué Wildlife Conservation Area, Cameroon
Tropical Conservation Science 5 (2012) 150-162
Abstract. Increasing human settlement and disturbance adjacent to protected areas have intensified competition between people and wildlife for resources and living space. In northern Cameroon, over 60,000 people live in villages surrounding Bénoué National Park. In that same area, as in other parts of Africa, savanna elephants damage crops, homes, water provision infrastructures, and grain stores. Using almost 1000 satellite-derived positions for two matriarch female elephants from 2007 to 2009, movement patterns were analyzed with respect to a highway, secondary roads, unpaved park roads, rivers, and villages through the use of log linear modeling. More than half of all locations and core areas occurred outside the park, while seasonal and individual differences in home range size and distribution were found within the protected area. Elephant occurrence within approximately 7 to 9 km of villages showed a decreasing trend with proximity. The highway appeared to act as a barrier to movement for one elephant herd, while the other did not come within 11 km of it. On the other hand, elephants remained close to the Bénoué River and secondary roads. Our findings show that in the Bénoué Wildlife Conservation Area, perennial water availability and human disturbance from the presence of villages can influence elephant spatial distribution in the protected area, and overlap of villages with elephant home range indicates a high potential for human-elephant conflict. This highlights the need for more effective land use planning to reduce such conflict and for additional research into movement patterns of the Bénoué National Park elephant population. © 2012 The Authors.

S. Gubbi, H.C. Poornesha & M.D. Madhusudan

Impact of vehicular traffic on the use of highway edges by large mammals in a South Indian wildlife reserve

Current Science 102 (2012) 1047-1051

Abstract. India's phenomenal economic growth over the last decade has been accompanied by a much-needed expansion and improvement in transport and other infrastructure networks. While there are legally mandated assessments of the potential ecological impacts of such infrastructure projects prior to implementation, rarely are there post-implementation assessments of their real ecological impacts. In this communication, we present results of a preliminary study examining the impact of vehicular traffic on the usage of road edges by large mammals along a highway passing through Nagarahole Tiger Reserve, southern India. We estimated large mammal encounter rates at remotely triggered camera traps on two consecutive sections of the same highway – one closed to vehicular traffic and the other open to vehicles only during daytime. We observed lower encounter rates of chital, gaur and elephants at camera traps in the highway segment with higher vehicular traffic density, suggesting that these species avoided busy highways. Based on our findings, we emphasize the importance of continued ecological impact assessments of development projects to identify and mitigate unforeseen impacts. Further, an approach to development planning that integrates conservation concerns, especially where development projects coincide with ecologically critical areas, is urgently needed in India.

G.S. Hayward

Conservation: clarifying the risk from herpesvirus to captive Asian elephants

Veterinary Record 170 (2012) 202-203

Abstract. none.

R. Hazarika & Anup Saikia

The pachyderm and the pixel: an assessment of elephant habitat suitability in Sonitpur, India

International Journal of Remote Sensing 34 (2013) 5317-5330

Abstract. Remote sensing and geographic information systems (GISs) are increasingly being used in protected area monitoring and habitat suitability studies. In this article, Erdas Imagine's Expert Classifier tool was used to assess the specific trajectories of habitat suitability change during 1994–2007 in the Sonitpur elephant habitat, India. Sonitpur has been witness to increasing human–elephant conflict in the past decade. The suitability analysis took into account information relating to forest type and density, elevation, slope, source of water, human activities in terms of settlement, agriculture, tea plantations, roads, and railways. Satellite imagery, data from topographical maps, digital elevation data, and global positioning system readings formed the major data inputs that were incorporated into a GIS. Various decision rules were created and confidence levels assigned to the input layers to generate high, medium, and low habitat suitability. The area witnessed a sharp decline in suitability from 63% in 1994 to less than 38% by 2007. The high-suitability area declined by more than 50% during this period. The unique natural protected areas of Sonitpur, which are a mix of reserved forests, wildlife sanctuaries, and a national park, urgently need to be protected from further habitat degradation. © 2013 Taylor & Francis.

S. Hedges, A. Johnson, M. Ahlering, M. Tyson, L.S. Eggert, B. Ibler & R. Pankow

Accuracy, precision, and cost-effectiveness of conventional dung density and fecal DNA based survey methods to estimate Asian elephant (*Elephas maximus*) population size and structure

Biological Conservation 159 (2013) 101–108

Abstract. Non-invasive DNA-based capture–mark–recapture (CMR) methods have been developed to estimate population size and other parameters and have the advantage that samples can be collected without the need to see or disturb the animals. There are, however, few comparisons of DNA-based CMR estimates of animal population size with estimates from non-genetic methods. We compared the results of a dung-density based survey of an Asian elephant (*Elephas maximus*) population with a simultaneous fecal DNA-based CMR survey of the same population. We found 545 dung-piles along 116 line transects, converted dung-

pile density to elephant density using rates of defecation and dung disappearance, and derived a population estimate of 141 elephants. We collected 267 fecal samples during three CMR sampling sessions: 215 (81%) yielded sufficient genotypic information for analysis and gave an estimated population size of 132 elephants, closely matching the estimate produced by the dung-density method but with greater precision. The DNA-based method also provided information on population structure. We conclude that DNA-based CMR methods provide more precise abundance estimates, and more data about population structure and dynamics, than dung density-based methods. Fecal DNA-based CMR methods also require less time in the field and can be used when dung density methods are impracticable. Finally, fecal DNA based CMR methods are now cheaper than dung density based methods when line transect survey costs are approximately equal to CMR survey costs and dung decay rate monitoring costs are greater than laboratory costs (which will usually be the case). © 2012 Reprinted with permission from Elsevier.

