

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 (2011) publications on Asian elephants.

M.A. Ahlering, F. Hailer, M.T. Roberts & C. Foley

A simple and accurate method to sex savannah, forest and Asian elephants using noninvasive sampling techniques

Molec. Ecology Resources 11 (2011) 831-834

Abstract. We report the development of a reliable and efficient method for molecular sexing of all extant elephant taxa. We developed primers that amplify two short Y-specific fragments (*SRY1* and *AMELY2*) and one longer X-specific fragment (*PLP1*), developed from elephant sequences in one multiplex PCR. All fragments were designed to be short (<200 basepairs) for use with degraded DNA and to be 50 basepairs apart to optimize visualization on agarose gels or as electropherograms. The multiplex PCR method matched sexes for at least 97.9% of the noninvasive savannah elephant samples and produced the expected female/male banding patterns for 14 African forest and 11 Asian elephant samples. We found this method to be more robust, efficient and less prone to contamination than previously developed sexing methods for elephants.

B.I. Annasiwaththa, R. Munasinghe, P. Fernando & P. Leimgruber

Design and development of power optimized satellite elephant collar with remote programmability

5th Internat. Conference on Information and Automation for Sustainability (2010) 370-375

Abstract. A satellite elephant collar is a device mounted on an elephant's neck to track its position and movements. This information is essential

for conservation and management of this highly endangered species. Currently available units are proprietary designs by few manufacturers and no literature can be found about their internal operation. This lack of published information hampers the evolution and development of future collaring systems with increased features and functionalities for research, conservation and management. Critical issues for improvement include live time of the collar, which is related to power consumption and operational modes of the units, and remote programmability allowing for changes in data acquisition during deployment. Most commercially available collars lack the ability to change data acquisition schedules remotely over the air, and therefore data acquisition is un-optimized, which is directly responsible for un-optimized power consumption. This paper presents the particular issue of power optimization of satellite elephant collars with remote programmability. A functional test collar was designed using general purpose electronic components and a number of software and hardware optimization techniques used during development. An expected life time over 580 days was achieved with 8 D size Ultralife U10015 batteries for the prototype collar which is about 160% improvement over common commercial collars. Further our collar design allows using more than 8 cells to increase lifespan of collar and capable of changing data acquisition schedule over the air from base station. © 2011 IEEE.

P. Bal, C.D. Nath, K.M. Nanaya, C.G. Kushalappa & C. Garcia

Elephants also like coffee: Trends and drivers of human–elephant conflicts in coffee agroforestry landscapes of Kodagu, Western Ghats, India

Environmental Management 47 (2011) 789–801

Abstract. Kodagu district produces 2% of

the world's coffee, in complex, multistoried agroforestry systems. The forests of the district harbour a large population of the Asian elephant (*Elephas maximus*). The combined effects of high elephant density and major landscape changes due to the expansion of coffee cultivation are the cause of human–elephant conflicts (HEC). Mitigation strategies, including electric fences and compensation schemes implemented by the Forest Department have met with limited success. Building on previous studies in the area, we assessed current spatial and temporal trends of conflict, analysed local stakeholders' perceptions and identified factors driving elephants into the estates. Our study, initiated in May 2007, shows that the intensity of HEC has increased over the last 10 years, exhibiting new seasonal patterns. Conflict maps and the lack of correlation between physical features of the coffee plantations and elephant visits suggest elephants move along corridors between the eastern and western forests of the district, opportunistically foraging when crossing the plantations. Dung analyses indicate elephants have selectively included ripe coffee berries in their diet. This is, to our knowledge, the first report of wild elephants feeding on coffee berries. If this new behaviour spreads through the population, it will compound an already severe conflict situation. The behavioural plasticity, the multiplicity of stakeholders involved, the difficulty in defining the problem and the limits of technical solutions already proposed suggest that HEC in Kodagu has the ingredients of a “wicked” problem whose resolution will require more shared understanding and problem solving work amongst the stakeholders.

N. Baskaran, M. Balasubramanian, S. Swaminathan & A.A. Desai

Feeding ecology of the Asian elephant *Elephas maximus* Linnaeus in the Nilgiri Biosphere Reserve, southern India

J. of the Bombay Nat. Hist. Society 107 (2010)

Abstract. We studied the activity patterns and feeding ecology of Asian elephants *Elephas maximus* in deciduous and dry thorn forests of the Nilgiri Biosphere Reserve, southern India. Over 20,000 instantaneous scan samplings on elephants revealed that 60% of the daylight hours were devoted to feeding. Feeding patterns were

strongly bimodal, with peaks in the morning and evening. Elephants spent less time feeding during the dry season than in the wet season, both in dry deciduous and dry thorn forests. Feeding decreased with increasing ambient temperature and its influence is more pronounced during the dry season in all the habitats. The time spent on feeding was less in dry thorn (53%) than in dry deciduous forests (68%), attributed to higher ambient temperatures coupled with poor shade availability and higher human disturbances in dry thorn forest. The diet of elephants constituted more species of browse (59) than grass (29), but grass formed the bulk of the annual diet (84.6%) than browse (15.4%). Elephants fed on more diverse food plants during the dry than the two wet seasons, and in the dry thorn than dry deciduous forests, which is discussed in the light of availability of grass biomass. The proportion of browsing was significantly more during the dry season in dry thorn forest, coinciding with poor availability of grass. These observations indicate that grass forms the principal diet of elephants in this area.

P. Bhatt, N.M.B. Pradhan, & P. Wegge

Seed dispersal by megaherbivores: do Asian elephants disperse *Mallotus philippinensis*, a main food tree in northern India and Nepal?

Journal of Natural History 45 (2011) 915–921

Abstract. Megaherbivores play an important role in dispersing forest trees. In lowland Nepal, we tested experimentally whether Asian elephants contributed to the spreading of *Mallotus philippinensis* in sal forest by ingesting seeds of this species. Seventy-seven dung samples and 200 ripe seeds were sown in plots. No germination was recorded in the dung plots, whereas >90% of the seeds in the control plots germinated. In sal forest, the abundance of all age classes of *Mallotus* was higher along elephant tracks than along random transects, but differences were small and not statistically significant. The results did not support the elephant dispersal hypothesis. Instead, we conclude that the spreading of *Mallotus* and concurrent declining of sal might be the result of shifting ecological successions, triggered by more flooding and a more erratic rainfall pattern combined with less frequent forest fires, all of which are assumed to favour *Mallotus*

and hamper regeneration of *Shorea robusta*. © 2011 Taylor & Francis.

K. Chelliah, G. Kannan, S. Kundu, N. Abilash, A. Madhusudan, N. Baskaran & R. Sukumar

Testing the efficacy of a chilli–tobacco rope fence as a deterrent against crop-raiding elephants

Current Science 99 (2010) 1239–1243

Abstract. Chilli-based repellents have shown promise as deterrents against crop-raiding elephants in Africa. We experimented with ropes coated with chilli-based repellent as a cheap alternative to existing elephant crop-raid deterrent methods in India. Three locations (Buxa Tiger Reserve, Wyanad Wildlife Sanctuary and Hosur Forest Division) representing varying rainfall regimes from high to low, and with histories of intense elephant–agriculture conflict, were selected for the experiments that were conducted over 2–3 months during the preharvest period of the kharif season in late 2006. Chilli and tobacco powder mixed with waste oil was applied to ropes strung around agricultural fields of 1.4–5.5 km perimeter and elephant approaches were monitored. Elephants breached the rope fences a few times at all three study sites. Female-led herds were far more deterred (practically 100% reduction) than were solitary males (c. 50%) by the chilli–tobacco rope. Efficacy of this method as a deterrent was significantly better in the low-rainfall regime relative to medium and high-rainfall regimes. The initial promising results present a case for more rigorous experimentation; these would help determine if the elephants avoiding the rope are responding physiologically to the chilli–tobacco smell or merely reacting cautiously to a novel substance in their environment.

