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 (2017) publications on Asian elephants.

K.P. Acharya, P.K. Paudel, S.R. Jnawali, P.R. Neupane & M. Köhl

Can forest fragmentation and configuration work as indicators of human–wildlife conflict? Evidences from human death and injury by wildlife attacks in Nepal

Ecological Indicators 80 (2017) 74-83

Abstract. Fragmented forests and heterogeneous landscapes are likely to have less natural vegetation and smaller core areas, a low degree of landscape connectivity, high prevalence of anthropogenic edges, and high landscape heterogeneity, which may alter—at varying degrees—behavior of wildlife species such as attacks on humans. We evaluated whether or not forest fragmentation (e.g. shape, size and distribution of forest patches measured as landscape shape index, effective mesh size, and landscape heterogeneity), habitats (proportion of bush and grassland, distance to water sources), and human disturbances (human population density) have a significant relationship with frequencies of human deaths and injuries by Bengal tiger (*Panthera tigris tigris*), common leopard (*Panthera pardus*), one-horned rhinoceros (*Rhinoceros unicornis*) and Asiatic elephant (*Elephas maximus*). Data on human injury and death were obtained from a national survey over five years (2010–2014). The relationship between wildlife attacks and landscape attributes were investigated using a zero-inflated Poisson regression model. Attacks by tigers were significantly and positively associated with forest fragmentation (effective mesh size which is high in a landscape consisting of disconnected small patches). Attacks by common leopards were strongly positively related with landscape heterogeneity, and negatively related to the proportion of bush and grassland. Attacks by one-horned rhinoceros were positively significantly related to the distance to water sources, and proportion of bush and grassland in the landscape. Attacks by elephants were strongly and positively associated with the forest fragmentation (landscape shape index, which increases as patches in the landscapes becomes disaggregated). These results suggest that forest fragmentation is inevitably a critical driver of human–wildlife conflicts, although the extent of effects varies depending on species specific habitat requirements.

M. Ackermann, J.M. Hatt, N. Schetle & H. Steinmetz

Identification of shedders of elephant endotheliotropic herpesviruses among Asian elephants (*Elephas maximus*) in Switzerland

PLoS One 12 (2017) e0176891

Abstract. Elephants, particularly Asian (*Elephas maximus*), are threatened by lethal elephant hemorrhagic disease (EHD) due to elephant endotheliotropic herpesviruses (EEHV). At least five of seven known EEHV types have been associated to EHD, with types 1, 4, and 5 predominantly affecting Asian elephants. In Switzerland, at least three Asian elephants have been lost due to EHD but nothing is known about the present EEHV1 circulation. Moreover, the prevalence of other EEHV types has never been assessed. Intermittent shedding of EEHV can be monitored through collecting trunk secretions and analyzing them by PCR methods that discriminate the different EEHV types. To identify EEHV shedders, seven of eight Asian elephants in a Swiss zoo were trained to provide

trunk wash samples. These were collected at intervals over a period of four months and tested by PCR for presence of EEHV1 through 6. Moreover, the quality of each sample was assessed by testing for the elephant TNF-alpha gene. Overall, 57% of the samples were valid with five of seven participating elephants identified as EEHV shedders. Two of those shed virus only once, whereas the other three, all closely related among each other, shed virus on multiple occasions. One of the frequent shedders had been in very close contact to all of the three EHD victims. Therefore, we speculate that this particular animal may represent the virus source in all three cases. However, when subtyping was conducted, the presently circulating virus was identified as EEHV1B, while the virus subtype causing EHD had been 1A in all three cases. In addition to four animals excreting EEHV1, a recently introduced animal was observed to shed EEHV3/4. We suggest that the policy of trunk washing to identify and characterize EEHV-shedders is to be endorsed in zoos with ongoing or planned elephant breeding programs. © 2017 The Authors.

