Recent Publications on Asian Elephants

Compiled by Jennifer Pastorini

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Major histocompatibility complex variation and evolution at a single, expressed DQA locus in two genera of elephants

Immunogenetics January 07, 2010

Abstract. Genes of the vertebrate major histocompatibility complex (MHC) are crucial to defense against infectious disease, provide an important measure of functional genetic diversity, and have been implicated in mate choice and kin recognition. As a result, MHC loci have been characterized for a number of vertebrate species, especially mammals; however, elephants are a notable exception. Our study is the first to characterize patterns of genetic diversity and natural selection in the elephant MHC. We did so using DNA sequences from a single, expressed DQA locus in elephants. We characterized six alleles in 30 African elephants (*Loxodonta africana*) and four alleles in three Asian elephants (*Elephas maximus*). In addition, for two of the African alleles and three of the Asian alleles, we characterized complete coding sequences (exons 1–5) and nearly complete non-coding sequences (introns 2–4) for the class II DQA loci. Compared to DQA in other wild mammals, we found moderate polymorphism and allelic diversity and similar patterns of selection; patterns of non-synonymous and synonymous substitutions were consistent with balancing selection acting on the peptides involved in antigen binding in the second exon. In addition, balancing selection has led to strong trans-species allelism that has maintained multiple allelic lineages across both genera of extant elephants for at least 6 million years. We discuss our results in the context of MHC diversity in other mammals and patterns of evolution in elephants. © 2010 with kind permission from Springer Science+Business Media.

M. Barua

Whose issue? Representations of human-elephant conflict in Indian and international media

Science Communication 32 (2010) 55-75

Abstract. The media play a key role in communicating conservation issues such as human-wildlife conflict, but corresponding literature on how issues are represented is limited. This article traces the depiction of human-elephant conflict in the media by examining (a) how conflicts are framed and (b) how ultimate and proximate causes are communicated in Indian and international newspapers. Issues were often polarized or framed in dramatic terms, and consonance in reporting causes was lacking. Active engagement with the media is needed to produce a nuanced debate on conflict, for which recognizing the role of different actors and working closely with individual journalists are vital. © 2010 SAGE Publications.

M. Barua, J. Tamuly & R.A. Ahmed

Mutiny or clear sailing? Examining the role of the Asian elephant as a flagship species

Human Dimensions of Wildlife 15 (2010) 145-160

Abstract. Flagship species are used to leverage public support for conservation. The success of a flagship is potentially determined by its popularity and ability to foster conservation intentions among a target audience. When flagships come into conflict with people, however, it is likely that conservation intentions get negatively affected. By examining peoples' exposures to the Asian elephant—a global conservation flagship—this study sought to (a) identify exposures that enable conservation intentions and (b) test whether human-elephant conflict undermines them. Survey results showed that exposure to wild elephants negatively affected intentions to conserve elephants, while specific concern for the

elephant and direct involvement in conservation activities led to positive intentions. These results suggest that the effective use of the Asian elephant as a flagship may be contingent on mitigating human-elephant conflict, for which engagement with concerned local actors and initiation of participatory conservation frameworks need to be considered. © 2010 Taylor & Francis Group, LLC.

G. Boschian & D. Sacca

Ambiguities in human and elephant interactions? Stories of bones, sand and water from Castel di Guido (Italy)

Quaternary International 214 (2010) 3-16

Abstract. Geoarchaeological and taphonomical studies have been carried out on the sequence and on the faunal remains of Castel di Guido (Central Italy), a Middle Pleistocene site with Acheulean industry and faunas including *Elephas* (*Palaeoloxodon*) *antiquus*, *Bos primigenius*, *Equus ferus* and other taxa. Investigation focused on remains accumulated on the bottom of a depressed area, probably an ephemeral stream channel sometimes acting as a seep. The assemblage resulted prevalently from human activity, as shown by the selection of the faunas, by the thorough fracturing of the bones, and by the occurrence of abundant chipped stone industry and bone bifaces. It is still a matter of debate whether the animals were hunted or scavenged. The present-day distribution of the remains does not represent exactly their original configuration, as in most sites of this type and age. More likely, the objects are partly in their original position and partly reworked, and lie within a complex palimpsest of several phases of fluvial transport and human activity, with the addition of external inputs of reworked bones and artefacts. © 2009 with permission from Elsevier and INQUA.

J.L. Brown, D.C. Kersey, E.W. Freeman & T. Wagener

Assessment of diurnal urinary cortisol excretion in Asian and African elephants using different endocrine methods

Zoo Biology 29 (2010) 274-283

Abstract. Longitudinal urine samples were collected from Asian and African elephants to assess sample processing and immunoassay techniques for monitoring adrenal activity. Temporal profiles of urinary cortisol measured by RIA and EIA, with and without dichloromethane extraction, were similar; all correlation coefficients were >0.90. However, based on regression analyses, cortisol immunoactivity in extracted samples was only 72-81% of that of unextracted values. Within assay technique, RIA values were only 74-81% of EIA values. Collection of 24-hr urine samples demonstrated a clear diurnal pattern of glucocorticoid excretion, with the lowest concentrations observed just before midnight and peak concentrations occurring around 0600-0800 hr. These results indicate that elephants fit the pattern of a diurnal species, and that glucocorticoid production is affected by a sleep-wake cycle similar to that described for other terrestrial mammals. Cortisol can be measured in both extracted and unextracted urine using RIA and EIA methodologies. However, unexplained differences in quantitative results suggest there may be sample matrix effects and that data generated using different techniques may not be directly comparable or interchangeable. © 2009 Wiley-Liss, Inc.

R. Clements, D.M. Rayan, A.W.A. Zafir, A. Venkataraman, R. Alfred, J. Payne, L. Ambu & D.S.K. Sharma

Trio under threat: can we secure the future of rhinos, elephants and tigers in Malaysia?