Earl of Cranbrook

Late quaternary turnover of mammals in Borneo: the zooarchaeological record

Biodiversity and Conserv. 19 (2010) 373–391

Abstract. The Quaternary has been a period of repeated, oscillating patterns of climate change. Global fluctuations in sea level affected the island status of Borneo, which was probably joined to continental Asia for more than half of the last 250,000 years. Alternating connection

and isolation, coupled with the ecological barrier of a savanna corridor running from the Malay Peninsula to Java during periods of marine recession, are reflected in the present mammal fauna of Borneo. 38% of mammal species (excluding bats) are endemic, and some distinctive species or subspecies are confined to the north of the island. No known sites in Borneo match the Early and Middle Pleistocene regional sources in eastern Java. However, caves at Niah, Sireh and Jambusan, Sarawak, and Madai, Sabah, provide a zooarchaeological record covering the past 50,000 years. The Late Pleistocene mammals of Borneo included ten species also present among a Javan Middle Pleistocene savanna-adapted assemblage. Of these, four are categorised as ‘megafauna’: a giant pangolin, Javan rhinoceros, Malay tapir and tiger; the Sumatran rhinoceros can be added. In addition, there are less secure Pleistocene records of Asian elephant from Sarawak and Brunei. Holocene canid remains from Madai could either be the dhole or an early domestic dog. Palynological data combined with the mammal fauna confirm that around 45,000 years ago the vicinity of Niah was vegetated by closed forest. The continuous presence of a suite of arboreal specialists, including large primates, indicates that forest cover persisted through the terminal Pleistocene. Among local extinctions, the giant pangolin apparently disappeared early in this period, but tiger, Javan rhinoceros and tapir probably survived into the last millennium. Human predation of juveniles may account for the loss of the large ungulates, but the disappearance of tiger needs another explanation. Despite hunting pressure throughout the terminal Pleistocene and



Roccia dell'elefante (Sardinia, Italy)

Holocene, a population of orangutan survived at Niah until perhaps the last millennium. Size diminution observed among large, medium and small mammal species is interpreted as the selective impact of environmental change. Once more is known about their ecology, changes in the bat fauna of Niah cave may provide indicators of environmental impacts affecting the wider mammal community during the later Holocene. In conclusion, it is recommended that the three nations, Brunei Darussalam, Malaysia and Indonesia, should support the WWF sponsored 'Heart of Borneo' as the most hopeful project to provide sustainable management of the rare and threatened wild mammals of the island. © 2009 Springer Science+Business Media.

S.K. Das & S. Chattopadhyay

Human fatalities from wild elephant attacks - A study of fourteen cases

Journal of Forensic and Legal Medicine 18 (2011) 154-157

Abstract. Human-wild elephant conflicts are frequently reported from various parts of the country. Encroaching of animal habitat by human civilization is a primary reason for this. The present study comprises of fourteen autopsy cases conducted at the Department of Forensic Medicine, B.S Medical College, Bankura, West Bengal, India over a period of three years. The study attempts to find out the nature of injuries caused by wild elephant attack and the common factors contributing to human-wild elephant conflict so that vulnerable population can be cautioned to avoid conflicts. A distinct seasonal as well as diurnal variation of attack incidences was noted. Attacks were sudden and unprovoked. Killer elephants were wild tuskers in all the cases. Victims were from the low socioeconomic group and the cause of death was due to trampling on the vital organs like chest and head. © 2011 with permission from Elsevier and Faculty of Forensic and Legal Medicine.

S. de Silva, A.D.G. Ranjeewa & S. Kryazhimskiy

The dynamics of social networks among female Asian elephants

BMC Ecology 11:17 (2011)

Abstract. Background: Patterns in the association

of individuals can shed light on the underlying conditions and processes that shape societies. Here we characterize patterns of association in a population of wild Asian Elephants at Uda Walawe National Park in Sri Lanka. We observed 286 individually-identified adult female elephants over 20 months and examined their social dynamics at three levels of organization: pairs of individuals (dyads), small sets of direct companions (ego-networks), and the population level (complete networks). Results: Corroborating previous studies of this and other Asian elephant populations, we find that the sizes of elephant groups observed in the field on any particular day are typically small and that rates of association are low. In contrast to earlier studies, our longitudinal observations reveal that individuals form larger social units that can be remarkably stable across years while associations among such units change across seasons. Association rates tend to peak in dry seasons as opposed to wet seasons, with some cyclicity at the level of dyads. In addition, we find that individuals vary substantially in their fidelity to companions. At the ego-network level, we find that despite these fluctuations, individuals associate with a pool of long-term companions. At the population level, social networks do not exhibit any clear seasonal structure or hierarchical stratification. Conclusions: This detailed longitudinal study reveals different social dynamics at different levels of organization. Taken together, these results demonstrate that low association rates, seemingly small group sizes, and fission-fusion grouping behavior mask hidden stability in the extensive and fluid social affiliations in this population of Asian elephants.

S. de Silva, A.D.G. Ranjeewa & D. Weerakoon
Demography of Asian elephants (*Elephas maximus*) at Uda Walawe National Park, Sri Lanka based on identified individuals

Biological Conservation 144 (2011) 1742-1752

Abstract. We provide estimates of population size and other demographic variables for individually-identified Asian elephants (*Elephas maximus*) in Uda Walawe National Park (UWNP), Sri Lanka based on systematic year-round observations. Two hundred and eighty-six adult females and 241 adult males were identified,

of which four adults (2% of males) had tusks. Sightings-based demographic models showed seasonal immigration and emigration from the study area. The total population, including non-adults, was between 804 and 1160 individuals. Density ranged from 102 to 116 adult females per 100 km² and remains at this level throughout the year. This large, un-fragmented population of Asian elephants should be of high conservation priority. We find that estimates of survivorship and migration rates should be based on long sampling intervals when possible, but estimates of density and population size can still be made when observations are constrained to shorter intervals, if spatial data are available. We offer suggestions to guide census design for other elephant populations or cryptic species. We urge that other locations be systematically surveyed as well using photographic identification. © 2011 with permission from Elsevier.

B. Djordjevic, J. Gudmundsson, A. Pham & T. Wille

Detecting regular visit patterns

Algorithmica 60 (2011) 829-852

Abstract. We are given a trajectory T and an area A . T might intersect A several times, and our aim is to detect whether T visits A with some regularity, e. g. what is the longest time span that a GPS-GSM equipped elephant visited a specific lake on a daily (weekly or yearly) basis, where the elephant has to visit the lake most of the days (weeks or years), but not necessarily on every day (week or year). During the modelling of such applications, we encountered an elementary problem on bitstrings, that we call LDS (LONGESTDENSESUBSTRING). The bits of the bitstring correspond to a sequence of regular time points, in which a bit is set to 1 if and only if the trajectory T intersects the area A at the corresponding time point. For the LDS problem, we are given a string s as input and want to output a longest substring of s , such that the ratio of 1's in the substring is at least a certain threshold. In our model, LDS is a core problem for many applications that aim at detecting regularity of T intersecting A . We propose an optimal algorithm to solve LDS, and also for related problems that are closer to applications, we provide efficient algorithms for detecting regularity.