N. Avni-Magen, S. Zaken, E. Kaufman & G. Kelmer

Use of infrared thermography in early diagnosis of pathologies in Asian elephants (*Elephas maximus*)

Israel J. of Veterinary Medicine 72 (2017) 22-27

Abstract. Thermography is an imaging technique using a specialized heat sensitive infrared camera, mapping body surface temperature changes, which may indicate inflammatory, vascular or neurological disorders. Thermal images were collected over three months from four Asian elephants at the Tisch Family Zoological Gardens in Jerusalem in which 935 body regions were identified with possible inflammatory pathologies. Suspected thermal areas were divided into three groups according to the appearance of inflammatory processes in a clinical examination: negative, positive and a pre-inflammatory group, which showed a thermal change while imaging, with clinical signs appearing only later on. An analysis of the documented regions it was found that in areas with a clinical signs delta temperatures were significantly higher compared to areas with no clinical signs. It was also found that pre-clinical areas showed a significantly higher temperature compared with that of the clinical and non-clinical areas. Receiver operating characteristic (ROC) test results showed an area under curve (AUC) of 0.91 with sensitivity values of 89.2% and a specificity of 83.4%. In addition, positive predictive value and negative predictive value received were: NPPV = 99.4%, PPV = 19.3%. It was concluded that thermography can be an effective diagnostic tool for early diagnosis of inflammatory processes and useful for regular and continuous monitoring of zoo elephants in general. Early detection of inflammatory processes using this technique makes it possible to prevent unnecessary stress that often accompanies veterinary examinations and to accelerate recovery.

N.N. Barman, B. Choudhury, V. Kumar, M. Koul, S.M. Gogoi, E. Khatoon, A. Chakroborty, P. Basumatary, B. Barua, T. Rahman, S.K. Das & S. Kumar

Incidence of elephant endotheliotropic herpesvirus in Asian elephants in India

Veterinary Microbiology 208 (2017) 159-163

Abstract. Elephant endotheliotropic herpesviruses (EEHVs) are the cause of acute hemorrhagic disease in endangered Asian and African elephants. In the present study, we report the incidence of EEHV infection and associated mortality in the captive elephant of Assam, India. Our result showed the gross morphology and histopathological changes of EEHV infection in the elephant. Moreover, the phylogenetic analysis of the polymerase, helicase, and GPCR genes from the infected tissue samples suggested the presence of EEHV1A virus. © 2017 Reprinted with permission from Elsevier.

T. Bhagwat, A. Hess, N. Horning, T. Khaing, Z.M. Thein, K.M. Aung, K.H. Aung, P. Phyo, Y.L. Tun, A.H. Oo, A. Neil, W.M. Thu, M. Songer, K.L. Connette, A. Bernd, Q. Huang, G. Connette & P. Leimgruber

Losing a jewel—Rapid declines in Myanmar's intact forests from 2002-2014

PLoS ONE 12 (2017) e0176364

Abstract. New and rapid political and economic

changes in Myanmar are increasing the pressures on the country's forests. Yet, little is known about the past and current condition of these forests and how fast they are declining. We mapped forest cover in Myanmar through a consortium of international organizations and environmental non-governmental groups, using freely available public domain data and open source software tools. We used Landsat satellite imagery to assess the condition and spatial distribution of Myanmar's intact and degraded forests with special focus on changes in intact forest between 2002 and 2014. We found that forests cover 42,365,729 ha or 63% of Myanmar, making it one of the most forested countries in the region. However, severe logging, expanding plantations, and degradation pose increasing threats. Only 38% of the country's forests can be considered intact with canopy cover >80%. Between 2002 and 2014, intact forests declined at a rate of 0.94% annually, totaling more than 2 million ha forest loss. Losses can be extremely high locally and we identified 9 townships as forest conversion hotspots. We also delineated 13 large (>100,000 ha) and contiguous intact forest landscapes, which are dispersed across Myanmar. The Northern Forest Complex supports four of these landscapes, totaling over 6.1 mil- lion ha of intact forest, followed by the Southern Forest Complex with three landscapes, comprising 1.5 million ha. These remaining contiguous forest landscape should have high priority for protection. Our project demonstrates how open source data and software can be used to develop and share critical information on forests when such data are not readily available elsewhere. We provide all data, code, and outputs freely via the internet.

B. Bhusri, P. Suksai, C. Mongkolphan, E. Tiyanun, P. Ratanakorn, K. Chaichoun & L. Sariya

Detection of elephant endotheliotropic herpesvirus 4 in captive asian elephants (*Elephas maximus*) in Thailand

Thai J. of Veterinary Medicine 47 (2017) 97-102

Abstract. Elephant endotheliotropic herpesviruses (EEHVs) can cause fatal hemorrhagic disease in elephants, especially young captive Asian elephants (*Elephas maximus*). Currently, seven EEHV types have been reported. In this study, EEHVs were examined in whole-blood samples derived from 56 captive Asian elephants from eight provinces in Thailand by nested PCR using primers specific to the viral DNA polymerase gene in an attempt to monitor EEHV elephant cases. After EEHV testing, one sample (1.78%) was positive and found to be closely related to EEHV4 with 99% amino acid identity. This sample was from a three-year-old female Asian elephant with no clinical signs. These data suggest that asymptomatic EEHV4 infection can occur in Asian elephants.