Biodiversity and Conserv. 19 (2010) 1115-1136

Abstract. Three of Malaysia's endangered large mammal species are experiencing contrasting futures. Populations of the Sumatran rhino (*Dicerorhinus sumatrensis*) have dwindled to critically low numbers in Peninsular Malaysia (current estimates need to be revised) and the state of Sabah (less than 40 individuals estimated). In the latter region, a bold intervention involving the translocation of isolated rhinos is being developed to concentrate them into a protected area to improve reproduction success rates. For the Asian elephant (*Elephas maximus*), recently established baselines for Peninsular Malaysia (0.09 elephants/km^2 estimated from one site) and Sabah (between 0.56 and 2.15 elephants/km^2 estimated from four sites) seem to indicate globally significant populations based on dung count surveys. Similar surveys are required

to monitor elephant population trends at these sites and to determine baselines elsewhere. The population status of the Malayan tiger (*Panthera tigris jacksoni*) in Peninsular Malaysia, however, remains uncertain as only a couple of scientifically defensible camera- trapping surveys (1.66 and 2.59 tigers/100 km^2 estimated from two sites) have been conducted to date. As conservation resources are limited, it may be prudent to focus tiger monitoring and protection efforts in priority areas identified by the National Tiger Action Plan for Malaysia. Apart from reviewing the conservation status of rhinos, elephants and tigers and threats facing them, we highlight existing and novel conservation initiatives, policies and frameworks that can help secure the long-term future of these iconic species in Malaysia.

R.H.I. Dale

Birth statistics for African (*Loxodonta africana*) and Asian (*Elephas maximus*) elephants in human care: history and implications for elephant welfare

Zoo Biology 29 (2010) 87-103

Abstract. African (*Loxodonta africana*) and Asian elephants (*Elephas maximus*) have lived in the care of humans for many years, yet there is no consensus concerning some basic parameters describing their newborn calves. This study provides a broad empirical basis for generalizations about the birth heights, birth weights, birth times and gestation periods of elephant calves born in captivity. I obtained data concerning at least one of these four characteristics for 218 newborn calves from 74 institutions. Over the past 30 years, newborn Asian elephants have been taller and heavier than newborn African elephants. Neonatal African elephants exhibited sex differences in both weight and height, whereas neonatal Asian elephants have exhibited sex differences only in height. Primiparous dams ex situ are at least as old as their in situ counterparts, whereas ex situ sires appear to be younger than sires in range countries. Confirming earlier anecdotal evidence, both African [N=47] and Asian [N=91] dams gave birth most often at night. © 2009 Wiley-Liss, Inc.

S. de Silva

Acoustic communication in the Asian elephant, *Elephas maximus maximus*

Behaviour 147 (2010) 825-852

Abstract. Existing knowledge of acoustic communication in elephants is based primarily on African species (*Loxodonta africana* and *Loxodonta cyclotis*). There has been comparatively less study of communication in Asian elephants (*Elephas maximus*). In order to provide a basis for understanding the evolution and function of acoustic communication in proboscideans, I present a quantitative description of vocal communication in wild Asian elephants. I classify calls by acoustic features into 8 'single' calls, 5 'combination' calls and one possibly unique male call for a total of at least 14 distinct call types. Some of these vocalizations have never before been described. Certain low-frequency calls are individually distinct. Acoustic signals occur in a wide range of social contexts, with some differences in call production among age and sex classes. © 2010 Koninklijke Brill NV, Leiden.

R. Duffy & L. Moore

Neoliberalising nature? Elephant-back tourism in Thailand and Botswana

Antipode 42 (2010) 742-766

Abstract. This paper examines the case of elephant-back safaris in Thailand and Botswana; it argues that tourism has extended and deepened neoliberalism by targeting and opening up new frontiers in nature. In essence tourism redesigns and repackages nature for global consumption. Through a cross comparison of the same product (the use of captive/trained elephants) in two very different contexts (Thailand and Botswana) this paper analyses the variations in "actually existing neoliberalisms" (Brenner and Theodore 2002) and demonstrates that the effects are not unremittingly negative (Castree 2008b). It also draws out the ways that neoliberalism is challenged and reshaped by context specific processes and so it does not completely displace existing ways of approaching nature. Instead, existing approaches mix with neoliberalism to create new ways of valuing and conserving elephants. © 2010 Editorial Board of Antipode.

C. Gaucherel, M. Balasubramanian, P.V. Karunakaran, B.R. Ramesh, G. Muthusankar, C. Hély & P. Couteron

At which scales does landscape structure influence the spatial distribution of elephants in the Western Ghats (India)?

Journal of Zoology 280 (2010) 185-194

Abstract. In spatial ecology, detailed covariance analyses are useful for investigating the influences of landscape properties on fauna and/or flora species. Such ecological influences usually operate at multiple scales, involving biological levels from individual to group, population or community and spatial units from field to farms and regions. The aim of this work was to analyze possible multiscale influences of some landscape properties on elephant distribution in the Western Ghats, India, by applying a recent and simple mathematical method to quantify such ecological relationships across space and scales. This method combines a moving window with various correlation indices to investigate the relationship between two mapped variables. Maps of landscape heterogeneity (quantified here at all locations of the landscape with a modified Shannon index) and Asian elephant presence (a two-dimensional presence probability) were significantly correlated. This correlation systematically decreased with increasing scales (i.e. sizes of the reference moving window). Yet, this global relationship includes both positive and negative correlations located at distinct places. We documented a positive feedback (reinforcement) because elephants appeared to seek greater habitat heterogeneity, in heterogeneous areas, such as along the interface between natural and a human-disturbed habitat or in the natural part of the studied landscape. In parallel, we observed a negative feedback (compensation) making elephants seeking more homogeneous places in some relatively heterogeneous zones. Such negative feedbacks corresponded to higher than average probabilities of elephant presence. Finally, when elephant density varied according to landscape heterogeneity (corresponding to significant correlations), it pointed towards swamps and grasslands, but not towards semi-evergreen or secondary forests (as it may have been expected). Land cover information appeared to be less relevant than an integrated heterogeneity index computed at all scales. © 2009 The Zoological Society of London.