T.L. Dow, W. Roudebush & F.N. Parker & J.L. Brown

Influence of age and gender on secretion of anti-Müllerian hormone in Asian (*Elephas maximus*) and African (*Loxodonta africana*) elephants

Theriogenology 75 (2011) 620-627

Abstract. Anti-Müllerian hormone (AMH) secretion was studied in Asian and African elephants varying in age and reproductive status. Overall mean concentrations did not differ ($P>0.05$) between species, but were markedly higher in male than female Asian elephants (31.01 ± 4.22 ng/mL and 0.19 ± 0.02 ng/mL, mean \pm SEM) and African elephants (40.27 ± 3.18 ng/mL, 0.17 ± 0.04 ng/mL), respectively. Anti-Müllerian hormone secretion was not significantly affected by ovarian cyclicity status (cycling vs noncycling), but was higher ($P<0.05$) in prepubertal (0.40 ± 0.10 ng/mL) than reproductive age (8-35 y; 0.18 ± 0.04 ng/mL) and aged (≥ 36 y; 0.16 ± 0.03 ng/mL) females. In males, AMH secretion was not significantly affected by musth status, but was age-related, with higher concentrations ($P>0.05$) in prepubertal (49.08 ± 6.11 ng/mL) as compared to aged (≥ 36 y; 22.27 ± 5.82 ng/mL) bulls; concentrations in mature bulls (8-35 y; 37.01 ± 3.17 ng/mL) were similar to prepubertal and older bulls. We concluded that circulating AMH concentrations in elephants were similar between species and not affected by reproductive status; however, concentrations were significantly higher in males than females, and in younger animals. The diagnostic value of AMH to assess fertility status of individual elephants remains to be determined. © 2010 with permission from Elsevier.

R. Duffy & L. Moore

Global regulations and local practices: the politics and governance of animal welfare in elephant tourism

J. of Sustainable Tourism 19 (2011) 589-604

Abstract. This paper examines challenges associated with global regulation of the tourism industry via an analysis of the use of elephants for trekking and safaris in Thailand and Botswana. It highlights inherent problems in applying universal principles in diverse locations; it unpicks the North-South power dynamics involved in drawing up global standards for elephant welfare

in tourism. The development and expansion of elephant riding raise important ethical issues around questions of animal welfare, especially definitions of acceptable and appropriate standards for working animals. This paper uses a political economy approach to understandings of global governance to analyse who has the power to govern, at what scale and with what effects. It examines the role of animal welfare NGOs as key epistemic communities shaping the debate on elephant welfare. It discusses the highly variable practices of working with elephants in Botswana and in Thailand. It concludes that attempts at global regulation need to seriously engage with local level practices if global standards are to be workable and acceptable for tour operators, animal welfare NGOs, elephant camp owners and tourists alike. It raises leading global governance issues and discussions of the role of NGOs in governance, in general. © 2011 Taylor & Francis.

A. Fangkum & A. Reungsang

Biohydrogen production from sugarcane bagasse hydrolysate by elephant dung: Effects of initial pH and substrate concentration

International Journal of Hydrogen Energy (2011) 8687-8696

Abstract. Pre-heated elephant dung was used as inoculum to produce hydrogen from sugarcane bagasse (SCB) hydrolysate. SCB was hydrolyzed by H_2SO_4 or NaOH at various concentrations (0.25-5% volume) and reaction time of 60 mm at 121°C, 1.5 kg/cm² in the autoclave. The optimal condition for the pretreatment was obtained when SCB was hydrolyzed by H_2SO_4 at 1% volume which yielded 11.28 g/L of total sugar (1.46 g glucose/L; 9.10 g xylose/L; 0.72 g arabinose/L). The maximum hydrogen yield of 0.84 mol H_2 /mol total sugar and the hydrogen production rate of 109.55 mL H_2 /L day were obtained at the initial pH 6.5 and initial total sugar concentration 10 g/L. Hydrogen-producing bacterium (*Clostridium pasteurianum*) and non hydrogen-producing bacterium (*Flavobacterium* sp.) were dominating species in the elephant dung and in hydrogen fermentation broth. *Sporolactobacillus* sp. was found to be responsible for a low hydrogen yield obtained. © 2010 Hydrogen Energy Publications, LLC, with permission from Elsevier.

P. Foerder, M. Galloway, T. Barthel, D.E. Moore III & D. Reiss

Insightful problem solving in an Asian elephant

PLoS ONE 6 (2011) e23251

Abstract. The “aha” moment or the sudden arrival of the solution to a problem is a common human experience. Spontaneous problem solving without evident trial and error behavior in humans and other animals has been referred to as insight. Surprisingly, elephants, thought to be highly intelligent, have failed to exhibit insightful problem solving in previous cognitive studies. We tested whether three Asian elephants (*Elephas maximus*) would use sticks or other objects to obtain food items placed out-of-reach and overhead. Without prior trial and error behavior, a 7-year-old male Asian elephant showed spontaneous problem solving by moving a large plastic cube, on which he then stood, to acquire the food. In further testing he showed behavioral flexibility, using this technique to reach other items and retrieving the cube from various locations to use as a tool to acquire food. In the cube’s absence, he generalized this tool utilization technique to other objects and, when given smaller objects, stacked them in an



Elephant Xayyalam Cave Temple (Laos)

attempt to reach the food. The elephant's overall behavior was consistent with the definition of insightful problem solving. Previous failures to demonstrate this ability in elephants may have resulted not from a lack of cognitive ability but from the presentation of tasks requiring trunk-held sticks as potential tools, thereby interfering with the trunk's use as a sensory organ to locate the targeted food.

K.E. Govoni, D. Goodman, R.M. Maclure, L.M. Penfold & S.A. Zinn

Serum concentrations of insulin-like growth factor-I and insulin-like growth factor binding protein-2 and -3 in eight hoofstock species

Zoo Biology 30 (2011) 275–284

Abstract. The somatotrophic axis, which includes growth hormone, insulin-like growth factor (IGF)-I, and IGF binding proteins (IGFBP), is involved in the regulation of growth and metabolism. Measures of the somatotrophic axis can be predictive of nutritional status and growth rate that can be utilized to identify nutritional status of individual animals. Before the somatotrophic axis can be a predictive tool, concentrations of hormones of the somatotrophic axis need to be established in healthy individuals. To begin to establish these data, we quantified IGF-I, IGFBP-2, and IGFBP-3 in males and females of eight threatened hoofstock species at various ages. Opportunistic blood samples were collected from *Bos javanicus* (Java banteng), *Tragelaphus eurycerus isaaci* (bongo), *Gazella dama ruficollis* (addra gazelle), *Taurotragus derbianus gigas* (giant eland), *Kobus megaceros* (Nile lechwe), *Hippotragus equines cottoni* (roan antelope), *Ceratotherium simum simum* (white rhinoceros), and *Elephas maximus* (Asian elephant). Serum IGF-I and IGFBPs were determined by radioimmunoassay and ligand blot, respectively. Generally, IGF-I and IGFBP-3 were greater in males, and IGFBP-2 was greater in females. In banteng ($P=0.08$) and male Nile lechwe ($P<0.05$), IGF-I increased with age, but decreased in rhinoceros ($P=0.07$) and female Nile lechwe ($P<0.05$). In banteng, IGFBP-3 was greater ($P<0.01$) in males. In elephants ($P<0.05$) and antelope ($P=0.08$), IGFBP-2 were greater in females. Determination of hormone concentrations in the somatotrophic axis in animals

makes it possible to develop models that can identify the nutritional status of these threatened hoofstock species. © 2010 Wiley-Liss, Inc.

T.B. Hildebrandt, I. Lueders, R. Hermes, F. Goeritz & J. Saragusty

Reproductive cycle of the elephant

Animal Reprod. Science 124 (2011) 176–183

Abstract. The combination of a few factors, including poor captive reproduction, secession of importation from the wild and advances in hormone detection and ultrasonography, has contributed to the current knowledge on the elephant reproductive cycle. Several reproductive features in elephants differ markedly from other mammals. These include the urogenital tract anatomy, length and structure of the reproductive cycle, the formation of multiple corpora lutea and the type and secretion pattern of reproductive hormones. Being 13–18 weeks in length, the elephant estrous cycle is the longest amongst all studied non-seasonal mammals to date. Progesterone increases 1–3 days after ovulation, indicating the start of the luteal phase, which lasts 6–12 weeks. This is followed by a 4–6-week follicular phase that is concluded by two, precisely spaced and timed, LH surges. In general, the first, anovulatory LH surge occurs exactly 19–21 days before the second, ovulatory surge. Normally, a single follicle is ovulated. However, beside a corpus luteum (CL) forming on the site of ovulation, multiple accessory CLs can be found on the ovaries. Unlike many other species, the predominant progestagen secreted by luteal tissues is not progesterone, but rather its 5- α -reduced metabolites. The currently known aspects of the unique estrous cycle in Asian and African elephants, covering estrous behavior, circulating hormones, ultrasonography and anatomy of the reproductive organs as well as hormonal manipulation treatment possibilities, will be reviewed here. © 2010 with permission from Elsevier.