C. Boehlke, S. Pötschke, V. Behringer, C. Hannig & O. Zierau

Does diet influence salivary enzyme activities in elephant species?

Journal of Comparative Physiology B 187 (2017) 213-226

Abstract. Asian elephants (*Elephas maximus*) and African elephants (*Loxodonta africana*) are herbivore generalists; however, Asian elephants might ingest a higher proportion of grasses than Africans. Although some studies have investigated nutrition-specific morphological adaptations of the two species, broader studies on salivary enzymes in both elephant species are lacking. This study focuses on the comparison of salivary enzymes activity profiles in the two elephant species; these enzymes are relevant for protective and digestive functions in humans. We aimed to determine whether salivary amylase (sAA), lysozyme (sLYS), and peroxidase (sPOD) activities have changed in a species-specific pattern during evolutionary separation of the elephant genera. Saliva samples of 14 Asian and 8 African elephants were collected in three German zoos. Results show that sAA and sLYS are salivary components of both elephant species in an active conformation. In contrast, little to no sPOD activity was determined in any elephant sample. Furthermore, sAA activity was significantly higher in Asian compared with African elephants. sLYS and sPOD showed no species-specific differences. The time of food provision until sample collection affected only sAA activity. In summary, the results suggest several possible factors modulating the activity of the mammal-typical enzymes, such as sAA, sLYS, and sPOD, e.g., nutrition and sampling

procedure, which have to be considered when analyzing differences in saliva composition of animal species. © 2016 With permission of Springer.

K. Buddhachat, J.L. Brown, C. Thitaram, S. Klinhom & K. Nganvongpanit

Distinguishing real from fake ivory products by elemental analyses: A Bayesian hybrid classification method

Forensic Science Internat. 272 (2017) 142-149

Abstract. As laws tighten to limit commercial ivory trading and protect threatened species like whales and elephants, increased sales of fake ivory products have become widespread. This study describes a method, handheld X-ray fluorescence (XRF) as a noninvasive technique for elemental analysis, to differentiate quickly between ivory (Asian and African elephant, mammoth) from non-ivory (bones, teeth, antler, horn, wood, synthetic resin, rock) materials. An equation consisting of 20 elements and light elements from a stepwise discriminant analysis was used to classify samples, followed by Bayesian binary regression to determine the probability of a sample being 'ivory', with complementary log log analysis to identify the best fit model for this purpose. This Bayesian hybrid classification model was 93% accurate with 92% precision in discriminating ivory from non-ivory materials. The method was then validated by scanning an additional ivory and non-ivory samples, correctly identifying bone as not ivory with >95% accuracy, except elephant bone, which was 72%. It was less accurate for wood and rock (25-85%); however, a preliminary screening to determine if samples are not Ca-dominant could eliminate inorganic materials. In conclusion, elemental analyses by XRF can be used to identify several forms of fake ivory samples, which could have forensic application. © 2017 Reprinted with permission from Elsevier.

S.M. Burke, L. Vogelnest, P. Thompson, E.R. Tovey & P. Williamson

Detection of aerosolized bacteria in expired air samples from Asian elephants (*Elephas maximus*)

Journal of Zoo and Wildlife Medicine 48 (2017) 431-439

Abstract. Elephant-mediated transmission of tuberculosis is assumed to be similar to human models, which state close and prolonged contact with an infected individual is required for transmission. Although considered a risk factor for infection, several case studies have reported that close contact with an elephant is not always necessary for transmission, and the role of aerosolized bacteria remains unclear. To investigate aerosol-mediated transmission of pathogenic bacteria from elephants, a method for the detection of aerosols using an adapted sampling system was developed. A commensal bacterium was isolated from the upper respiratory tract of elephants (*Elephas maximus*) and was used as a proxy organism to detect aerosolized droplets in the sampling system. It was found that elephants are capable of producing aerosolized bacterial particles of a size small enough to remain airborne for prolonged periods and penetrate the lower regions of the human respiratory tract. © 2017 American Association of Zoo Veterinarians.