J.J. Genin, P.A. Willems, G.A. Cavagna, R. Lair & N.C. Heglund

Biomechanics of locomotion in Asian elephants

J. of Experimental Biology 213 (2010) 694-706

Abstract. Elephants are the biggest living terrestrial animal, weighing up to five tons and measuring up to three metres at the withers. These exceptional dimensions provide certain advantages (e.g. the mass-specific energetic cost of locomotion is decreased) but also disadvantages (e.g. forces are proportional to body volume while supportive tissue strength depends on their cross-sectional area, which makes elephants relatively more fragile than smaller animals). In order to understand better how body size affects gait mechanics the movement of the centre of mass (COM) of 34 Asian elephants (*Elephas maximus*) was studied over their entire speed range of 0.4-5.0 m s^{-1} with force platforms. The mass-specific mechanical work required to maintain the movements of the COM per unit distance is ~0.2 J kg^{-1} m–1 (about 1/3 of the average of other animals ranging in size from a 35 g kangaroo rat to a 70 kg human). At low speeds this work is reduced by a pendulum-like exchange between the kinetic and potential energies of the COM, with a maximum energy exchange of ~60% at 1.4 m s^{-1}. At high speeds, elephants use a bouncing mechanism with little exchange between kinetic and potential energies of the COM, although without an aerial phase. Elephants increase speed while reducing the vertical oscillation of the COM from about 3 cm to 1 cm. © 2010 reproduced with permission from The Company of Biologists Ltd.

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

Prediction of estrus cyclicity in Asian elephants (*Elephas maximus*) through estimation of fecal progesterone metabolite: development of an enzyme-linked immuno-sorbent assay

Theriogenology 73 (2010) 1051-1060

Abstract. Asian elephants (*Elephas maximus*), prominent "flagship species", are listed under the category of endangered species (EN – A2c, ver. 3.1; IUCN Red List 2009) and there is a need for

their conservation. This requires understanding demographic and reproductive dynamics of the species. Monitoring reproductive status of any species is traditionally being carried out through invasive blood sampling and this is restrictive for large animals such as wild or semi-captive elephants due to legal, ethical, and practical reasons. Hence, there is a need for a non-invasive technique to assess reproductive cyclicity profiles of elephants, which will help in the species' conservation strategies. In this study, we developed an indirect competitive enzyme linked immuno-sorbent assay (ELISA) to estimate the concentration of one of the progesterone-metabolites i.e., allopregnanolone (5 -P-3OH) in fecal samples of Asian elephants. We validated the assay which had a sensitivity of 0.25 μM at 90% binding with an EC50 value of 1.37 μM. Using female elephants, kept under semi-captive conditions in the forest camps of Mudumalai Wildlife Sanctuary, Tamil Nadu and Bandipur National Park, Karnataka, India, we measured fecal progesterone-metabolite (5 -P-3OH) concentrations in six animals and showed their clear correlation with those of serum progesterone, measured by a standard radio-immuno assay. Statistical analyses using a Linear Mixed Effect model showed a positive correlation ($P < 0.1$) between the profiles of fecal 5 -P-3OH (range: 0.5–10 μg/g) and serum progesterone (range: 0.1–1.8 ng/mL). Therefore, our studies show, for the first time, that the fecal progesterone-metabolite assay could be exploited to predict estrus cyclicity and to potentially assess the reproductive status of captive and free-ranging female Asian elephants, thereby helping to plan their breeding strategy. © 2010 with permission from Elsevier Inc.

C. Gómez-Centurión

Treasures fit for a king. King Charles III of Spain's Indian elephants

J. of the History of Collections 22 (2010) 29-44

Abstract. The practice of collecting exotic animals saw an unprecedented rise at the Spanish court in the eighteenth century, particularly during the reign of Charles III. His most prized specimens were three Indian elephants, regarded as genuine crown jewels and symbolizing the power, wealth and prestige of a great sovereign more eloquently than any other animal. They gave a clear sign of the breadth and strength of his diplomacy, the influence of which extended as far away as India. The interest aroused by their acquisition and the diplomatic procedures involved are examined here, together with the problems encountered in bringing these animals to the Iberian Peninsula and maintaining them in the unusual conditions of the Aranjuez Palace. © 2009 by permission of Oxford University Press.

B.R. Harish, B.M. Shivaraj, B.M. Chandranaik, M.D. Venkatesh & C. Renukaprasad

Hemorrhagic septicemia in Asian elephants *Elephas maximus* in Karnataka state, India

Journal of Threatened Taxa 1(2009) 194-195

Abstract. none

S. Hedges & D. Gunaryadi

Reducing human–elephant conflict: do chillies help deter elephants from entering crop fields?

Oryx 44 (2010) 139-146

Abstract. Crop raiding by elephants is the most prevalent form of human–elephant conflict and can result in devastating economic losses for farmers, loss of human lives and the killing or capture of elephants. Chilli (capsaicin)-based elephant deterrents have been promoted as tools for reducing such conflict but have been little tested. From October 2005 to April 2006 we tested crop-guarding systems around Way Kambas National Park in Indonesia. We evaluated the effectiveness of community-based guarding using traditional tools (e.g. noise-makers) at one site and community-based guarding plus chilli-grease-covered fences and tripwire-triggered sirens at another site. We monitored human–elephant conflict rates around the Park to assess the effectiveness of our mitigation trials. Over the trial period there were 34 attempts by elephants to enter crop fields at the chilli and sirens site and 57 attempts to enter fields at the conventional site but 91.2% of attempts were repelled successfully at both sites. Over the same period there were 401 crop-raiding incidents elsewhere around the Park. In 2007 farmers at both our former sites voluntarily adopted the methods that had been used at the conventional site, but not at the chilli and sirens site, and were able to repel 156

of 178 (87.6%) attempted elephant raids. We conclude that community-based guarding using conventional tools is the key to keeping elephants out of crops and that chilli-grease fences (and sirens) do not add any significant deterrent effect but do add expense and create additional work. However, other chilli-based deterrents may be effective and chillies have value as elephant-resistant cash crops. © 2009 Fauna & Flora International, Cambridge University Press.