R. Joshi & R. Singh

Does wide ranging tuskers survive in north-west India?

National Academy Science Letters - India 33 (2010) 205–215

Abstract. No permission to print it.

R. Joshi, R. Singh, A. Dixit, R. Agarwal, M.S. Negi, N. Pandey, R. Pushola & S. Rawat

Is isolation of protected habitats the prime conservation concern for endangered Asian elephants in Shivalik landscape?

Global Journal of Environmental Research 4 (2010) 113-126

Abstract. In north-west India, many protected habitats are rapidly becoming isolated primarily because of growing human population, expansion of agriculture land and increasing infrastructure of motor roads, passing across the different protected areas. We assessed the impact of national highways on wildlife corridors and on the elephant's distribution within the 'Shivalik Elephant Reserve'. All the highways discussed spreads across the potential elephant's habitat and are being used by elephants round the year specially during dry period. However, elephant's movement was observed throughout the year on Haridwar - Bijnor national highway, which links the Khara forest of the Rajaji National Park with Anjani forest of the Haridwar forest division and is a crucial wildlife corridor as far as elephant's movement is concerned chiefly due to presence of river Ganges. Wildlife corridors, which are situated across this landscape traditionally maintains and still holds the healthy population of Asian elephants as a single entity. Elephants use the Chilla - Motichur, Motichur - Kansrao - Barkot, Motichur - Gohri and Rawasan - Sonanadi wildlife corridor on seasonal basis and their movements are more common during summer whereas Khara - Anjani wildlife corridor is being utilized by elephants throughout the year and still holds one of the strong sex - ratio of eastern population of elephants. During the last one decade, vehicle traffic pressure in documented highways has increased to two folds and elephants are not in the situation to cross the road easily specially during evening hours. Mortality rate among small mammals and large carnivores has also increased during the recent past. The majority of documented corridors in 'Shivalik Elephant Reserve' now seem to be in a critical condition. The long-term effects will include genetic isolation, habitat fragmentation within the same forest and enhancement in the human - elephant conflict in adjoining areas. Understanding how animal populations react to

such vast events and their behavioural response is thus essential for addressing future challenges for wildlife management and conservation.

S. Kaewmanee, G. Watanabe, M. Kishimoto, W.Z. Jin, Y. Yamamoto, T. Yamamoto, K. Nagaoka, E. Narushima, T. Komiya & K. Taya

Secretion of inhibin during the estrous cycle in the female Asian elephant (*Elephas maximus*)

J. of Veterinary Med. Science 73 (2011) 77-82

Abstract. To define the source of circulating inhibin of female Asian elephants, the immunolocalizations of inhibin alpha, beta(A), and beta(B) subunits, 3beta-hydroxysteroid dehydrogenase (3beta-HSD), aromatase cytochrome P450 (P450arom) and cytochrome 17alpha-hydroxylase P450 (P450 c17) were investigated. Concentrations of immunoreactive (ir-) inhibin, progesterone and follicle-stimulating hormone (FSH) during the estrous cycle were measured by radioimmunoassay. Inhibin immunoreactivity in follicular fluid and homogenate of corpora lutea were also measured. Immunolocalization of inhibin subunits, 3beta-HSD, P450arom and P450c17 were detected in granulosa cells of antral follicles and luteal cells. The follicular fluid contained high level of ir-inhibin and bioactive inhibin. The homogenate of corpora lutea also contained ir-inhibin. Serum ir-inhibin remained low levels during the early non-luteal phase, began to increase from the late non-luteal phase and continued to increase during the early luteal phase. Serum ir-inhibin showed maximal levels at the middle of luteal phase, and gradually decreased to the baseline three weeks prior to progesterone decline. The serum ir-inhibin levels were positively correlated with progesterone throughout the estrous cycle. On the other hand, ir-inhibin was negatively correlated with FSH during late non-luteal and early luteal phases. These findings strongly suggest that corpus luteum is one of the sources of inhibin as well as granulosa cells in the Asian elephant.

Meagan K. Kay

Evaluation of DNA extraction techniques for detecting *Mycobacterium tuberculosis*-complex organisms in Asian elephant trunk washes

J. of Clinical Microbiology 49 (2011) 618-623

Abstract. Rapid and sensitive diagnostic assays for the detection of tuberculous mycobacteria in elephants are lacking. DNA extraction with PCR analysis is useful for tuberculosis screening in many species but has not been validated on elephant trunk wash samples. We estimated the analytical sensitivity and specificity of three DNA extraction methods to detect *Mycobacterium tuberculosis* complex organisms in trunk wash specimens. A ZR soil microbe DNA kit (ZR) and a traditional salt and ethanol precipitation (TSEP) approach were evaluated under three different treatment conditions: heat treatment, phenol treatment, and contamination with *Mycobacterium avium*. A third approach, using a column filtration method, was evaluated for samples contaminated with soil. Trunk wash samples from uninfected elephants were spiked with various concentrations of *M. bovis* cells and subjected to the described treatment conditions prior to DNA extraction. Extracted DNA was amplified using IS6110-targeted PCR analysis. The ZR and TSEP methods detected as low as 1 to 5 *M. bovis* cells and 10 *M. bovis* cells, respectively, per 1.5 ml of trunk wash under all three conditions. Depending on the amount of soil present, the column filtration method detected as low as 5 to 50 *M. bovis* cells per 1.5 ml of trunk wash. Analytical specificity was assessed by DNA extraction from species of nontuberculous mycobacteria and amplification using the same PCR technique. Only *M. bovis* DNA was amplified, indicating 100% analytical specificity of this PCR technique. Our results indicate that these DNA extraction techniques offer promise as useful tests for detection of *M. tuberculosis* complex organisms in elephant trunk wash specimens. © 2011 with permission from American Society for Microbiology.

A. Kumar, B.G. Marcot & G. Talukdar

Designing a protected area network for conservation planning in jhum landscapes of Garo Hills, Meghalaya

Journal of the Indian Society of Remote Sensing 38 (2010) 501-512

Abstract. We studied vegetation and land cover characteristics within the existing array of protected areas (PAs) in South Garo Hills of Meghalaya, northeast India and introduce

the concept of protected area network (PAN) and methods to determine linkages of forests among existing PAs. We describe and analyse potential elements of a PAN, including PAs, reserved forests, surrounding buffers as zones of influence, and connecting forest corridors, which collectively can provide old-forest habitat for wildlife species linked across a landscape dominated by jhum (shifting cultivation) agriculture. ANOVA and Chi-square analyses of patch characteristics and forest tree diversity suggested the presence of equally species-rich and diverse old forest cover (tropical evergreen, semi-evergreen and deciduous forest types) in portions of unprotected private and community owned land, which could be designated as additions to, and network linkages among, existing PAs. Such additions and linkages would help provide for conservation of elephants and existing native forest biodiversity and would constitute a PAN in the region. Most (80%) of the total forest cover of the region belongs to private or community owned land. Therefore, such additions could be formally recognized under the aegis of the 2003 amendments of the Wildlife (Protection) Act 1972, which include provisions to designate selected forest patches within private lands as Community Reserves.