B. Ibler & R. Pankow

Data on the sleep in the herd of Asian Elephants (*Elephas maximus*) at Berlin Zoological Garden

Der Zoologische Garten 81 (2012) 239–245

Abstract. Due to the night observations during the gravidity of the Asian elephant "Pang Pha" in 2005 it was possible to receive data on the sleeping behavior of 1.3 Asian elephants (*Elephas maximus*) at Berlin Zoological Garden. These elephants were the breeding bull "Victor" (born 22.10.1993 at Zoological Center Ramat Gan), "Pang Pha" (born 1987 in Thailand), "Drumbo" (born 1970) and "Iyoti" (born 1974 in India). Elephant "Pang Pha" slept only one and a half hour, whereas the two older cows lay nearly four hours. The bull lay longest. © 2012 Reprinted with permission from Elsevier. [Main text in German]

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

Effect of pre-freeze semen quality, extender and cryoprotectant on the post-thaw quality of Asian elephant (*Elephas maximus indicus*) semen

Cryobiology 66 (2013) 52-59

Abstract. Semen cryopreservation and artificial insemination (AI) are potentially valuable methods for supporting the breeding management of endangered species like the Asian elephant. Cryopreservation of Asian elephant semen has however proven problematic with respect to maintenance of both adequate semen quality and fertility post-thaw. In this study, nine ejaculates from three adult bulls were used to compare the influence of extender (TEST versus INRA96®) and penetrating cryoprotectants (3% glycerol, 5% glycerol and 4% methylformamide) on post-thaw semen quality. We demonstrate that not only the freezing process, but also the quality of the semen before freezing, significantly influences the freezability of Asian elephant semen. Pre-freeze motility, viability, semen volume, semen pH, sperm concentration and the incidence of sperm mid-piece and tail abnormalities all significantly ($p < 0.05$) affected post-thaw semen quality. While extender and cryoprotectant did not significantly affect any of the above semen quality parameters post-thaw, the skim-milk based extender (INRA96®) preserved DNA integrity better ($p < 0.05$) than the egg yolk extender (TEST). Considerable between-ejaculate variation in all post-thaw semen quality parameters was also noted. It is concluded that strict criteria for semen quality is essential for the selection of Asian elephant bull ejaculates suitable for cryopreservation; stricter initial selection should improve the mean post-thaw quality. © 2012 Reprinted with permission from Elsevier.

P.S. Jothish

Frugivory and seed dispersal of woody species by the Asian elephant (*Elephas maximus*) in a mid-elevation tropical evergreen forest in India

Journal of Tropical Ecology 29 (2013) 181-185

Abstract. Frugivory and seed dispersal by the Asian elephant, *Elephas maximus*, in a mid-elevation tropical evergreen forest in India was studied by dung analysis and conducting seed

germination trials on ingested and control seeds. A total of 384 dung piles were observed during the period February 2007 to December 2008. Fruits/ seeds and seedlings of 27 woody species were observed from the dung piles. Seed germination experiments showed that seeds from dung were viable and germination time of ingested seeds was significantly lower than that of control seeds. It was observed that 43.6% of the seedlings in the dung piles established as saplings. The study suggests that the Asian elephant is a legitimate seed disperser in tropical forests in its range. © 2013 Cambridge University Press.

K. Karthik

Tuberculosis goes wild: Emphasis on elephants

J. of Veterinary Advances 2 (2012) 534-538

Abstract. Tuberculosis being a slow spreading disease has almost let its roots into all animal species. It does not have any discrimination between wild and domestic animals. Even though science has extended its view towards various aspects of TB yet it has to find out a solution to break the chain of TB spread. *Mycobacteria* even though a minute organism it strikes hard the mammoth. Even the elephants have no excuse to TB. Now there are lots of case reports about the occurrence of TB in elephants especially in zoos. From these elephants it spreads to the elephant handlers, thus playing a significant role in the zoonosis of TB. This article mainly deals with the historical aspect of TB in elephants, zoonotic and epidemiological aspects. This article also emphasis on the diagnosis and the treatment aspects of tuberculosis in elephants. Research in the zone of tuberculosis in elephants is required in order to save the elephants and also to prevent the spread of TB to humans and other animals.

W.K. Kiso, V. Selvaraj, J. Nagashima, A. Asano, J.L. Brown, D.L. Schmitt, J. Leszyk, A.J. Travis & B.S. Pukazhenthi

Lactotransferrin in Asian elephant (*Elephas maximus*) seminal plasma correlates with semen quality

PLoS ONE 8(8) e71033

Abstract. Asian elephants (*Elephas maximus*) have highly variable ejaculate quality within individuals, greatly reducing the efficacy of artificial insemination and making it difficult to devise a sperm cryopreservation protocol for this endangered species. Because seminal plasma influences sperm function and physiology, including sperm motility, the objectives of this study were to characterize the chemistry and protein profiles of Asian elephant seminal plasma and to determine the relationships between seminal plasma components and semen quality. Ejaculates exhibiting good sperm motility (≤65%) expressed higher percentages of spermatozoa with normal morphology (80.3±13.0 vs. 44.9±30.8%) and positive Spermac staining (51.9±14.5 vs. 7.5±14.4%), in addition to higher total volume (135.1±89.6 vs. 88.8±73.1 ml) and lower sperm concentration (473.0±511.2 vs. 1313.8±764.7x10^6 cells ml^{-1}) compared to ejaculates exhibiting poor sperm motility (≤10%; $P<0.05$). Comparison of seminal plasma from ejaculates with good versus poor sperm motility revealed significant differences in concentrations of creatine phosphokinase, alanine aminotransferase, phosphorus, sodium, chloride, magnesium, and glucose. These observations suggest seminal plasma influences semen quality in elephants. One- and two-dimensional (2D) gel electrophoresis revealed largely similar compositional profiles of seminal plasma proteins between good and poor motility ejaculates. However, a protein of ca. 80 kDa was abundant in 85% of ejaculates with good motility, and was absent in 90% of poor motility ejaculates ($P<0.05$). We used mass spectrometry to identify this protein as lactotransferrin, and immunoblot analysis to confirm this identification. Together, these findings lay a functional foundation for understanding the contributions of seminal plasma in the regulation of Asian elephant sperm motility, and for improving semen collection and storage in this endangered species.

E. Lee, Y. Lee, S. Moon, N. Kim, S. Kim, M. Yang, D. Choi & M. Han

The identification of elephant ivory evidences of illegal trade with mitochondrial cytochrome b gene and hypervariable D-loop region

Journal of Forensic and Legal Medicine 20 (2013) 174-178

Abstract. DNA analysis of elephant ivory of illegal trade was handled in this work. The speciation and geographical origin of nine

specimens of elephant ivory were requested by the police. Without national authorization, the suspect had purchased processed ivory seals from January to May, 2011 by Internet transactions from a site in a neighboring country. The DNA of decalcified ivory evidences was isolated with QIAGEN Micro Kit. The total 844–904 base pair sized sequences of mitochondrial cytochrome b and D-loop region could be acquired using direct sequencing analysis. They were compared with the sequences registered in GenBank. It was confirmed that most specimens were likely from African forest elephants (*Loxodonta cyclotis*), one from African savanna elephant (*Loxodonta africana*) and one from Asian elephant (*Elephas maximus*). Analysis of the mitochondrial hypervariable D-loop region sequence of elephants verified that one African savanna elephant might be from South Africa and one Asian elephant from Laos. Cytochrome b and D-loop region located in the mitochondrial DNA resulted in the successful determination of elephant DNA from nine processed ivory specimens. © 2012 Reprinted with permission from Elsevier.