N. Irie & T. Hasegawa

Elephant psychology: What we know and what we would like to know

Japanese Psychol.Research 51(2009) 177-181

Abstract. Although elephants are well-known and one of the most popular species among people, their behavior and cognitive abilities have not been studied very extensively. But recently, more and more researchers are becoming interested in studying their cognition, particularly their general intelligence, including causal reasoning and mirror self recognition, memory, and numerical cognition. Although genetically elephants are more closely related to the small-brained aardvarks and manatees than to primates, they hold enormous potential in their cognitive skills. Also, studying their cognition is important from the point of view of animal welfare in captivity. © 2009 Japanese Psychological Association.

D. Jayantha, P.N. Dayawansa, U.K.G.K. Padmalal & W.D. Ratnasooriya

Social relationships of wild juvenile Asian Elephants *Elephas maximus* in the Udawalawa National Park, Sri Lanka

Journal of Threatened Taxa 1 (2009) 211-214

Abstract. Social relationships of juvenile wild elephants (3-6 years old) in the Udawalawa National Park were studied. Focal animal sampling was employed to quantify behaviour of juveniles encountered on 450 different occasions. Nearest neighbour (NN) and nearest neighbour distance (NND) were considered for proximity analysis and the social relationships of focal animals. Adult females and juveniles were the NN of the study group during 50.8% and 37.6% of the total observed time respectively. The mean NND was 1.62m (SD±2.8), and it was less than 5m 98% of the time while 33% of the time the study group was touching (NND<1m) the NN. There was a significant difference between NND categories ($p<0.05$). Eighty percent of the NN infants stayed at a touching distance and were cared or allo-mothered by the juveniles under discussion. Time allocated for different behaviour patterns by the study group varied with the NN. When the study animals were accompanied by age-mates, they spent 17% of time in social playing and another 3% in non-play social contacts, but only 1% in each behaviour pattern when the adult females were in close proximity. Maximum social contacts were observed between study animals and infants. The findings suggest that juvenile elephants associate more frequently with adult females and near-age mates while they show social relationships in a varying degree with different associates. Play and social contacts of juveniles with conspecifics, especially with peers, provides opportunity to develop skills and social confidence necessary in adulthood. © 2009 The Author.

M.A. Kumar, D. Mudappa & T.R.S. Raman

Asian elephant *Elephas maximus* habitat use and ranging in fragmented rainforest and plantations in the Anamalai Hills, India

Tropical Conserv. Science 3 (2010) 143-158

Abstract. The persistence of wide-ranging mammals such as Asian elephants in fragmented landscapes requires extending conservation efforts into human-dominated landscapes around protected areas. Understanding how elephants use such landscapes may help facilitate their movements and reduce conflict incidence. We studied elephants' use of fragmented habitats and ranging patterns of focal herds in a landscape of rainforest fragments embedded in tea, coffee, and Eucalyptus plantations in the Anamalai Hills. Elephant herds entering this landscape were tracked daily between April 2002 and March 2006, resulting in 985 GPS locations of herds obtained across six major habitats. Natural vegetation in rainforest fragments and riparian habitats, despite low coverage in the landscape, was preferred by elephants during the day. At night, elephants preferred riparian vegetation, avoided other habitats such as swamps and settlements, while the remaining habitats were used proportional to availability. Use of rainforest fragments and

riparian vegetation increased over three years of study with a corresponding decline in the use of tea monoculture. Among plantation habitats, coffee, and Eucalyptus were used significantly more during wet and dry seasons, respectively. The concentration of elephants along a major riparian system in the center of the landscape emphasized the role of water and food availability in habitat use during the dry season. Protection of rainforest fragments, secondary vegetation along rivers, and regulated and sequential felling (instead of clear-felling) of Eucalyptus along elephant movement routes will help retain forage, cover, and passage routes of elephant herds and may reduce direct human-elephant encounters in such fragmented landscapes. © 2010 The Authors.

K.D. Lewis, D.J. Shepherdson, T.M. Owens & M. Keele

A survey of elephant husbandry and foot health in North American zoos

Zoo Biology 29 (2010) 221-236

Abstract. The foot health of elephants in human care is a longstanding concern. In 2001, the AZA Standards for Elephant Management and Care were published recommending husbandry to improve foot health. This article reports the results of a 2006 survey: basic statistics describing facility, husbandry, and foot health attributes are reported and relationships among variables are investigated. Median area available to elephants exceeded standard recommendations (755 ft^2 per elephant indoor and 10,000 ft^2 outdoor). Concrete makes up 69% of indoor area and natural substrates account for 85% of outdoor area. Elephants in AZA facilities received an average of 45.5 min/day of exercise, and facilities with a structured exercise plan provided significantly more exercise than did facilities without a structured exercise plan ($z=-2.522$, $P=0.012$). Enrichment is important to psychological health and may also stimulate activity beneficial to foot health; 95% of institutions had a structured enrichment program. Preventative foot care was nearly universal, and 100% of facilities performed routine nail and pad trimming. However, foot pathology has not been eradicated; 33% of institutions reported at least one pathology in the previous year. This study found a strong inverse relationship between foot pathology and exercise ($2(3)=24.34$, $P<0.001$). Younger herds were less likely to have a member diagnosed with arthritis ($2(1)=8.90$, $P=0.003$). Lameness was unrelated to age or pathology, and only the presence of arthritis explained lameness ($z=-7.81$, $P<0.001$). African elephants seemed to experience lower rates of foot pathology and arthritis than Asian elephants; however, this was explained by differences in age. © 2009 Wiley-Liss, Inc.

G.J. Mason & J.S. Veasey

How should the psychological well-being of zoo elephants be objectively investigated?