C. Çakırlar & S. Ikram

'When elephants battle, the grass suffers.' Power, ivory and the Syrian elephant

Levant 48 (2016) 167-183

Abstract. The craftsmanship of the ivory objects in Late Bronze Age and Iron Age Eastern Mediterranean leave no doubt as to their intention to impress. Elephant teeth are an important raw material for the manufacture of these objects. Zooarchaeological research shows that cranial, dental, and postcranial remains of Asian elephants (*Elephas maximus*) are nearly as ubiquitous as worked ivory across Southwest Asia. This paper attempts to reconstruct the origins, habitat, range, life style and the end of the Syrian elephant. It discusses recent bone and tooth finds of this animal from Kinet Höyük and Tell Atchana in the Hatay in Turkey against the background of previous research on the 'Syrian elephant' and ivory production in the Levant. It confirms the proposal that Asian elephants were not endemic to the region and that their arrival was anthropogenic. The Syrian elephant was the product of the power-hungry Bronze Age elite in the region. Having become an 'evolutionarily significant unit' for centuries, these elephants died out in the 8th or 7th century BC. Present evidence,

including off-site evidence, suggests that while their local extinction was also anthropogenic, elephants themselves were not merely passive victims in the process; they have made an already difficult and degraded environment even more unsustainable for themselves and the human communities in the region. The immense demand for ivory and competition among first commercial, then territorial powers of the Bronze Age Levant, who symbolically associated themselves with elephants, caused the birth of the 'Syrian elephant'. In their demise, not only the elites, but also non-elite herders and agriculturalists were probably responsible. © 2016 Council for British Research in the Levant.

B.M. Chandranaik, B.P. Shivashankar, K.S. Umashankar, P. Nandini, P. Giridhar, S.M. Byregowda & B.M. Shrinivasa

***Mycobacterium tuberculosis* infection in free-roaming wild Asian elephant**

Emerging Infectious Diseases 23 (2017) 555-557

Abstract. Postmortem examination of a wild Asian elephant at Rajiv Gandhi National Park, India, revealed nodular lesions, granulomas with central caseation, and acid-fast bacilli in the lungs. PCR and nucleotide sequencing confirmed the presence of *Mycobacterium tuberculosis*. This study indicates that wild elephants can harbor *M. tuberculosis* that can become fatal.

C. Cox

The elephant in the sales room: Ivory and the British antiques trade

International Journal of Cultural Property 23 (2016) 321-334

Abstract. In March 2015, it was reported that His Royal Highness, the Duke of Cambridge would "like to see all the ivory owned by Buckingham Palace destroyed." In May 2015, the Conservative Party's manifesto stated that if elected the party would "press for a total ban on ivory sales," and policy decisions made as part of President Obama's National Strategy for Combating Wildlife Trafficking saw "all commercial imports of African elephant ivory, including antiques" being prohibited.1 In a changing international environment, the United Kingdom's antique trade faces a threat to the legitimate sale of pre- 1947 worked ivory without the extent of any illegal trade being clear. With only 15 convictions since 1992 for offences relating to the trade in ivory in the English courts, this article examines the two most recent cases, which came to court in 2014. © 2016 International Cultural Property Society.

R. Dale &d J.M. Plotnik

Elephants know when their bodies are obstacles to success in a novel transfer task

Scientific Reports 7 (2017) e46309

Abstract. The capacity to recognise oneself as separate from other individuals and objects is difficult to investigate in non-human animals. The hallmark empirical assessment, the mirror self-recognition test, focuses on an animal's ability to recognise itself in a mirror and success has thus far been demonstrated in only a small number of species with a keen interest in their own visual reflection. Adapting a recent study done with children, we designed a new body-awareness paradigm for testing an animal's understanding of its place in its environment. In this task, Asian elephants (*Elephas maximus*) were required to step onto a mat and pick up a stick attached to it by rope, and then pass the stick forward to an experimenter. In order to do the latter, the elephants had to see their body as an obstacle to success and first remove their weight from the mat before attempting to transfer the stick. The elephants got off the mat in the test significantly more often than in controls, where getting off the mat was unnecessary. This task helps level the playing field for non-visual species tested on cognition tasks and may help better define the continuum on which body- and self-awareness lie. © 2017 The Authors.