J. Li, Y. Hou, Y. Li & J. Zhang

The latest straight-tusked elephants (*Palaeoloxodon*)? "Wild elephants" lived 3000 years ago in North China

Quaternary International 281 (2012) 84-88

Abstract. Large quantities of archeology and literature records indicate that during the Shang Dynasty and a part of the Zhou Dynasty of Chinese history, about 2000 BC to 1000 BC, there once were wild elephants living in North China. For a long time, it was believed that all of these elephants belonged to the species *Elephas maximus*. Many scholars suggested that this phenomenon could show a much higher temperature at that time. However, as the research of Chinese historical climate has already indicated, even in the Megathermal Maximum, most of the parts of North China were still controlled by the climate of the Warm Temperate Zone, not the Subtropic Zone. This paper presents evidence suggesting that the so-called "wild elephants" in North China during that time belonged to *Palaeoloxodon* sp., not *E. maximus*. © 2011 Reprinted with permission from Elsevier.

P.D. Ling J.G. Reid, X. Qin, D.M. Muzny, R. Gibbs, J. Petrosino, R.S. Peng, J.-C. Zong, S.Y. Heaggans, & G.S. Hayward

Complete genome sequence of elephant endotheliotropic herpesvirus 1A

Genome Announcements 1 (2013) e00106-13

Abstract. Elephant endotheliotropic herpesvirus 1A is a member of the Proboscivirus genus and is a major cause of fatal hemorrhagic disease in endangered juvenile Asian elephants worldwide. Here, we report the first complete genome sequence from this genus, obtained directly from necropsy DNA, in which 60 of the 115 predicted genes are not found in any known herpesvirus. © 2013 Ling et al.

A.M. Lister, W. Dirks, A. Assaf, M. Chazan, P. Goldberg, Y.H. Applbaum, N. Greenbaum & L.K. Horwitz

New fossil remains of *Elephas* from the southern Levant: Implications for the evolutionary history of the Asian elephant

Palaeogeography, Palaeoclimatology, Palaeoecology 386 (2013) 119-130

Abstract. We describe new fossil remains of elephant (*Elephas* cf. *hysudricus*) from archaeological sites in the Levant: Ma'ayan Baruch (Israel) and 'Ain Soda (Jordan). Both sites date to the Middle Pleistocene based on stone artefacts typical of Levantine Late Acheulian assemblages. The elephant remains show 'primitive' dental features reminiscent of *E. hysudricus* from the Plio-Pleistocene of the



Minneriya National Park (Sri Lanka)

Siwaliks (northern India), the species thought to be ancestral to Asian elephant *E. maximus*. Regionally, the new fossils are chronologically intermediate between an earlier (ca. 1 Ma) record of *Elephas* sp. from Evron Quarry (Israel), and Holocene remains of *E. maximus* from archaeological sites in NW Syria, Turkey, Iraq and Iran. It is unclear at present whether this represents continuity of occupation or, more plausibly, independent westward expansions. © 2013 Reprinted with permission from Elsevier.

K.K. Mohapatra, A.K. Patra & D.S. Paramanik

Food and feeding behaviour of Asiatic elephant (*Elephas maximus* Linn.) in Kuldiha Wild Life Sanctuary, Odisha, India

J. of Environmental Biology 34 (2013) 87-92

Abstract. The feeding behaviour of Asiatic elephant (*Elephas maximus*) with food reference was studied in Kuldiha Wildlife Sanctuary in Odisha during 2007 to 2009. Though the study area houses a good number of plant species only 71 species were identified as elephant fodder plants. The food trail of elephant was observed as twig breaking, bark peeling, branch breaking, stem twisting uprooting and flower plucking in different regions of study area during different seasons. Alteration of predominantly browsing strategy with that of grazing around the year was related to seasonal variation of food plants. Consumption of tree species (56%) was highest as compared to shrubs (20%), herbs (14%) and climbers (10%). A high degree of variation in dicot monocot ratio (61:10)) was marked during identification of elephant fodder plant by direct observation. Microscopic analysis of dung showing a high degree of variation in average dicot monocot ratio suggested that the food plant selection of elephant was highly opportunistic and seasonal. The elephants extensively fed on the plant species like *Careya arborea*, *Kydia calycina*, *Helicteres isora*, *Mallotus philippinensis*, *Aegle marmelos*, *Zizyphus mauritiana*, *Bauhinia racemosa*, *Bauhinia vahlii*, *Mimosa pudica*, *Asparagus racemosus*, *Smilax zeylanica* and *Diosporea* species. They were fond of *Madhuca indica* (Mahula) flowers in winter and fruits of *Mangifera indica* (Mango) in summer. They were never found feeding on *Tectona grandis* and *Eucalyptus maculate* inside the study area. © 2013 Triveni Enterprises. Reproduced with permission.

H.S. Mumby, A. Courtiol, K.U. Mar & V. Lummaa

Climatic variation and age-specific survival in Asian elephants from Myanmar

Ecology 94 (2013) 1131–1141

Abstract. Concern about climate change has intensified interest in understanding how climatic variability affects animal life histories. Despite such effects being potentially most dramatic in large, long-lived and slowly reproducing terrestrial mammals, little is known of the effects of climatic variation on survival in those species. Asian elephants (*Elephas maximus*) are endangered across their distribution, and inhabit regions characterized by high seasonality of temperature and rainfall. We investigated the effects of monthly climatic variation on survival and causes of death in Asian elephants using a unique demographic dataset of 1024 semi-captive longitudinally monitored elephants from four sites in Myanmar between 1965 and 2000. Temperature had a significant effect on survival in both sexes and across all ages. For elephants between 1 month and 17 years, maximal survival was reached at around 24ºC and any departures from this temperature increased mortality, whereas neonates and mature elephants had maximal survival at even lower temperatures. Although males experienced higher mortality overall, sex differences in these optimal temperatures were small. Because the elephants spent more time during a year in temperatures higher than 24ºC than in temperatures below it, most deaths occurred at hot (temperatures over 24ºC) rather than cold periods. Decreased survival at higher temperatures resulted partially from increased deaths from infectious disease and heat stroke, whilst the lower survival in the coldest months is associated with an increase in non-infectious diseases and poor health in general. Survival was also related to rainfall, with the highest survival rates during the wettest months for all ages and sexes. Our results show that even the normal-range monsoon variation in climate can exert large impact on elephant survival in Myanmar leading to extensive absolute differences in mortality: switching from favorable to unfavorable climatic

conditions within average years doubled the odds for mortality. The persistence of a long-term trend towards higher global temperatures, combined with the possibility of higher variation in temperature between seasons, may pose a challenge to the survival of species such as Asian elephants. © 2013 Ecological Soc. of America.