Zoo Biology 29 (2010) 237-255

Abstract. Animal welfare (sometimes termed well-being) is about feelings - states such as suffering or contentment that we can infer but cannot measure directly. Welfare indices have been developed from two main sources: studies of suffering humans, and of research animals deliberately subjected to challenges known to affect emotional state. We briefly review the resulting indices here, and discuss how well they are understood for elephants, since objective welfare assessment should play a central role in evidence-based elephant management. We cover behavioral and cognitive responses (approach/avoidance; intention, redirected and displacement activities; vigilance/startle; warning signals; cognitive biases, apathy and depression-like changes; stereotypic behavior); physiological responses (sympathetic responses; corticosteroid output - often assayed non-invasively via urine, feces or even hair; other aspects of HPA function, e.g. adrenal hypertrophy); and the potential negative effects of prolonged stress on reproduction (e.g. reduced gametogenesis; low libido; elevated still-birth rates; poor maternal care) and health (e.g. poor wound-healing; enhanced disease rates; shortened lifespans). The best validated, most used welfare indices for elephants are corticosteroid outputs and stereotypic behavior. Indices suggested as valid, partially validated, and/or validated but not yet applied within zoos include: measures of preference/avoidance; displacement movements; vocal/postural signals of affective (emotional) state; startle/vigilance; apathy; salivary and urinary epinephrine; female acyclity; infant mortality rates; skin/foot infections; cardio-vascular disease; and

premature adult death. Potentially useful indices that have not yet attracted any validation work in elephants include: operant responding and place preference tests; intention and vacuum movements; fear/stress pheromone release; cognitive biases; heart rate, pupil dilation and blood pressure; corticosteroid assay from hair, especially tail-hairs (to access endocrine events up to a year ago); adrenal hypertrophy; male infertility; prolactinemia; and immunological changes. © 2009 Wiley-Liss, Inc.

G.J. Mason & J.S. Veasey

What do population-level welfare indices suggest about the well-being of zoo elephants?

Zoo Biology 29 (2010) 256-273

Abstract. To assess zoo elephants' welfare using objective population-level indices, we sought data from zoos and other protected populations (potential benchmarks) on variables affected by poor well-being. Such data were available on fecundity, potential fertility, stillbirths, infant mortality, adult survivorship, and stereotypic behavior. Most of these can also be affected by factors unrelated to well-being; therefore, for each, we analyzed the potential role of these other factors. Population-level comparisons generally indicate poor reproduction, and poor infant and adult survivorship in zoos compared with benchmark populations (with some differences between zoo regions and over time). Stereotypic behavior also occurs in c. 60% of zoo elephants; as the population-level welfare index least open to alternative interpretations, this represents the strongest evidence that well-being is/has been widely compromised. Poor well-being is a parsimonious explanation for the diverse range of population-level effects seen, but to test this hypothesis properly, data are now needed on, for example, potential confounds that can affect these indices (to partition out effects of factors unrelated to well-being), and causes of the observed temporal effects, and differences between species and zoo regions. Regardless of whether such additional data implicate poor well-being, our findings suggest that elephant management has generally been sub-optimal. We also discuss the selection and utilization of benchmark data, as a useful future approach for evaluating such issues. © 2010 Wiley-Liss, Inc.

Elephant relief at the Kesava temple in Somnathpur, India built in 1268

S. Nair, R. Balakrishnan, C.S. Seelamantula & R. Sukumar

Vocalizations of wild Asian elephants (*Elephas maximus*): structural classification and social context

Journal of the Acoustical Society of America 126 (2009) 2768-2778

Abstract. Elephants use vocalizations for both long and short distance communication. Whereas the acoustic repertoire of the African elephant (*Loxodonta africana*) has been extensively studied in its savannah habitat, very little is known about the structure and social context of the vocalizations of the Asian elephant (*Elephas maximus*), which is mostly found in forests. In this study, the vocal repertoire of wild Asian elephants in southern India was examined. The calls could be classified into four mutually exclusive categories, namely, trumpets, chirps, roars, and rumbles, based on quantitative analyses of their spectral and temporal features. One of the call types, the rumble, exhibited high structural diversity, particularly in the direction and extent of frequency modulation of calls. Juveniles produced three of the four call types, including

trumpets, roars, and rumbles, in the context of play and distress. Adults produced trumpets and roars in the context of disturbance, aggression, and play. Chirps were typically produced in situations of confusion and alarm. Rumbles were used for contact calling within and among herds, by matriarchs to assemble the herd, in close-range social interactions, and during disturbance and aggression. Spectral and temporal features of the four call types were similar between Asian and African elephants.

C. Neto de Carvalho

Vertebrate tracksites from the Mid-Late Pleistocene eolianites of Portugal: the first record of elephant tracks in Europe

Geological Quarterly 53 (2009) 407-414

Abstract. This study describes the palaeoichnology of the Malhao Dune Field (Pleistocene), the first report of vertebrate tracksites from all the Cenozoic front Portugal. At least 14 stratigraphic horizons with mammal and bird footprints and trackways occur, including those of elephants. Footprints produced by elephants show four feet with four toes imprints on each foot and heteropody in a narrow gauge. The presence of three possibly parallel trackways points to gregarious behavior of sub-adults/females of *Elephas antiquus*. The ichnospecies *Proboscipeda panfamilia*, found in the Malhão and Pessegueiro sectors, represents possibly the first Pleistocene elephant trackways, and record one of the latest occurrences of *E. antiquus* in Europe. The new ichnogenus and ichnospecies *Leporidichnites malhaoi*, interpreted as lagomorph tracks, are also described. © 2009 The Author.

J.M. Plotnik, F.B.M. de Waal, D. Moore III & D. Reiss

Self-recognition in the Asian elephant and future directions for cognitive research with elephants in zoological settings

Zoo Biology 29 (2010) 179-191

Abstract. The field of animal cognition has grown steadily for nearly four decades, but the primary focus has centered on easily kept lab animals of varying cognitive capacity, including rodents, birds and primates. Elephants (animals not easily kept in a laboratory) are generally thought of as highly social, cooperative, intelligent animals, yet few studies - with the exception of long-term behavioral field studies - have been conducted to directly support this assumption. In fact, there has been remarkably little cognitive research conducted on Asian (*Elephas maximus*) or African (*Loxodonta africana* or *L. cyclotis*) elephants. Here, we discuss the opportunity and rationale for conducting such research on elephants in zoological facilities, and review some of the recent developments in the field of elephant cognition, including our recent study on mirror self-recognition in *E. maximus*. © 2009 Wiley-Liss, Inc.