M.A. Kumar & M. Singh

Behavior of Asian elephant (*Elephas maximus*) in a land-use mosaic: Implications for human-elephant coexistence in the Anamalai Hills, India

Wildlife Biology in Practice 6 (2010) 69-80

Abstract. Understanding behavior of elephants in human-dominated landscapes can facilitate creation of management tools for conflict resolution and help foster human-elephant coexistence. We studied behavior of Asian elephants (*Elephas maximus*) in the Valparai plateau, a 220 km² landscape matrix of rainforest fragments, tea, coffee, and Eucalyptus plantations in the Anamalai Hills of the Western Ghats of India. We studied the nearest neighbor distance among elephants within the herd and their feeding behavior in habitat mosaics. We also recorded reactions of elephants to human proximity and number of people in the vicinity. We employed scan sampling for data collection. Feeding by

elephants was lowest in open canopy habitat of tea, and it gradually increased in canopy covered plantations of coffee and *Eucalyptus* and in densely covered natural vegetation. Vigilance behavior of elephants was lowest in forest fragments and riverine vegetation as they could avoid encountering humans. This behavior peaked in tea plantations due to intense human activity there. Elephants maintained closer inter-individual distances in tea and this distance gradually increased in canopy habitats of coffee, *Eucalyptus* and natural vegetation. More humans in the vicinity and closer proximity to elephants reduced feeding and increased agitation in elephants, while proximity to settlements did not have any influence. We, therefore, suggest that protection and non-conversion of canopy habitats, restoration of rivers with native species, and maintaining distance from elephants would foster normal activities of elephants and help promote human-elephant coexistence in such landscapes. © 2010 Mavatur, Singh.

M. Kuntner, L.J. May-Collado & I. Agnarsson
Phylogeny and conservation priorities of afrotherian mammals (Afrotheria, Mammalia)

Zoologica Scripta 40 (2011) 1-15

Abstract. Phylogenies play an increasingly important role in conservation biology providing a species-specific measure of biodiversity - evolutionary distinctiveness (ED) or phylogenetic diversity (PD) - that can help prioritize conservation effort. Currently, there are many available methods to integrate phylogeny and extinction risk, with an ongoing debate on which may be best. However, the main constraint on employing any of these methods to establish conservation priorities is the lack of detailed species-level phylogenies. Afrotheria is a recently recognized clade grouping anatomically and biologically diverse placental mammals: elephants and mammoths, dugong and manatees, hyraxes, tenrecs, golden moles, elephant shrews and armadillo. To date, phylogenetic studies have focused on understanding higher level relationships among the major groups within Afrotheria. Here, we provide a species-level phylogeny of Afrotheria based on nine molecular loci, placing nearly

70% of the extant afrotherian species (50) and five extinct species. We then use this phylogeny to assess conservation priorities focusing on the widely used evolutionary distinctiveness and global endangeredness (EDGE) method and how that compares to the more recently developed PD framework. Our results support the monophyly of Afrotheria and its sister relationship to Xenarthra. Within Afrotheria, the basal division into Afroinsectiphilia (armadillo, tenrecs, golden moles and elephant shrews) and Paenungulata (hyraxes, dugongs, manatees and elephants) is supported, as is the monophyly of all afrotherian families: Elephantidae, Procaviidae, Macroscelididae, Chrysochloridae, Tenrecidae, Trichechidae and Dugongidae. Within Afroinsectiphilia, we recover the most commonly proposed topology (Tubulidentata sister to Afroscorica plus Macroscelidea). Within Paenungulata, Sirenia is sister to Hyracoidea plus Proboscidea, a controversial relationship supported by morphology. Within Proboscidea, the mastodon is sister to the remaining elephants and the woolly mammoth sister to the Asian elephant, while both living elephant genera, *Loxodonta* and *Elephas* are paraphyletic. Top ranking evolutionarily unique species always included the armadillo, followed by several species of elephant shrews and tenrecs. For conservation priorities top ranking species always included the semi-aquatic Nimba otter shrew, some poorly known species, such as the Northern shrew tenrec, web-footed tenrec, giant otter shrew and Giant golden mole, as well as high profile conservation icons like Asian elephant, dugong and the three species of manatee. Conservation priority analyses were broadly congruent between the EDGE and PD methodologies. However, for certain species EDGE overestimates conservation urgency as it, unlike PD, fails to account for the status of closely related, but less threatened, species. Therefore, PD offers a better guide to conservation decisions. © 2010 the Authors and the Norwegian Academy of Science and Letters.

S. Laohachaiboon

Conservation for whom? Elephant conservation and elephant conservationists in Thailand

Southeast Asian Studies 48 (2010) 74-95

Abstract. This paper traces the historical development of elephant conservation in Thailand through the exploration of two interrelated state organizations: the Thai Elephant Conservation Center (TECC) and the National Elephant Institute (NEI). By examining their ideological construction, policies and interactions with society, as well as their conflicts with other elephant-related communities, this paper argues that despite all the state's attempts to take the lead in tackling elephantine problems, these organizations continuously faced the dilemma of elephant conservation during their development. Firstly, TECC struggled to sustain organizational survival while simultaneously concretizing their activities for internationally acclaimed elephant conservation in the 1990s. Secondly, NEI experienced difficulty in balancing its expected roles after 2002 in protecting elephants in collaboration with local communities, as well as functioning internationally as a lynchpin of the nation for elephant conservation.

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

Detection and evaluation of novel herpesviruses in routine and pathological samples from Asian and African elephants: Identification of two new probosciviruses (EEHV5 and EEHV6) and two new gammaherpesviruses (EGHV3B and EGHV5)

Veterinary Microbiology 147 (2011) 28-41

Abstract. Systemic infections with elephant endotheliotropic herpesviruses (EEHV) cause a rapid onset acute hemorrhagic disease with an 85% mortality rate. More than 60 cases have been confirmed worldwide occurring predominantly in juvenile Asian elephants. Originally, three virus types EEHV1A, EEHV1B and EEHV2 were identified, all members of the Proboscivirus genus within the Betaherpesvirinae. However, four elephant gammaherpesviruses (EGHV) have also been found by DNA PCR approaches in eye and genital secretions of asymptomatic animals, and two more versions of the probosciviruses, EEHV3 and EEHV4, were recently detected in acute hemorrhagic disease cases. To ask whether even more species of elephant herpesviruses may exist, we have developed several new diagnostic DNA PCR assays using multiple round primers

in the DNA POL region. These have been used routinely for nearly three years to screen samples submitted to the Elephant Herpesvirus Laboratory for diagnosis of possible cases of EEHV disease in blood and necropsy tissue, as well as in biopsies of other suspicious lesions or growths. Several more cases of EEHV1-associated hemorrhagic disease were confirmed, but in addition, we describe here eleven examples of other known and novel herpesviruses detected and evaluated with these reagents. They include the prototypes of four new elephant herpesviruses, two more within the proboscivirus group EEHV5 and EEHV6, plus two more gammaherpesviruses EGHV3B and EGHV5. We also report initial semi-quantitative PCR assays demonstrating very high viral loads in the blood of the EEHV3 and EEHV4-associated hemorrhagic disease cases. © 2010 with permission from Elsevier.

I. Lueders, B. Drews, C. Niemuller, C. Gray, P. Rich, J. Fickel, G. Wibbelt, F. Göritz & T.B. Hildebrandt

Ultrasonographically documented early pregnancy loss in an Asian elephant (*Elephas maximus*)

Reproduction, Fertility and Development 22 (2010) 1159-1165

Abstract. Early embryonic resorption or fetal loss is known to occur occasionally in captive elephants; however, this has mostly been reported anecdotally. The present study documents the case of a 24-year-old, multiparous Asian elephant cow that suffered embryonic death and resorption at around 18 weeks of gestation. From ovulation onwards, this female



Playing in the mud (Yala NP (Sri Lanka))

was sonographically examined 58 times. Blood was collected twice weekly for progestagen determination via enzyme immunoassay. On Day 42 after ovulation, a small quantity of fluid was detected in the uterine horn, which typically indicates the presence of a developing conceptus. Repeated inspections followed what appeared to be a normal pregnancy until Day 116. However, on Day 124, signs of embryonic life were absent. Progestagen concentrations started declining two weeks later, reaching baseline levels one month after embryonic death. Retrospectively, ultrasound examination revealed several abnormalities in the uterine horn. Besides an existing leiomyoma, multiple small cystic structures had formed in the endometrium at the implantation site and later in the placenta. These pathological findings were considered as possible contributors to the early pregnancy failure. PCR for endotheliotropic elephant herpes virus (EEHV) (which had occurred previously in the herd) as well as serology for other infectious organisms known to cause abortion in domestic animals did not yield any positive results. Although no definitive reason was found for this pregnancy to abort, this ultrasonographically and endocrinologically documented study of an early pregnancy loss provides important insights into the resorption process in Asian elephants. © 2010 CSIRO.