F. Nocete, J.M. Vargas, T.X. Schuhmacher, A. Banerjee & W. Dindorf

The ivory workshop of Valencina de la Concepción (Seville, Spain) and the identification of ivory from Asian elephant on the Iberian Peninsula in the first half of the 3rd millennium BC

Journal of Archaeological Science 40 (2013) 1579–1592

Abstract. During excavations in the huge ditched enclosure of Valencina de la Concepción (Seville, Spain), the main centre from the first hierarchical framework-settlement in the Guadalquivir Valley, a pit with remains of a context for producing ivory artefacts, dating from the first half of the 3rd millennium BC, was discovered in the large metallurgical nucleate workshops. Scientific (Optical Microscopy, FIRT and Raman Spectroscopy, C/N Isotope Ratio Mass Spectrometry) analyses revealed that the ivory belonged to Asian elephants and the archaeological study, which was made in a specialized workshop context. In this paper we present the archaeological context, the study of the ivory artefacts and the state of research on ivory in the Lower Guadalquivir Basin during the 3rd millennium BC. In a parallel way, this paper discusses the significance of this workshop context in the configuration and function of the long distance circulation of raw material and the specialized craft areas in the first political centres. © 2012 Reprinted with permission from Elsevier.

S.A. Nofs, R.L. Atmar, W.A. Keitel, C. Hanlon, J.J. Stanton, Jie Tan, J.P. Flanagan, L. Howard, P.D. Ling, R.P.V.J. Rajapakse, M. Iwagami, S. Wickramasinghe, S.M. Walker & T. Agatsuma

Prenatal passive transfer of maternal immunity in Asian elephants (*Elephas maximus*)

Veterinary Immunology and Immunopathology 153 (2013) 308-311

Abstract. Asian (*Elephas maximus*) and African (*Loxodonta africana*) elephants exhibit characteristics of endotheliochorial placentation, which is common in carnivore species and is associated with modest maternal to fetal transplacental antibody transfer. However, it remains unknown whether the bulk of passive immune transfer in elephants is achieved prenatally or postnatally through ingestion of colostrum, as has been documented for horses, a species whose medical knowledgebase is often extrapolated for elephants. To address this issue, we took advantage of the fact that many zoo elephants are immunized with tetanus toxoid and/or rabies vaccines as part of their routine health care, allowing a comparison of serum antibody levels against these antigens between dams and neonates. Serum samples were collected from 3 newborn Asian elephant calves at birth (before ingestion of colostrum); 2-4 days after birth; and 2-3 months of age. The findings indicate that the newborns had anti-tetanus toxoid and anti-rabies titers that were equivalent to or higher than the titers of their dams from birth to approximately 3 months of age, suggesting that the majority of maternal-to-fetal transfer is transplacental and higher than expected based on the architecture of the Asian elephant placenta. © 2013 Reprinted with permission from Elsevier.

G. Nogge

Elefantenhaltung in Europa und Indien – ein Vergleich

Elephant keeping in Europe and India – a comparison

Der Zoologische Garten 81 (2012) 231-238

Abstract. In none of the countries of origin Asian elephants are taken any more from the wild. Instead breeding stations arise. In India the methods of keeping elephants have become subject of scientific investigations. As a result elephants in the long run will be allowed to be held only in forest camps. The concepts of elephant husbandry are discussed and developed also outside the countries of origin. Under consideration of their biological, ecological and social requirements elephants have to be managed in groups. It is the author's opinion that protected contact will be the method of the future. © 2013 Reprinted with permission from Elsevier. [Main text in German.]

B.L. Ong, Y.F. Ngeow, M.F. Razak, Y. Yakubu, Z. Zakaria, A.R. Mutalib, L. Hassan, H.F. Ng & K. Verasahib

Tuberculosis in captive Asian elephants (*Elephas maximus*) in Peninsular Malaysia

Epidemiology & Infection 141 (2013) 1481–1487

Abstract. A cross-sectional study was conducted from 10 January to 9 April 2012, to determine the seroprevalence of tuberculosis (TB) of all captive Asian elephants and their handlers in six locations in Peninsular Malaysia. In addition, trunk-wash samples were examined for tubercle bacillus by culture and polymerase chain reaction (PCR). For 63 elephants and 149 elephant handlers, TB seroprevalence was estimated at 20·4% and 24·8%, respectively. From 151 trunk-wash samples, 24 acid-fast isolates were obtained, 23 of which were identified by hsp65-based sequencing as non-tuberculous mycobacteria. The *Mycobacterium tuberculosis*-specific PCR was positive in the trunk-wash samples from three elephants which were also seropositive. Conversely, the trunk wash from seven seropositive elephants were PCR negative. Hence, there was evidence of active and latent TB in the elephants and the high seroprevalence in the elephants and their handlers suggests frequent, close contact, two-way transmission between animals and humans within confined workplaces. © 2011 Cambridge University Press.

J.M. Plotnik, J.J. Pokorny, T. Keratimanochaya, C. Webb, H.F. Beronja, A. Hennessy, J. Hill, V.J. Hill, R. Kiss, C. Maguire, B.L. Melville, V.M.B. Morrison, D. Seecoomar, B. Singer, J. Ukehaxhaj, S.K. Vlahakis, D. Ylli, N.S. Clayton, J. Roberts, E.L. Fure, A.P. Duchatelier & D. Getz

Visual cues given by humans are not sufficient for Asian elephants (*Elephas maximus*) to find hidden food

PLOS ONE 8 (2013) e61174

Abstract. Recent research suggests that domesticated species – due to artificial selection by humans for specific, preferred behavioral traits – are better than wild animals at responding to visual cues given by humans about the location of hidden food. Although this seems to be supported by studies on a range of domesticated (including dogs, goats and horses) and wild (including wolves and chimpanzees) animals, there is also evidence that exposure to humans positively influences the ability of both wild and domesticated animals to follow these same cues. Here, we test the performance of Asian elephants (*Elephas maximus*) on an object choice task that provides them with visual-only cues given by humans about the location of hidden food. Captive elephants are interesting candidates for investigating how both domestication and human exposure may impact cue-following as they represent a non-domesticated species with almost constant human interaction. As a group, the elephants (n = 7) in our study were unable to follow pointing, body orientation or a combination of both as honest signals of food location. They were, however, able to follow vocal commands with which they were already familiar in a novel context, suggesting the elephants are able to follow cues if they are sufficiently salient. Although the elephants' inability to follow the visual cues provides partial support for the domestication hypothesis, an alternative explanation is that elephants may rely more heavily on other sensory modalities, specifically olfaction and audition. Further research will be needed to rule out this alternative explanation. © 2013 Plotnik et al.