C.M. Proctor, E.W. Freeman & J.L. Brown

Results of a second survey to assess the reproductive status of female Asian and African elephants in North America

Zoo Biology 29 (2010) 127-139

Abstract. Surveys are being conducted to monitor the reproductive health of elephants managed by the TAG/SSP. This study summarizes results of a 2005 survey and compares data to one conducted in 2002. Surveys were returned for 100% and 79.0% of Asian and African elephants, respectively. Of those, 79.3% of Asian and 92.1% of African elephants had weekly progestagen data to assess ovarian cyclicity. For Asian elephants, acyclicity rates were similar between the 2002 and 2005 surveys (13.3% versus 10.9%), whereas irregular cycling increased in 2005 (2.6% versus 7.6%), respectively. For African elephants, the percentages of both acyclicity (22.0% versus 31.2%) and irregular cycling females (5.2% versus 11.8%) increased. In both species, ovarian inactivity was more prevalent in the older age categories (>30 years of age), but for African elephants also occurred in the reproductive aged groups. Reproductive tract pathologies did not account for the majority of acyclicity problems. Several females changed cyclicity status between the two surveys, including from noncycling to cycling, suggesting this is not an irreversible condition. However, seven African females went from cycling to abnormal or no cyclic activity. In summary, the incidence of ovarian acyclicity in Asian elephants is low and stable, but appears to be increasing in African females. These findings reinforce the need for

long-term reproductive monitoring programs and continuous reproductive surveys, even for females not being considered for breeding. With more data we hope to determine what factors are related to changes in ovarian status and how to reverse the trend towards acyclicity. © 2009 Wiley-Liss, Inc.

L. Ren, C.E. Miller, R. Lair & J.R. Hutchinson
Integration of biomechanical compliance, leverage, and power in elephant limbs
PNAS 107 (2010) 7078–7082
Abstract. The structure and motion of elephant limbs are unusual compared with those of other animals. Elephants stand and move with straighter limbs (at least when walking), and have limited speed and gait. We devised novel experiments to examine how the limbs of elephants support and propel their mass and to explore the factors that may constrain locomotor performance in these largest of living land animals. We demonstrate that elephant limbs are remarkably compliant even in walking, which maintains low peak forces. Dogma defines elephant limbs as extremely "columnar" for effective weight support, but we demonstrate that limb effective mechanical advantage (EMA) is roughly one-third of that predicted for their size. EMA in elephants is actually smaller than that in horses, which are only one-tenth their mass; it is comparable to human limb values. EMA drops sharply with speed in elephants, as it does in humans. Muscle forces therefore must increase as the limbs become more flexed, and we show how this flexion translates to greater volumes of muscle recruited for locomotion and hence metabolic cost. Surprisingly, elephants use their forelimbs and hindlimbs in similar braking and propulsive roles, not dividing these functions among limbs as was previously assumed or as in other quadrupeds. Thus, their limb function is analogous to four-wheel-drive vehicles. To achieve the observed limb compliance and low peak forces, elephants synchronize their limb dynamics in the vertical direction, but incur considerable mechanical costs from limbs working against each other horizontally. © 2010 National Academy of Sciences.

H.S. Riddle, B.A. Schulte, A.A. Desai & L. van der Meer
Elephants - a conservation overview
Journal of Threatened Taxa 2 (2010) 653-661
Abstract. Loss of habitat is one of the most significant problems facing elephants worldwide, leading to clashes over resources between wildlife and humans where elephants receive the largest part of blame – defined as Human Elephant Conflict (HEC). The sub-Saharan region of Africa contains an approximate population of 500,000 elephants that occupy 37 range countries. The African Elephant (*Loxodonta africana*) is categorized as Vulnerable in the Red List of Threatened Species; they are listed there as two distinct subspecies: the Savanna Elephant (*L. a. africana*) and the Forest Elephant (*L. a. cyclotis*). The Red List of Threatened Species categorizes the Asian Elephant (*Elephas maximus*) as endangered, and today they are found in 13 range states. The Asian Elephant population is estimated to be 30,000 to 50,000 with approximately 60% of the population being present in India. Due to threats of poaching, the elephant ivory debate has been an important part of recent meetings of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) as Parties have debated proposals for one-time sales of legal government stockpiles of elephant tusks. To maintain elephant populations into the future, long-term and large-scale planning is necessary to ensure adequate space and protection for elephants and people living in elephant habitats. © 2010 The Authors.

M. Sa-ardrit, N. Thongtip, K. Kornkaewrat, T. Faisaikarm, Y. Kitiyanant, S. Mahasawangkul, A. Pinyopummin & K. Saikhun
Assessment of viability and acrosomal status of Asian elephant (*Elephas maximus*) sperm after treatment with calcium ionophore and heparin
Journal of the South African Veterinary Association 80 (2009) 146-150
Abstract. Knowledge about the acrosomal status of Asian elephant (*Elephas maximus*) sperm is extremely limited. The objective of this study was to evaluate the viability and acrosomal status of Asian elephant sperm following induction by

calcium ionophore and heparin using propidium iodide (PI) and fluorescein isothiocyanate conjugated peanut agglutinin (FITC-PNA). Semen samples were collected from elephant bulls by manual stimulation. Semen was diluted with extender, cooled to 4 C and transported to a laboratory for the experiment. Sperm cells were incubated in modified Tyrode's medium containing either 1mM calcium ionophore or 10 mg/ml heparin for 5 h at 39 C. Sperm recovered at the onset (0 h), 1, 2, 3, 4 and 5 h of incubation were simultaneously assessed for the viability and acrosomal status using dual staining of FITC-PNA and PI. Results were confirmed by transmission electron microscopy. A progressive increase in the proportion of live-acrosome reacted sperm was observed within 3 h of incubation in both treatment groups which slightly decreased at 4 to5 h of incubation. At 1 to 3 h of incubation, the percentage of live-acrosome reacted sperm induced by calcium ionophore was higher ($P < 0.05$) than those induced by heparin and the control. However, there were no statistical differences at 4 to 5 h of incubation. A progressive reduction of the percentage of motile sperm was observed in the control as well as both treatment groups. Sperm motility decreased sharply when they were incubated in calcium ionophore compared with incubation in heparin and control groups. These results indicate that the occurrence of live-acrosome reacted sperm in the Asian elephant was induced by calcium ionophore at a rate higher than that induced by heparin.