T. Eisenberg, J. Rau, U. Westerhüs, T. Knauf-Witzens, A. Fawzy, K. Schlez, M. Zschöck, E. Prenger-Berninghoff, C. Heydel, R. Sting, S.P. Glaeser, D. Pulami, M. van der Linden & C. Ewers

***Streptococcus agalactiae* in elephants – A comparative study with isolates from human and zoo animal and livestock origin**

Veterinary Microbiology 204 (2017) 141-150

Abstract. *Streptococcus agalactiae* represents a significant pathogen for humans and animals. However, there are only a few elderly reports on *S. agalactiae* infections in wild and zoo elephants

even though this pathogen has been isolated comparatively frequently in these endangered animal species. Consequently, between 2004 and 2015, we collected *S. agalactiae* isolates from African and Asian elephants (n = 23) living in four different zoos in Germany. These isolates were characterised and compared with isolates from other animal species (n = 20 isolates) and humans (n = 3). We found that the isolates from elephants can be readily identified by classical biochemistry and MALDI-TOF mass spectrometry. Further characterisations for epidemiological issues were achieved using Fourier transform-infrared spectroscopy, capsule typing and molecular fingerprinting (PFGE, RAPD PCR). We could demonstrate that our elephant isolate collection contained at least six different lineages that were representative for their source of origin. Despite generally broad antimicrobial susceptibility of *S. agalactiae*, many showed tetracycline resistance in vitro. *S. agalactiae* plays an important role in bacterial infections not only in cattle and humans, but also in elephants. Comparative studies were able to differentiate *S. agalactiae* isolates from elephants into different infectious clusters based on their epidemiological background.

A. Gangadharan, S. Vaidyanathan & C.C. St. Clair

Planning connectivity at multiple scales for large mammals in a human-dominated biodiversity hotspot

J. for Nature Conservation 36 (2017) 38-47

Abstract. Connectivity for large mammals across human-altered landscapes results from movement by individuals that can be described via nested spatial scales as linkages (or zones or areas) with compatible land use types, constrictions that repeatedly funnel movement (as corridors) or impede it (as barriers), and the specific paths (or routes) across completely anthropogenic features (such as highways). Mitigation to facilitate animal movement through such landscapes requires similar attention to spatial scale, particularly when they involve complex topography, diverse types of human land use, and transportation infrastructure. We modeled connectivity for Asian elephant (*Elephas maximus*) and gaur (*Bos gaurus*) in the Shencottah Gap, a multiple-use region separating two tiger reserves in the Western Ghats, India. Using 840 km of surveys for animal signs within a region of 621 km^2, we modeled landscape linkages via resource selection functions integrated across two spatial resolutions, and then potential dispersal corridors within these linkages using circuit theoretical models. Within these corridors, we further identified potential small-scale movement paths across a busy transportation route via least-cost paths and evaluated their viability. Both elephants and gaur avoided human-dominated habitat, resulting in broken connectivity across the Shencottah Gap. Predicted corridor locations were sensitive to analysis resolution, and corridors derived from scale-integrated habitat models correlated best with habitat quality. Less than 1% of elephant and gaur detections occurred in habitat that was poorer in quality than the lowest-quality component of the movement path across the transportation route, suggesting that connectivity will require habitat improvement. Only 28% of dispersal corridor area and 5% of movement path length overlapped with the upper 50% quantile of the landscape linkage; thus, jointly modeling these three components enabled a more nuanced evaluation of connectivity than any of them in isolation.

V.R. Goswami & D. Vasudev

Triage of conservation needs: The juxtaposition of conflict mitigation and connectivity considerations in heterogeneous, human-dominated landscapes

Frontiers in Ecology and Evol. 4 (2017) e144

Abstract. Conservation of wide-ranging endangered species is increasingly focused on large heterogeneous landscapes. At such scales, particularly when conservation landscapes are human dominated, it is imperative that prioritization techniques be used to allocate limited resources wisely. Moreover, spatial aspects of conservation planning warrant key consideration within these landscapes, such that certain sites that are key to either mitigating threats to species or to maintaining ecological processes, are prioritized. However, there are often multiple conservation needs, and multiple associated

constraints, for species conservation in such landscapes. While there are tools to prioritize sites based on single or few conservation requirements and constraints, there is less knowledge on how these conservation needs, or corresponding management interventions, relate to each other in a scenario where conservation focus on one issue potentially detracts from another. We take the specific example of two conservation needs that are central to landscape-scale conservation of the endangered Asian elephant *Elephas maximus*, namely the maintenance of connectivity, and the mitigation of human–elephant conflict. We show that conservation decision making, in addition to considering which species and sites to focus on, should also prioritize conservation needs. We review documentation of conflict mitigation and examine if the maintenance of connectivity was simultaneously addressed, and if so, whether optimal conservation solutions differed when connectivity considerations were included. We conclude with a discussion on the triage of conservation needs, and future prospects and challenges in ensuring that landscape-scale conservation strategies account for multiple interacting conservation needs for endangered species in heterogeneous human-dominated landscapes.