R.P.V.J. Rajapakse, M. Iwagami, S. Wickramasinghe, S.M. Walker & T. Agatsuma

Morphology and surface topography of the schistosome *Bivitellobilharzia nairi* from the Asian elephant (*Elephas maximus maximus*) in Sri Lanka

Journal of Helminthology 87 (2013) 348–355

Abstract. *Bivitellobilharzia nairi* was first recorded from an Indian elephant (*Elephas maximus*) in Berlin. Infections with this parasite have become increasingly important in *E. maximus maximus* populations in Sri Lanka. The present work is the first morphological description of this schistosome from Sri Lanka. A number of adult worms were recovered from a dead Asian elephant near the elephant orphanage, Pinnawala, in Sri Lanka. The observed clinical features of the infected elephant included emaciation, subventral oedema and anaemia. Post-mortem results indicated that the liver was enlarged and adult schistosomes were found in the blood vessels of the liver parenchyma. The total number of

worms recovered from a portion of the liver was 129,870, which is an average of 22 worms per 100 g of liver. The present study uses both light microscopic and scanning electron microscope (SEM) techniques for the morphological and topographical characterization of this parasite and to permit comparison with other species of schistosomes. Morphologically, these worms correspond very well to the description of *B. nairi* by Dutt & Srivastava (1955). Moreover, it is clear that *B. nairi* is a distinctive species easily differentiated from other schistosomes. The SEM study of the tegument of male worms shows that the surface of *B. nairi* is smoother than in other schistosomes. © 2012 Cambridge Univ. Press.

A. Rizvanovic, M. Amundin & M. Laska

Olfactory discrimination ability of Asian elephants (*Elephas maximus*) for structurally related odorants

Chemical Senses 38 (2013) 107-118

Abstract. Using a food-rewarded two-choice instrumental conditioning paradigm, we assessed the ability of Asian elephants, *Elephas maximus*, to discriminate between 2 sets of structurally related odorants. We found that the animals successfully discriminated between all 12 odor pairs involving members of homologous series of aliphatic 1-alcohols, n-aldehydes, 2-ketones, and n-carboxylic acids even when the stimuli differed from each other by only 1 carbon. With all 4 chemical classes, the elephants displayed a positive correlation between discrimination performance and structural similarity of odorants in terms of differences in carbon chain length. The animals also successfully discriminated between all 12 enantiomeric odor pairs tested. An analysis of odor structure–activity relationships suggests that a combination of molecular structural properties rather than a single molecular feature may be responsible for the discriminability of enantiomers. Compared with other species tested previously on the same sets of odor pairs (or on subsets thereof), the Asian elephants performed at least as well as mice and clearly better than human subjects, squirrel monkeys, pigtail macaques, South African fur seals, and honeybees. Further comparisons suggest that neither the relative nor the absolute size of the olfactory bulbs appear to be reliable predictors of between-species differences in olfactory discrimination capabilities. In contrast, we found a positive correlation between the number of functional olfactory receptor genes and the proportion of discriminable enantiomeric odor pairs. Taken together, the results of the present study support the notion that the sense of smell may play an important role in regulating the behavior of Asian elephants. © 2012 The Authors.

M.F. Rowe, G.S. Bakken, J.J. Ratliff & V.A. Langman

Heat storage in Asian elephants during submaximal exercise: behavioral regulation of thermoregulatory constraints on activity in endothermic gigantotherms

Journal of Experimental Biology 216 (2013) 1774-1785

Abstract. Gigantic size presents both opportunities and challenges in thermoregulation. Allometric scaling relationships suggest that gigantic animals have difficulty dissipating metabolic heat. Large body size permits the maintenance of fairly constant core body temperatures in ectothermic animals by means of gigantothermy. Conversely, gigantothermy combined with endothermic metabolic rate and activity likely results in heat production rates that exceed heat loss rates. In tropical environments, it has been suggested that a substantial rate of heat storage might result in a potentially lethal rise in core body temperature in both elephants and endothermic dinosaurs. However, the behavioral choice of nocturnal activity might reduce heat storage. We sought to test the hypothesis that there is a functionally significant relationship between heat storage and locomotion in Asian elephants (*Elephas maximus*), and model the thermoregulatory constraints on activity in elephants and a similarly sized migratory dinosaur, Edmontosaurus. Pre- and post-exercise (N=37 trials) measurements of core body temperature and skin temperature, using thermography were made in two adult female Asian elephants at the Audubon Zoo in New Orleans, LA, USA. Over ambient air temperatures ranging from 8 to 34.5°C, when elephants exercised in full sun, ~56 to 100% of active metabolic heat production was stored in core body tissues. We estimate that during nocturnal activity, in the absence of

solar radiation, between 5 and 64% of metabolic heat production would be stored in core tissues. Potentially lethal rates of heat storage in active elephants and Edmontosaurus could be behaviorally regulated by nocturnal activity. © 2013 Reproduced with permission from the Journal of Experimental Biology.

S. Sadhu, P.K. Ghosh, T.K. De, T.K. Maiti

Optimization of cultural condition and synergistic effect of lactose with Carboxymethyl cellulose on cellulase production by *Bacillus* sp. isolated from fecal matter of elephant (*Elephas maximus*)

Advances in Microbiology 3 (2013) 280-288

Abstract. A cellulase producing bacterium (E3 strain) was isolated from fecal matter of elephant and identified as *Bacillus* sp. using 16S rDNA sequenced based molecular phylogenetic approach. While studying the effect of substrates like Carboxymethyl cellulose (CMC), avicel, starch, maltose, sucrose, glucose, fructose, galactose and lactose on cellulase production, it was found that CMC was best carbon source induced cellulase production followed by lactose in this bacterial strain. A positive synergistic effect of lactose with CMC was also observed with enhancement of 5 - 6 times in cellulase production. The optimum cellulase production was recorded with 1% CMC and 1% lactose when added individually in the Omeliansky's medium. The results showed that addition lactose with CMC greatly enhances the production and activity of various cellulase enzymes. The optimal fermentation conditions for the biosynthesis of cellulase by this strain were found to be temperature: 37˚C, pH 7.0. The nitrogen source NH4Cl at 0.15% was optimum for cellulase production by this bacterium. © 2013 The Authors.