S.K. Mikota & J.N. Maslow

**Tuberculosis at the human–animal interface:
An emerging disease of elephants**

Tuberculosis 91 (2011) 208–211

Abstract. Over the past 15 years, cases of infection with organisms of the *Mycobacterium tuberculosis* complex have been diagnosed among captive elephants in the United States and worldwide. Outbreak investigations have documented that among staff employed at facilities housing infected animals, skin test conversion to purified protein derivative have been documented. Clonal spread among animals in close contact and even inter-species spread between elephant and human has been documented. Detection of actively infected animals relies on samples obtained by trunk wash. Diagnosis has been augmented by the development of a multi-antigen serologic assay with excellent specificity and sensitivity. Treatment regimens are still in development

with efficacy largely unknown due to a paucity of both premortem follow-up and necropsy data of treated animals. The epidemiology, diagnosis and treatment of tuberculosis in elephants require additional careful study of clinical data. © 2011 with permission from Elsevier.

R. Murphree, J.V. Warkentin, J.R. Dunn, W. Schaffner & T.F. Jones

Elephant-to-human transmission of tuberculosis, 2009

Emerging Infectious Diseases 17 (2011) 366–371

Abstract. In 2009, the Tennessee Department of Health received reports of 5 tuberculin skin test (TST) conversions among employees of an elephant refuge and isolation of *Mycobacterium tuberculosis* from a resident elephant. To determine the extent of the outbreak and identify risk factors for TST conversion, we conducted a cohort study and onsite assessment. Risk for conversion was increased for elephant caregivers and administrative employees working in the barn housing the *M. tuberculosis*-infected elephant or in offices connected to the barn (risk ratio 20.3, 95% confidence interval 2.8–146.7). Indirect exposure to aerosolized *M. tuberculosis* and delayed or inadequate infection control practices likely contributed to transmission. The following factors are needed to reduce risk for *M. tuberculosis* transmission in the captive elephant industry: increased knowledge about *M. tuberculosis* infection in elephants, improved infection control practices, and specific occupational health programs.

U. Parkar, R.J. Traub, S. Vitali, A. Elliot, B. Levecke, I. Robertson, T. Geurdene, J. Steele, B. Drake & R.C.A. Thompson

Molecular characterization of *Blastocystis* isolates from zoo animals and their animal-keepers

Veterinary Parasitology 169 (2010) 8–17

Abstract. *Blastocystis* is an enteric protist and one of the most frequently reported parasitic infections in humans and a variety of animal hosts. It has also been reported in numerous parasite surveys of animals in zoological gardens and in particular in non-human primate species. PCR-based methods capable of the direct

detection of *Blastocystis* in faeces were used to detect *Blastocystis* from various hosts, including non-human primates, Australian native fauna, elephants and giraffes, as well as their keepers from a Western Australian zoo. Additional faecal samples were also collected from elephants and giraffes from four other zoos in Amsterdam (The Netherlands), Antwerp (Belgium), Melbourne and Werribee (Australia). Information regarding the general health and lifestyle of the human volunteers were obtained by questionnaire. Overall, 42% and 63% of animals and zoo-keepers sampled from the Western Australian zoo were positive for *Blastocystis*, respectively. The occurrence of *Blastocystis* in elephants and giraffes from other cities was similar. This is the first report of *Blastocystis* found in the elephant, giraffe, quokka, southern hairy nosed wombat and western grey kangaroo. Three novel and what appear to be highly host-specific subtypes (STs) of *Blastocystis* in the elephant, giraffe and quokka are also described. These findings indicate that further exploration of the genetic diversity of *Blastocystis* is crucial. Most zoo-keepers at the Perth Zoo were harbouring *Blastocystis*. Four of these zoo-keeper isolates were identical to the isolates from the southern hairy nosed wombat and five primate species. © 2010 with permission from Elsevier B.V.

R. Pillay, A.J.T. Johnsingh, R. Raghunath & M.D. Madhusudan

Patterns of spatiotemporal change in large mammal distribution and abundance in the southern Western Ghats, India

Biological Conservation 144 (2011) 1567–1576

Abstract. Large mammals face high risks of anthropogenic extinction owing to their larger body mass and associated life history traits. Recent worldwide mammal declines have highlighted the conservation importance of effective assessments of trends in distribution and abundance of species. Yet reliable data depicting the nature and extent of changes in population parameters is sparse, primarily due to logistical problems in covering large areas and difficulties in obtaining reliable information at large spatial scales, particularly over time. We used key informant surveys to generate detection histories for 18 species of large mammals (body mass >2 kg) at two

points in time (present and 30 years ago) in the Southern subregion of the Western Ghats global biodiversity hotspot. Multiple-season occupancy models were used to assess temporal trends in occupancy, detectability and vital rates of extinction and colonization for each species. Our results show significant declines in distribution for large carnivores, the Asian elephant and endemic ungulates and primates. There is a significant decline in detectability for 16 species, which suggests a decline in their abundance. These patterns of change in distribution and abundance repeat in our assessments of spatial variation in occupancy dynamics between the three contiguous forest complexes and two human-dominated landscapes into which the southern Western Ghats has been fragmented. Extinction rates are highest in the human-dominated landscapes. Declines in abundance for several species suggest the presence of extinction debts, which may soon be repaid with imminent range contractions and subsequent species extinctions unless immediate remedial conservation measures are taken. Detection/non-detection surveys of key informants used in an occupancy modeling framework provide potential for rapid conservation status assessments of multiple species across large spatial scales over time. © with permission from 2011 Elsevier Ltd.

J.M. Plotnik, R. Lair, W. Suphachoksahakun & F.B.M. de Waal

Elephants know when they need a helping trunk in a cooperative task

Proceedings of the National Academy of Sciences 108 (2011) 5116–5121

Abstract. Elephants are widely assumed to be among the most cognitively advanced animals, even though systematic evidence is lacking. This void in knowledge is mainly due to the danger and difficulty of submitting the largest land animal to behavioral experiments. In an attempt to change this situation, a classical 1930s cooperation paradigm commonly tested on monkeys and apes was modified by using a procedure originally designed for chimpanzees (*Pan troglodytes*) to measure the reactions of Asian elephants (*Elephas maximus*). This paradigm explores the cognition underlying coordination toward a shared goal. What do animals know or learn about the benefits

of cooperation? Can they learn critical elements of a partner's role in cooperation? Whereas observations in nature suggest such understanding in nonhuman primates, experimental results have been mixed, and little evidence exists with regards to nonprimates. Here, we show that elephants can learn to coordinate with a partner in a task requiring two individuals to simultaneously pull two ends of the same rope to obtain a reward. Not only did the elephants act together, they inhibited the pulling response for up to 45 s if the arrival of a partner was delayed. They also grasped that there was no point to pulling if the partner lacked access to the rope. Such results have been interpreted as demonstrating an understanding of cooperation. Through convergent evolution, elephants may have reached a cooperative skill level on a par with that of chimpanzees. © 2011 the Authors.