R.C. Sidle & A.D. Ziegler

Elephant trail runoff and sediment dynamics in northern Thailand

J.of Environmental Quality 39 (2010) 871-881

Abstract. Although elephants may exert various impacts on the environment, no data are available on the effects of elephant trails on runoff, soil erosion, and sediment transport to streams during storms. We monitored water and sediment fluxes from an elephant trail in northern Thailand during seven monsoon storms representing a wide range of rainfall energies. Runoff varied from trivial amounts to 353 mm and increased rapidly in tandem with expanding contributing areas once a threshold of wetting occurred. Runoff coefficients during the two largest storms were much higher than could be generated from the trail itself, implying a 4.5- to 7.9-fold increase in the drainage areas contributing to storm runoff. Clockwise hysteresis patterns of suspended sediment observed during most storms was amplified by a "first flush" of sediment early on the hydrograph in which easily entrained sediment was transported. As runoff areas expanded during the latter part of large storms, discharge increased but sediment concentrations declined. Thus, sediment flux was better correlated to kinetic energy of rainfall on the falling limbs of most storm hydrographs compared to rising limbs. Based on a power function relationship between sediment flux and storm kinetic energy, the estimated annual sediment yield from the trail for 135 storms in 2005 was 308 to 375 Mg ha^{-1} yr^{-1}, higher than from most disturbed land surfaces in the tropics. The eight largest storms (30% of total storm energy) in 2005 transported half of the total annual sediment. These measurements together with site investigations reveal that highly interconnected elephant trails, together with other source areas, directly link runoff and sediment to streams.

M. Techakumphu, R. Rungsiwiwut, P. Numchaisrika & A. Thongphakdee

Cloned Asian elephant (*Elephas maximus*) embryos reconstructed from rabbit recipient oocytes

Thai Journal of Vet. Medicine 40 (2010) 63-68

Abstract. The information about reproductive biology, especially embryo development of Asian elephant (*Elephas maximus*) generated from naturally fertilization is lacking. In the present study, somatic cell nuclear transfer (SCNT) was applied as an alternative way to produce the elephant embryos. The fibroblasts derived from ear skin of Asian elephant and rabbit were used as the donor cells and rabbit oocytes were used as the recipient cytoplasm. The objectives of the study were 1) to find the optimal conditions for fusion and activation by using electrical pulses (experiment I) and 2) to investigate the *in vitro* development of cloned Asian elephant in comparison to clone rabbit embryos (experiment

II). Enucleation was accomplished by aspiration of the first polar body and the metaphase II plate together with a small amount of cytoplasm. The donor cells were transferred into the perivitelline space of the enucleated oocytes. In experiment I, sixty-one of elephant-rabbit reconstructed units were fused by electrical pulses E1 (3.2 kV/cm, 3 pulses, 20 μs) and sixty-nine units were fused by E2 (2.0 kV/cm, 2 pulses, 20 μs) in 0.3 M mannitol with 0.1 mM Ca^{2+} and Mg^{2+}. The fused units were activated by using the same electrical pulses and incubated in activation medium for 1 h. Subsequently, the activated embryos were cultured in B2 medium containing 2.5% fetal calf serum and the developmental rate was observed daily for 7 days. The results showed that the fusion and cleavage rates of elephant-rabbit cloned embryos fused and activated by E1 were significantly higher than E2 ($p<0.05$). Electrical pluses program E1 was selected for further investigation in experiment II. The fusion and activation rated of elephant-rabbit units displayed significantly higher than rabbit-rabbit units ($p<0.05$). However, by comparison of cloned embryo development between elephant- and rabbit-rabbit units, the development from cleavage throughout the blastocyst stage of elephant-rabbit cloned units was similar to those of rabbit-rabbit units. In conclusion, fusion and activation protocol of E1 is suitable for elephant-rabbit SCNT and the elephant nuclei could be reprogrammed and developed to blastocyst stage in enucleated rabbit oocytes. The present study provides the fundamental knowledge for further investigation of conservation and therapeutic aims, including cloned elephant embryo development *in vivo* after transfer, rescuing valuable elephant and establishment of elephant embryonic stem cells.

H. Telkänranta

Conditioning or cognition? Understanding interspecific communication as a way of improving animal training (a case study with elephants in Nepal

Sign Systems Studies 37 (2009) 542-557

Abstract. When animals are trained to function in a human society (for example, pet dogs, police dogs, or sports horses), different trainers and training cultures vary widely in their ability to understand how the animal perceives the communication efforts of the trainer. This variation has considerable impact on the resulting performance and welfare of the animals. There are many trainers who frequently resort to physical punishment or other pain-inflicting methods when the attempts to communicate have failed or when the trainer is unaware of the full range of the potential forms of human-animal communication. Negative consequences of this include animal suffering, imperfect performance of the animals, and sometimes risks to humans, as repeated pain increases aggression in some animals. The field of animal training is also interesting from a semiotic point of view, as it effectively illustrates the differences between the distinct forms of interaction that are included in the concept of communication in the zoosemiotic discourse. The distinctions with the largest potential in improving human-animal communication in animal training, is understanding the difference between verbal communication of the kind that requires rather high cognitive capabilities of the animal, and communication based on conditioning, which is a form of animal learning that does not require high cognitive ability. The differences and potentials of various types of human-animal communication are discussed in the form of a case study of a novel project run by a NGO called Working Elephant Programme of Asia (WEPA), which introduces humane, science-based training and handling methods as an alternative to the widespread use of pain and fear that is the basis of most existing elephant training methods.