P. Sarkar, S. Verma & V. Menon

Food selection by Asian elephant (*Elephus maximus*) in Kameng Elephant Reserve in Northeast India

The Clarion 1 (2012) 70-79

Abstract. A study was conducted to find out the food selection by Asian elephant (*Elephus maximus*) in Kameng Elephant Reserve (KER) during 2001-05. For this, two methods were followed viz (i) twelve trails were surveyed 42 times covering different seasons to record the feeding sign of elephant and (ii) another six trails were laid for vegetation sampling to know the abundance and distribution of different food plant on the habitat. A total of 36 quadrats each with 10 x 10m were plotted at every 500 meter interval of each trail. The vegetation data (food plants) was processed using computer programs Biodiversity Pro and EstimateS 8.0. Species diversity, evenness, spatial distribution, and similarity matrix were calculated. The study found that the Asian elephant selected 46 species of plant as food belonging to 26 families. Plant family Arecacea (Calamus sp.) was selected more as food followed by Moracea (Artocarpus, Ficus species). Although only 18% food plants show significant random distribution (out of 77% species random distribution) and most of the food plants seem to have scattered distribution. The relative abundance of the food species consumed by elephant appeared to be on an average only 0.8 % (SE = 0.3) of the total number of tree species found in the sampled region. This random distribution and relatively low abundance of food species may result in wider movement or distribution of elephants in search of food plants.

W. Schaftenaar

Delayed postpartum fetotomy in an Asian elephant (*Elephas maximus*)

J. of Zoo and Wildlife Med. 44 (2013) 130-135

Abstract. A 37-yr-old Asian elephant (*Elephas maximus*) started parturition after 640 days of pregnancy but no fetal parts entered the birth canal. Despite veterinary intervention, the calf was not delivered. After 13 mo calving resumed and a full-term dead calf advanced into and lodged within the vagina. With standing xylazine tranquilization, the dam received a vagino-vestibulotomy to permit total fetotomy of the calf, which presented with bilateral carpal arthrogryposis. Severe infection of the caudal vaginal vestibulum complicated wound healing, and over the following year two corrective surgeries were performed, which resolved the fistula 3 mo after the second debridement. The elephant not only survived the procedures but also resumed normal estrous cycles, as demonstrated by blood progesterone concentration monitoring.

A.F. Sitompul, C.R. Griffin , N.D. Rayl & T.K. Fuller

Spatial and temporal habitat use of an Asian elephant in Sumatra

Animals 3 (2013) 670-679

Abstract. Increasingly, habitat fragmentation caused by agricultural and human development has forced Sumatran elephants into relatively small areas, but there is little information on how elephants use these areas and thus, how habitats can be managed to sustain elephants in the future. Using a Global Positioning System (GPS) collar and a land cover map developed from TM imagery, we identified the habitats used by a wild adult female elephant (*Elephas maximus sumatranus*) in the Seblat Elephant Conservation Center, Bengkulu Province, Sumatra during 2007–2008. The marked elephant (and presumably her 40–60 herd mates) used a home range that contained more than expected medium canopy and open canopy land cover. Further, within the home range, closed canopy forests were used more during the day than at night. When elephants were in closed canopy forests they were most often near the forest edge vs. in the forest interior. Effective elephant conservation strategies in Sumatra need to focus on forest restoration of cleared areas and providing a forest matrix that includes various canopy types.

A.F. Sitompul, C.R. Griffin & T.K. Fuller

Sumatran elephant ranging behavior in a fragmented rainforest landscape

International Journal of Biodiversity and Conservation 5 (2013) 66-72

Increasingly, habitat fragmentation by agricultural and human development has forced Sumatran elephants (*Elephas maximus sumatranus*) into relatively small areas; yet, there is no information on the movements and home range behaviors of elephants on Sumatra. Using a GPS collar, we estimated the home range sizes of an adult female elephant (one of a herd of 40 to 60) in the Seblat Elephant Conservation Center (SECC), Bengkulu Province of Sumatra in 2007 to 2008. We assessed the level of autocorrelation among elephant locations, and used correlation and logistic regression analyses to examine relationships between elephant movements and monthly rainfall, and elephant locations with the remotely sensed enhanced vegetation index (EVI), and distance to roads and rivers. Overall home range size was 97.4 km^2 for the minimum convex polygon (MCP), and 95.0 km^2 for the 95% fixed kernel (FK), estimator. There were no relationships between average monthly elephant home range sizes or movement distances with rainfall. Distances to rivers and ex-logging roads had little effect on elephant locations, but EVI, an index of canopy photosynthetic capacity, did correspond with elephant locations, occurring predominately in forests with intermediate canopy cover versus closed canopy forests. Consistent food and water availability in the lowland forests of the SECC in combination with high human development surrounding the center probably affect the small home range size.

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-km^2 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.

S. Sripiboon, P. Tankaew, G. Lungka & C. Thitaram

The occurrence of elephant endotheliotropic herpesivrus in captive Asian elephants (*Elephas maximus*): First case of EEHV4 in Asia

J. of Zoo and Wildlife Med. 44 (2013) 100-104

Abstract. Elephant endotheliotropic herpesvirus (EEHV) is a type of herpesvirus that causes acute hemorrhagic disease in Asian elephants (*Elephas maximus*) and is often fatal, especially in calves. This study describes the postmortem evaluation of two captive-born Asian elephants (2 and 3 yr of age, respectively) diagnosed with EEHV in Thailand. Both elephants presented only mild depression, lethargy, and anorexia before death within 24 hr of symptom onset. Necropsies were performed, and tissue samples were tested for EEHV viral presence using polymerase chain reaction. Molecular and phylogenetic evidence illustrated two types of EEHV, which were closely related to EEHV1A in Case 1 and EEHV4 in Case 2. Pathologic findings differed between the cases. More specific organ tropism was found in Case 1, where mainly the cardiovascular system was affected. In contrast, in Case 2, hemorrhages were noted in most organs, including in the gastrointestinal, respiratory, and cardiovascular systems. This report is the first to document EEHV4 in Asia and the second case of this strain to be identified in an elephant worldwide.