A.H.M.R. Sarker & E. Røskaft

Human–wildlife conflicts and management options in Bangladesh, with special reference to Asian elephants (*Elephas maximus*)

Internat. J. of Biodiversity Science, Ecosystem Services & Management 6 (2010) 164–175

Abstract. In this study, we explored the interaction between humans and Asian elephants (*Elephas maximus*). We analysed local mitigation techniques and propose possible measures to reduce human–elephant conflicts. For four protected areas in Bangladesh, we investigated how people interact with elephants and other crop-damaging species. Crop-damaging species differed from site to site, but elephants were generally the most frequent offenders. Although some people were able to control crop damage caused by other wildlife, damage caused by wild elephants was mostly uncontrollable. Forest villagers were somewhat tolerant of damage caused by other wildlife but they were not tolerant of damage caused by wild elephants. Tolerance of crop damage caused by wildlife other than wild elephants tended to increase with distance of respondents from protected areas. Non-tolerance of crop damage caused by wildlife was more common in southeast Bangladesh than in the north. Habitat destruction, caused by high population growth and poverty, appeared to be a major cause for increasing human–elephant

conflict. There is an urgent need for adoption of an umbrella strategy (e.g. estimate the size of elephant populations, develop landscape-scale conservation plans and create forest buffer zones under community-based natural resource management schemes) in the use of conflict mitigation as a conservation tool for Asian elephants. © 2010 Taylor & Francis.

J.J. Stanton, J.C. Zong, E. Latimer, J. Tan, A. Herron, G.S. Hayward & P.D. Ling

Detection of pathogenic elephant endotheliotropic herpesvirus in routine trunk washes from healthy adult Asian elephants (*Elephas maximus*) by use of a real-time quantitative polymerase chain reaction assay
Am. J. of Vet. Research 71 (2010) 925–933

Abstract. Objective: To investigate the pathogenesis and transmission of elephant endotheliotropic herpesvirus (EEHV1) by analyzing various elephant fluid samples with a novel EEHV1-specific real-time PCR assay. Animals: 5 apparently healthy captive Asian elephants (*Elephas maximus*) from the same herd. A real-time PCR assay was developed that specifically detects EEHV1. The assay was used to evaluate paired whole blood and trunk-wash samples obtained from the 5 elephants during a 15-week period. Deoxyribonucleic acid sequencing and viral gene subtyping analysis were performed on trunk-wash DNA preparations that had positive results for EEHV1. Viral gene subtypes were compared with those associated with past fatal cases of herpesvirus-associated disease within the herd. The PCR assay detected viral DNA to a level of 1200 copies/ml of whole blood. It was used to detect EEHV1 in trunk secretions of 3 of the 5 elephants surveyed during the 15-week period. Viral gene subtyping analysis identified 2 distinct elephant herpesviruses, 1 of which was identical to the virus associated with a previous fatal case of herpesvirus-associated disease within the herd. EEHV1 was shed in the trunk secretions of healthy Asian elephants. Trunk secretions may provide a mode of transmission for this virus. Results of this study may be useful for the diagnosis, treatment, and management of EEHV1-associated disease and the overall management of captive elephant populations.

D. Suwattana, J. Prasupphachok, S. Kanchanapangka, W. Koykul

Tetranucleotide microsatellite markers for molecular testing in Thai domestic elephants (*Elephas maximus indicus*)

The Thai Journal of Veterinary Medicine 40 (2010) 405-409

Abstract. Eleven microsatellite loci were evaluated for genetic profiles of Thai domestic elephants (*Elephas maximus indicus*) and their suitability as genetic markers for molecular testing. A total of 66 animals were tested. 10 out of 11 loci could be amplified and they demonstrated polymorphism with allelic numbers per locus ranging from 7 (LaT06) to 39 (LaT18). Values of expected heterozygosity (H_e) and Polymorphic Information Content (PIC) were between 0.6449 (LaT17) - 0.9593 (LaT05) and 0.5934 (LaT17) - 0.9578 (LaT05), respectively. Analysis of the ten microsatellite markers revealed Combined Exclusion Probability (CEP) of 99.99998783% or 1.2167×10^{-7} and 99.91% confident for individual verification, suggesting that using all these loci together as a set of genetic markers is an extremely powerful tool for the unique identification. In addition, this set of microsatellite markers provides a qualified system for fingerprinting purposes and parentage testing in Thai domestic elephants.

J. Theuerkauf & R. Gula

Towards standardisation of population estimates: defecation rates of elephants should be assessed using a rainfall model

Annales Zoologici Fennici 47 (2010) 398-402

Abstract. Daily defecation rate is an important variable in density estimation of African (*Loxodonta africana*) and Asian (*Elephas maximus*) elephants. However, there has been no attempt to construct a general model that predicts defecation rates. By comparing 16 published studies, we found that annual and seasonal daily defecation rates increased with annual rainfall following a power regression model. We recommend calculating defecation rates based on the regressions from our meta-analysis, rather than using a defecation rate from any single study. © 2010 Finnish Zoological and Botanical Publishing Board.

Y. Trisurat, A. Pattanavibool, G.A. Gale & D.H. Reed

Improving the viability of large-mammal populations by using habitat and landscape models to focus conservation planning

Wildlife Research 37 (2010) 401-412

Abstract. Assessing the viability of animal populations in the wild is difficult or impossible, primarily because of limited data. However, there is an urgent need to develop methods for estimating population sizes and improving the viability of target species. Aims: To define suitable habitat for sambar (*Cervus unicolor*), banteng (*Bos javanicus*), gaur (*Bos gaurus*), Asian elephant (*Elephas maximus*) and tiger (*Panthera tigris*) in the Western Forest Complex, Thailand, and to assess their current status as well as estimate how the landscape needs to be managed to maintain viable populations. The present paper demonstrates a method for combining a rapid ecological assessment, landscape indices, GIS-based wildlife-habitat models, and knowledge of minimum viable population sizes to guide landscape-management decisions and improve conservation outcomes through habitat restoration. The current viabilities for gaur and elephant are fair, whereas they are poor for tiger and banteng. However, landscape quality outside the current distributions was relatively intact for all species, ranging from moderate to high levels of connectivity. In addition, the population viability for sambar is very good under the current and desired conditions. If managers in this complex wish to upgrade the viabilities of gaur, elephant, tiger and banteng within the next 10 years, park rangers and stakeholders should aim to increase the amount of usable habitat by ~2170 km² or 17% of existing suitable habitats. The key strategies are to reduce human pressures, enhance ungulate habitats and increase connectivity of suitable habitats outside the current distributions. The present paper provides a particularly useful method for managers and forest-policy planners for assessing and managing habitat suitability for target wildlife and their population viability in protected-area networks where knowledge of the demographic attributes (e.g. birth and death rates) of wildlife populations are too limited to perform population viability analysis. © 2010 CSIRO.

J.H. van der Kolk, M.J. Hoyer, F.A.L.M. Verstappen, M.S.A.B.I. Wolters, M. Treskes, G.C.M. Grinwis & M.J.L. Kik

Diabetes mellitus in a 50-year-old captive Asian elephant (*Elephas maximus*) bull

Veterinary Quarterly 31 (2011) 99–101

Abstract. none.

V. Vanitha, K. Thiyagesan & N. Baskaran

Daily routine of captive Asian elephants (*Elephas maximus*) in three management systems of Tamil Nadu, India and its implications for elephant welfare

Scientific Transactions in Environment and Technovation 3 (2010) 116-122

Abstract. No permission to print it.

V. Vanitha, K. Thiyagesan & N. Baskaran

Demography of captive Asian elephants *Elephas maximus* Linnaeus in three management systems in Tamil Nadu, India

Journal of the Bombay Natural History Society 107 (2010) 30-37

Abstract. Captive Asian elephants *Elephas maximus* are managed in three systems in Tamil Nadu namely, private, Hindu temples and forest department. We studied the population size and structure, natality and mortality during 2003-05 in the three systems to assess their long-term viability. The population in the three systems totalled 133 individuals in 2005 with adult class constituting over 75% of the population. Sex ratio of the population was biased towards females in private establishments (male to female 1:10) and temples (1:21), but male biased in the forest department (1:0.5) with adult males constituting

50% of the total population. There was no breeding in private and temple populations. In the forest department population, fecundity has dropped (0.065/adult female/year) over the past 10 years (1996-2005) compared to an earlier (1969-1989) estimate (0.155/adult female/year). Mean mortality estimated together for the three systems is higher (3.9%) than reported earlier (1.9%). Given the aging population trends and with no breeding and fewer chances of additions from the forest department due to ban on elephant sale, captive populations in private establishments and temples may not survive in the long run. Sustainability appears rather remote for population of the forest department system with a male bias, increase in mortality and a decrease in fecundity.