C. Thitaram, C. Somgird, S. Mahasawangkul, T. Angkavanich, R. Roongsri, N. Thongtip, B. Colenbrander, F.G. van Steenbeek & J.A. Lenstra

Genetic assessment of captive elephant (*Elephas maximus*) populations in Thailand

Conservation Genetics 11 (2010) 325-330

Abstract. The genetic diversity and population structure of 136 captive Thai elephants (*Elephas maximus*) with known region of origin were investigated by analysis of 14 highly polymorphic microsatellite loci. We did not detect significant indications of inbreeding and only a low differentiation of elephants from

different regions. This is probably explained by the combined effects of isolation by distance and exchange between different regions or between captive and wild elephant populations. Estimates of effective population sizes were in the range of 90-240 individuals, which emphasizes the necessity to guard against inbreeding as caused by the current use of a restricted number of breeding bulls.

N.E. Todd

New phylogenetic analysis of the family Elephantidae based on cranial-dental morphology

The Anatomical Record 293 (2010) 74-90

Abstract. In 1973, Vincent Maglio published a seminal monograph on the evolution of the Elephantidae, in which he revised and condensed the 100+ species named by Henry Fairfield Osborn in 1931. Michel Beden further revised the African Elephantidae in 1979, but little systematic work has been done on the family since this publication. With addition of new specimens and species and revisions of chronology, a new analysis of the phylogeny and systematics of this family is warranted. A new, descriptive character dataset was generated from studies of modern elephants for use with fossil species. Parallel evolution in cranial and dental characters in all three lineages of elephants creates homoplastic noise in cladistic analysis, but new inferences about evolutionary relationships are possible. In this analysis, early *Loxodonta* and early African *Mammuthus* are virtually indistinguishable in dental morphology. The *Elephas* lineage is not monophyletic, and results from this analysis suggest multiple migration events out of Africa into Eurasia, and possibly back into Africa. New insight into the origin of the three lineages is also proposed, with *Stegotetrabelodon* leading to the *Mammuthus* lineage, and *Primelephas* as the ancestor of *Loxodonta* and *Elephas*. These new results suggest a much more complex picture of elephantid origins, evolution, and paleogeography. © 2009 Wiley-Liss, Inc.

N.E. Todd

Qualitative comparison of the cranio-dental osteology of the extant elephants, *Elephas maximus* (Asian elephant) and *Loxodonta africana* (African elephant)

The Anatomical Record 293 (2010) 62-73

Abstract. Few osteological descriptions of the extant elephants and no detailed morphological comparison of the two genera, *Elephas* and *Loxodonta*, have been done in recent years. In this study, 786 specimens of extant elephants (crania, mandibles, and molars) were examined for characters unique to each species. Differences between sexes in each species were described, as well as differences between subspecies of each species. Striking differences in morphology were noted between sexes of both elephants and between subspecies, which may complement current genetic studies, the focus of which is to determine division at the subspecies or species level, particularly differences between the savanna elephant (*Loxodonta africana africana*) and the forest elephant (*Loxodonta africana cyclotis*). In addition, examination of the two living elephants provides an excellent dataset for identifying phylogenetic characters for use in examining evolutionary relationships within and between fossil lineages of elephantids. © 2009 Wiley-Liss, Inc.

N.M. Weissenböck, F. Schober, G. Fluch, C. Weiss, T. Paumann, C. Schwarz & W. Arnold

Reusable biotelemetric capsules: A convenient and reliable method for measuring core body temperature in large mammals during gut passage

Journal of Thermal Biology 35 (2010) 147-153

Abstract. It is still not fully understood how megaherbivores regulate their body temperature (Tb), particularly with respect to their unfavourable surface to volume ratio. The paucity of information is probably owing to the difficulty obtaining physiological parameters from such animals. We developed a precise and reliable non-invasive method for determining the Tb of large-bodied mammals. We used this method on African and Asian elephants. Small capsules (30 g) containing a temperature-sensitive transmitter and a memory for onboard data storage were hand-fed 71 times to elephants (N=21) and Tb was measured during gut passage. In 64 cases, sensors were successfully retrieved. The operation and reliability of our data loggers

was sufficient and compared favourably with any other published method. © 2010 with permission from Elsevier.

L. Yon, B. Faulkner, S. Kanchanapangka, N. Chaiyabutr, S. Meepan & B. Lasley

A safer method for studying hormone metabolism in an Asian elephant (*Elephas maximus*): accelerator mass spectrometry

Zoo Biology 28 (2010) 1-7

Abstract. Noninvasive hormone assays provide a way to determine an animal's health or reproductive status without the need for physical or chemical restraint, both of which create unnecessary stress for the animal, and can potentially alter the hormones being measured. Because hormone metabolism is highly species-specific, each assay must be validated for use in the species of interest. Validation of noninvasive steroid hormone assays has traditionally required the administration of relatively high doses of radiolabelled compounds (100 μCi or more of ^{14}C labeled hormone) to permit subsequent detection of the excreted metabolites in the urine and feces. Accelerator mass spectrometry (AMS) is sensitive to extremely low levels of rare isotopes such as ^{14}C, and provides a way to validate hormone assays using much lower levels of radioactivity than those traditionally employed. A captive Asian bull elephant was given 1 μCi of ^{14}C-testosterone intravenously, and an opportunistic urine sample was collected 2 hr after the injection. The sample was separated by HPLC and the ^{14}C in the fractions was detected by AMS to characterize the metabolites present in the urine. A previously established HPLC protocol was used, which permitted the identification of fractions into which testosterone sulfate, testosterone glucuronide, and the parent compound testosterone elute. Results from this study indicate that the majority of testosterone excreted in the urine of the Asian bull elephant is in the form of testosterone sulfate. A small amount of testosterone glucuronide is also excreted, but there is no parent compound present in the urine at all. These results underscore the need for enzymatic hydrolysis to prepare urine samples for hormone assay measurement. Furthermore, they highlight the importance of proper hormone assay validation in order to ensure accurate measurement of the desired hormone. Although this study demonstrated the utility of AMS for safer validation of noninvasive hormone assays in nondomestic species, this methodology could also be applied to studies of nutrient metabolism and drug pharmakokinetics, both areas in great need of further study in wildlife species. © 2010 Wiley-Liss, Inc.

If you need additional information on any of the articles in the above section, please feel free to contact me. You can also let me know about new (2010) publications on Asian elephants.

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Wanamali (collared elephant on the very right) and her herd in southern Sri Lanka