J.J. Stanton, J.-C. Zong, C. Eng, L. Howard, J. Flanagan, M. Stevens, D. Schmitt, E. Wiedner, D. Graham, R.E. Junge, M.A. Weber, M. Fischer, A. Mejia, J. Tan, E. Latimer, A. Herron, G.S. Hayward & P.D. Ling

Kinetics of viral loads and genotypic analysis of elephant endotheliotropic herpesvirus-1 infection in captive Asian elephants (*Elephas maximus*)

J. of Zoo and Wildlife Medicine 44 (2013) 42-54

Abstract. Elephant endotheliotropic herpesviruses (EEHVs) can cause fatal hemorrhagic disease in juvenile Asian elephants (*Elephas maximus*); however, sporadic shedding of virus in trunk washes collected from healthy elephants also has been detected. Data regarding the relationship of viral loads in blood compared with trunk washes are lacking, and questions about whether elephants can undergo multiple infections with EEHVs have not been addressed previously. Real-time quantitative polymerase chain reaction was used to determine the kinetics of EEHV1 loads, and genotypic analysis was performed on EEHV1 DNA detected in various fluid samples obtained from five Asian elephants that survived detectable EEHV1 DNAemia on at least two separate occasions. In three elephants displaying clinical signs of illness, preclinical EEHV1 DNAemia was detectable, and peak whole-blood viral loads occurred 3–8 days after the onset of clinical signs. In two elephants with EEHV1 DNAemia that persisted for 7–21 days, no clinical signs of illness were observed. Detection of EEHV1 DNA in trunk washes peaked approximately 21 days after DNAemia, and viral genotypes detected during DNAemia matched those detected in subsequent trunk washes from the same elephant. In each of the five elephants, two distinct EEHV1 genotypes were identified in whole blood and trunk washes at different time points. In each case, these genotypes represented both an EEHV1A and an EEHV1B subtype. These data suggest that knowledge of viral loads could be useful for the management of elephants before or during clinical illness. Furthermore, sequential infection with both EEHV1 subtypes occurs in Asian elephants, suggesting that they do

not elicit cross-protective sterilizing immunity. These data will be useful to individuals involved in the husbandry and clinical care of Asian elephants.

N. Stephens, L. Vogelnest, C. Lowbridge, A. Christensen, G.B. Marks, V. Sintchenko & J. McAnulty

Transmission of *Mycobacterium tuberculosis* from an Asian elephant (*Elephas maximus*) to a chimpanzee (*Pan troglodytes*) and humans in an Australian zoo

Epidemiology and Infection 141 (2013) 1488-97

Abstract. *Mycobacterium tuberculosis* is primarily a pathogen of humans. Infections have been reported in animal species and it is emerging as a significant disease of elephants in the care of humans. With the close association between humans and animals, transmission can occur. In November 2010, a clinically healthy Asian elephant in an Australian zoo was found to be shedding *M. tuberculosis*; in September 2011, a sick chimpanzee at the same zoo was diagnosed with tuberculosis caused by an indistinguishable strain of *M. tuberculosis*. Investigations included staff and animal screening. Four staff had tuberculin skin test conversions associated with spending at least 10 hours within the elephant enclosure; none had disease. Six chimpanzees had suspected infection. A pathway of transmission between the animals could not be confirmed. Tuberculosis in an elephant can be transmissible to people in close contact and to other animals more remotely. The mechanism for transmission from elephants requires further investigation. © 2013 Cambridge University Press.

N. Sthitmatee, T. Warinrak & W. Wongkalasin

Susceptibility of *Clostridium difficile* isolated from healthy captive Asian elephants to metronidazole and vancomycin

Thai J. of Veterinary Med. 43 (2013) 313-316

Abstract. Susceptibility to metronidazole and vancomycin, drugs of choice for *Clostridium difficile* infection, of 15 *C. difficile* isolates from 6 healthy Asian elephants was determined. All of the isolates belonged to only 1 ribotype pattern and carried both toxin A and B genes. The Minimal inhibitory concentration range of metronidazole and vancomycin, drugs of choice for treatment of *C. difficile* infection, was 0.125-4.0 μg/ml and 0.125-2.0 μg/ml, respectively. Moreover, MIC50 and MIC90 for metronidazole were 0.75 and 1.5 μg/ml while vancomycin was 1.0 and 2.0 μg/ml. There was no evidence of resistance to these antimicrobials. These results might be a preliminary data for further study of animal *C. difficile*.

S.J. Sugumar & R. Jayaparvathy

An early warning system for elephant intrusion along the forest border areas

Current Science 104 (2013) 1515-1526

Abstract. Man–animal conflict has been on the rise in the forest border areas with herds of wild pachyderms straying into human habitation. The surveillance and tracking of elephant herds are difficult due to their size and nature of movement. In this article, we present an analytical procedure to study the behaviour of elephants along forest border areas by taking migration data into consideration using a three-state Markov chain. The migration data over the whole year is divided into four different periods for the study. We also develop an intrusion detection system to detect the intrusion of herds of wild elephants from the forests into the human habitation and to send an early warning through SMS to the forest officials to take necessary action. We validate the analytical results in comparison with the data obtained from the Forest Department. We also present a multi-class classification algorithm for providing zero false alarm rate. Species classification accuracy percentage is found to be 91.25.

S. Sulandari & M.S.A. Zein

Mitochondrial DNA variation of the Sumatran elephant populations in Sumatera, Indonesia

Biotropia 19 (2012) 92-102

Abstract. Genetic analysis of Mitochondrial DNA diversity in Sumatran elephant (*Elephas maximus sumatranus*) was conducted. A 630 bp segment of mitochondrial DNA was amplified from 105 different Sumatran elephant samples from 5 locations in Sumatera (Bentayan, Sugihan, Bukit Salero Lahat, Seblat, Way Kambas) using a set of primers: MDL3 (5'-CCCACAAT-TAATGGGCCC-GGAGCG-3') and MDL5 (5'-TTACATGAATTGGCAGCCA-ACCAG-

3'). The objectives of this study were to generate mitochondrial DNA D-loop sequences for all available Sumatran elephant samples and to define haplotypes and nucleotide sequence diversity of the different Sumatran elephant populations. The nucleotide sequence of a total of 105 PCR products were successfully determined with an average length of 616 bp. However, mitochondrial DNA fragments for this analysis used the first 601 bases. Six different haplotypes (BP, BT, BS, BR, BX and BY) were identified in Sumateran elephant populations. The majority of the sampled individuals carried haplotype BT. BX and BY are most likely novel derived haplotypes. All haplotypes, except for the haplotype BP belong to the Sumatera clade. The haplotype BX was derived from the haplotype BT, and the haplotype BY was derived from the haplotype BS by one transversion, respectively. All the other substitutions identified in this network were transitions. The haplotype BP is widely distributed from Sri Lanka, Sumatera, Peninsular Malay and China. Although reported to be distributed in Sumatera and Peninsular Malay the haplotype BU was not detected among the samples analysed in this study. Genetic distances within populations in Bentayan, Bukit Salero Lahat, Seblat, Sugihan and Way Kambas ranged from 0.0000 - 0003, and the genetic distance between the populations that is 0.0000 - 0.0022. The distance between haplotypes of different Sumatran elephant populations was shown to be low. The diversity of haplotypes and nucleotides in Sumatera Island were low, the highest diversity was found in elephants sampled in the region of Bukit Salero Lahat and the lowest was found in elephants from Bentayan and Sugihan. Overall, the results of analysis of Fu and Li's F*test statistic indicates that the population of Sumatran elephants in Sumatra is -0.78871, which suggests that there is no inbreeding. However, the results are not significant (P>0.10) and additional studies are required to confirm this finding.