V. Vanitha, K. Thiyagesan & N. Baskaran

Prevalence of intestinal parasites among captive Asian Elephants *Elephas maximus*: effect of season, host demography, and management systems in Tamil Nadu, India

Journal of Threatened Taxa 3 (2011) 1527-1534

Abstract. Maintenance of wild animals in captivity is fraught with numerous challenges, including the control of disease. This study evaluates the effect of season, host demography (age-sex), and differing management systems on the prevalence of intestinal parasites among elephants managed in three captive systems: temple, private, and forest department, in Tamil Nadu. In addition, the study also assessed the availability of veterinary care for elephants in these systems. The parasitic prevalence was evaluated by direct microscopic identification of helminth eggs in faecal samples (n = 115) collected from different age/sex classes of elephants. Of the 115 elephants examined, 37% showed positive results, being infected only with *Strongyles* sp. The prevalence rate varied significantly across seasons, with the highest rate during summer (49%) followed by monsoon (41%) and the lowest rate during winter (15%). While males had a significantly lower parasite prevalence compared to females (29% vs. 40%), age classes showed no significant difference. Despite the fact that the proportion of animals receiving veterinary care was higher under the forest department system (100%) compared to the private system (26%), parasite prevalence



A good scratch (Lolugas Wewa, Sri Lanka)

was significantly higher under the former (48%) than the latter (31%) system. The difference in the proportion of animals with parasitic prevalence among the three systems could be due to differing management practices (i.e. in solitary versus groups). © 2011 the Authors.

V. Vanitha, K. Thiyagesan & N. Baskaran

Social life of captive Asian elephants (*Elephas maximus*) in Southern India: Implications for elephant welfare

Journal of Applied Animal Welfare Science 14 (2011) 42-58

Abstract. Asian elephants in the wild live in complex social societies; in captivity, however, management often occurs in solitary conditions, especially at the temples and private places of India. To investigate the effect of social isolation, this study assessed the social group sizes and the presence of stereotypies among 140 captive Asian elephants managed in 3 captive systems (private, temple, and forest department) in Tamil Nadu, India, between 2003 and 2005. The majority of the facilities in the private (82%) and temple (95%) systems held a single elephant without opportunity for social interaction. The forest department managed the elephants in significantly larger groups than the private and temple systems. Among the 3 systems, the proportion of elephants with stereotypies was the highest in temple (49%) followed by private system (26%) and the forest department facility (6%); this correlates with the social isolation trend observed in the 3 systems and suggests a possible link between social isolation and abnormal elephant behavior separate from other environmental factors. The results of this study indicate it would be of greater benefit to elephant well being to keep the patchily distributed solitary temple and private elephants who are socially compatible and free from contagious diseases in small social groups at “common elephant houses” for socialization. © 2011 Taylor & Francis Group, LLC.

G.R. van Sonsbeek, J.H. van der Kolk, J.P.T.M. van Leeuwen & W. Schaftenaar

Preliminary validation of assays to measure parameters of calcium metabolism in captive Asian and African elephants in western Europe

Journal of Veterinary Diagnostic Investigation 23 (2011) 504-510

Abstract. Hypocalcemia is a well known cause of dystocia in animals, including elephants in captivity. In order to study calcium metabolism in elephants, it is of utmost importance to use properly validated assays, as these might be prone to specific matrix effects in elephant blood. The aim of the current study was to conduct preliminary work for validation of various parameters involved in calcium metabolism in both blood and urine of captive elephants. Basal values of these parameters were compared between Asian elephants (*Elephas maximus*) and African elephants (*Loxodonta africana*). Preliminary testing of total calcium, inorganic phosphorus, and creatinine appeared valid for use in plasma and creatinine in urine in both species. Furthermore, measurements of bone alkaline phosphatase and N-terminal telopeptide of type I collagen appeared valid for use in Asian elephants. Mean heparinized plasma ionized calcium concentration and pH were not significantly affected by 3 cycles of freezing and thawing. Storage at 4°C, room temperature, and 37°C for 6, 12, and 24 hr did not alter the heparinized plasma ionized calcium concentration in Asian elephants. The following linear regression equation using pH (range: 6.858–7.887) and ionized calcium concentration in heparinized plasma was utilized: $iCa_{7.4} \text{ (mmol/l)} = -2.1075 + 0.3130 \cdot pH_{\text{actual}} + 0.8296 \cdot iCa_{\text{actual}}$ (mmol/l). Mean basal values for pH and plasma in Asian elephant whole blood were 7.40 ± 0.048 and 7.49 ± 0.077 , respectively. The urinary specific gravity and creatinine concentrations in both Asian and African elephants were significantly correlated and both were significantly lower in Asian elephants. © 2011 the Authors.

S. Weerakhun, Y. Wichianrat, T. Laophakdee, P. Juntako & T. Torsri

Blood glucose levels in Asian elephants (*Elephas maximus*) of Thailand

KKU Veterinary Journal 20 (2010) 208-217
Main text is in Thai!

Abstract. Objective: To determine blood glucose levels in Asian elephants in Thailand. Materials and Methods: 46 Asian elephants in 3 provinces (Surin, Kanchanaburi, and

Prajaubkirikhan) were evaluated. We interviewed elephant owners and evaluated the body condition score of all elephants. Blood samples were collected from the ear vein and examined by self-glucose monitoring test (ACCU-CHEK® Advantage II). In addition, the female elephants in Surin (n=9) were experimental with fasting and non-fasting conditions; then, their blood glucose levels were compared by using paired t-test. Results: Mean (range) body condition scores of the elephants in Surin, Kanchanaburi, and Prajaubkirikhan were 11.9 (6-14), 12.4 (7-16) and 11.8 (9-14), respectively. Mean (range) blood glucose levels of the elephants in Surin, Kanchanaburi and Prajaubkirikhan were 79.6 (47-119), 67.4 (47-94) and 75.2 (47-112) mg/dL, respectively. Mean (range) blood glucose levels in growing (age 12-20 years), mature (age 21-46 years) and aging (age >46 years) elephants were 73.9 (53-112), 81.4 (47-119) and 67.4 (47-94), respectively. In puberty age (21-46 years) were blood glucose value higher than another group may be more digestibility and feed intake, so type of plants or foods and quantity of feeding relatively associated with blood glucose value. Blood glucose level in the fasting female elephants was significantly lower than that of the non-

fasting (mean (range): 68.7 (57-87) vs 90.4 (66-119) mg/dL; p-value=0.01). Conclusion: Body condition scores of the elephants in each province are similar. Mature elephants have their blood glucose levels higher than do growing and aging elephants. Fasting reduces blood glucose levels in the female elephants.

E.B. Wiedner, N.Y. Takeuchi, R. Isaza & D. Barber

Baseline levels of trace metals in blood of captive Asian elephants (*Elephas maximus*)

Journal of Zoo and Wildlife Medicine 42 (2011) 360-362

Abstract. Whole blood from 33 healthy captive Asian elephants (*Elephas maximus*) was analyzed for 12 trace elements: aluminum, chromium, manganese, cobalt, nickel, copper, zinc, arsenic, selenium, cadmium, mercury, and lead for the purpose of estimating preliminary baseline population parameters for these minerals. Metals were quantified by inductively coupled plasma mass spectroscopy. Baseline ranges for all animals and for all trace elements were comparable to normal concentrations reported in other species. This is the first report of normal trace element levels in the blood of captive elephants. © 2011 American Association of Zoo Veterinarians.



Collared female “Samudra” with her herd in Minneriya National Park (Sri Lanka)