I.C. Suter, M. Hockings & G.S. Baxter
Changes in elephant ownership and employment in the Lao PDR: Implications for the elephant-based logging and tourism industries
Human Dimensions of Wildlife 18 (2013) 279-291

Abstract. Communities in the Lao People's Democratic Republic (PDR) have been utilizing captive Asian elephants (*Elephas maximus*) for centuries. The elephant handler (mahout) profession has remained fundamentally unchanged. Captive elephants, however, are no longer necessary in roles where they were once considered vital, particularly the logging industry. To gauge mahout demographics and assess problems associated with elephant industries, we surveyed 133 mahouts in the Lao PDR. We found that mahoutship is an aging industry with a vanishing family association. Contrasts between logging and tourism mahouts were apparent when observing family tradition, finances, and industry-related experiences. Logging mahouts rely on tourism to provide them with future employment; however, tourism cannot currently employ elephants on a scale similar to that of logging operations. The need for the traditional mahout and a large population of captive elephants may have reached its finality in Laos. © 2013 Taylor & Francis Group, LLC.

G.S. Wilkie, A.J. Davison, M. Watson, K. Kerr, S. Sanderson, T. Bouts, F. Steinbach & A. Dastjerdi
Complete genome sequences of elephant endotheliotropic herpesviruses 1A and 1B determined directly from fatal cases
Journal of Virology 87 (2013) 6700-6712

Abstract. A highly lethal hemorrhagic disease associated with infection by elephant endotheliotropic herpesvirus (EEHV) poses a severe threat to Asian elephant husbandry. We have used high-throughput methods to sequence the genomes of the two genotypes that are involved in most fatalities, namely, EEHV1A and EEHV1B (species *Elephantid herpesvirus 1*, genus *Proboscivirus*, subfamily Betaherpesvirinae, family Herpesviridae). The sequences were determined from postmortem tissue samples, despite the data containing tiny proportions of viral reads among reads from a host for which the genome sequence was not available. The EEHV1A genome is 180,421 bp in size and consists of a unique sequence (174,601 bp) flanked by a terminal direct repeat (2,910 bp). The genome contains 116 predicted protein-coding genes, of which six are fragmented, and seven paralogous gene families are present.

The EEHV1B genome is very similar to that of EEHV1A in structure, size, and gene layout. Half of the EEHV1A genes lack orthologs in other members of subfamily Betaherpesvirinae, such as human cytomegalovirus (genus Cytomegalovirus) and human herpesvirus 6A (genus *Roseolovirus*). Notable among these are 23 genes encoding type 3 membrane proteins containing seven transmembrane domains (the 7TM family) and seven genes encoding related type 2 membrane proteins (the EE50 family). The EE50 family appears to be under intense evolutionary selection, as it is highly diverged between the two genotypes, exhibits evidence of sequence duplications or deletions, and contains several fragmented genes. The availability of the genome sequences will facilitate future research on the epidemiology, pathogenesis, diagnosis, and treatment of EEHV-associated disease. © 2013 American Society for Microbiology.

G. Wilson, A.A. Desai, D.A. Sim & W.L. Linklater

The influence of the invasive weed Lantana camara on elephant habitat use in Mudumalai Tiger Reserve, southern India

Journal of Tropical Ecology 29 (2013) 199-207

Abstract. Invasive weeds like *Lantana camara* have a range of effects on animals such as elephant. These plants are not edible by the Asian elephant (*Elephas maximus*). They also compete for space with elephant food plants and take over large areas of elephant habitat. We tested whether the addition of *L. camara* to a model consisting of measured environmental variables improved predictions of habitat use by elephant in Mudumalai Tiger Reserve, India. Elephant dung density was used to assess elephant habitat use from 62 line transects 1-km in length. Results indicated that habitat and impact of human settlements significantly influenced elephant habitat use at a landscape scale. However, we found no evidence for the hypothesis that the addition of *L. camara* significantly predicted elephant habitat use at the landscape level. We then tested the association of *L. camara* on elephant habitat use in the dry deciduous forest (DDF) where there was a significant interaction between DDF and *L. camara*. In the DDF, *L. camara* significantly predicted elephant habitat use. We conclude that while no significant effects of *L. camara* were seen at the level of an entire reserve, at a finer scale and in specific habitats negative effects of this invasive plant on elephant habitat use were observed. © 2013 Cambridge University Press.

S. Yasui, A. Konno, M. Tanaka, G. Idani, A. Ludwig, D. Lieckfeldt & M. Inoue-Murayama

Personality assessment and its association with genetic factors in captive Asian and African elephants

Zoo Biology 32 (2013) 70-78

Abstract. Elephants live in a complex society based on matrilineal groups. Management of captive elephants is difficult, partly because each elephant has a unique personality. For a better understanding of elephant well being in captivity, it would be helpful to systematically evaluate elephants' personalities and their underlying biological basis. We sent elephant' personality questionnaires to keepers of 75 elephants. We also used 196 elephant DNA samples to search for genetic polymorphisms in genes expressed in the brain that have been suggested to be related to personality traits. Three genes, androgen receptor (AR), fragile X related mental retardation protein interacting protein (NUFIP2), and acheate-scute homologs 1 (ASH1) contained polymorphic regions. We examined the association of personality with intraspecific genetic variation in 17 Asian and 28 African elephants. The results suggest that the ASH1 genotype was associated with neuroticism in Asian elephants. Subjects with short alleles had lower scores of neuroticism than those with long alleles. This is the first report of an association between a genetic polymorphism and personality in elephants. © 2012 Reproduced with permission of John Wiley & Sons, Inc.



Wild elephants waiting to be fed (Sri Lanka)