A.K.J. Gowda, N.K. Dharanesha, P. Giridhar & S.M.B. Gowda

***Cobboldia elephantis* (Cobbold, 1866) larval infestation in an Indian elephant (*Elephas maximus*)**

Journal of Parasitic Diseases 41 (2017) 364-366

Abstract. In the present study, post-mortem was conducted on a female elephant aged about 37 years died at Rajeev Gandhi National Park, Hunsur, Mathigoodu Elephant Camp, Karnataka state. The animal suffered with diarrhoea, anorexia, dehydration and was unable to walk for about one week before death and was treated with antibiotics and fluid therapy for three days. The post-mortem examination revealed that, the gastric mucosa was severely congested, hyperaemic and numerous stomach bots attached to the mucosa. The bots were recovered from the gastric mucosa and processed for species identification. The posterior spiracles of the bots showed three longitudinal parallel slits in each spiracle, the abdominal segments had a row of belt like triangular shaped spines and the anterior end had two powerful oral hooks with cephalo-pharyngeal skeleton. Based on the above said morphological characters, the bots were identified as *Cobboldia elephantis*. This seems to be the first report of *C. elephantis* in free range wild elephant from Karnataka state. © 2017 With permission of Springer.

T.N.E. Gray, A. Billingsley, B. Crudge, J.L. Frechette, R. Grosu, V. Herranz-Muñoz, J. Holden, O. Keo, K. Kong, D. MacDonald, T. Neang, R. Ou, C. Phan & S. Sim

Status and conservation significance of ground-dwelling mammals in the Cardamom Rainforest Landscape, southwestern Cambodia

Cambodian Journal of Natural History 2017 (2017) 38-48

Abstract. The Cardamom Rainforest Landscape (CRL) is a 17,000 km^2 protected landscape in southwestern Cambodia spanning an elevation range from sea-level to above 1,700 m. Despite the conservation value of the landscape there is little recent published information on the status and conservation significance of the ground-dwelling mammal populations. We report on seven camera trap studies conducted in five protected areas across the landscape between 2012 and 2016 with 255 trap-stations and >30,000 trap-nights. At least 30 species of medium to large ground-dwelling mammals were detected including one species included on the IUCN Red List as Critically Endangered, two as Endangered, eight as Vulnerable, and three as Near Threatened. Sun bears *Helarctos malayanus*, mainland clouded leopards *Neofelis nebulosa*, and dholes *Cuon alpinus* were detected from six or more of the seven studies. Populations of these three species in the landscape, though below ecological carrying capacity, are regionally significant. However we did not detect any *Panthera* cats, confirming that tigers *P. tigris* and leopards *P. pardus* are likely to have been extirpated. With the exception of these two species, and deciduous dipterocarp forest specialist ungulates, all globally threatened ground-dwelling and freshwater mammals likely to occur in the CRL have been detected in recent camera trapping

surveys. The Cardamoms are thus of global conservation significance. However, poaching, particularly snaring, combined with the presence of domestic dogs across the landscape is likely to be impacting current and future conservation value strongly. The persistence of significant mammalian biodiversity requires a paradigm shift in both governmental and civil society responses to the drivers of poaching. © 2017 Centre for Biodiversity Conservation.

B.J. Greco, C.L. Meehan, J,L. Heinsius & J.A. Mench

Why pace? The influence of social, housing, management, life history, and demographic characteristics on locomotor stereotypy in zoo elephants

Applied Animal Behaviour Science 194 (2017) 104-111

Abstract. Stereotypic behaviors (SB) are common in zoo-housed elephants, and these behaviors can be performed at high rates. Elephants perform different SB forms (e.g., weaving, pacing), but no published studies have evaluated the factors contributing to the development or performance of these different forms. Instead, as with most SB studies across species, elephant studies have relied on analyses that aggregate all SB forms, which limits the development and testing of form-specific hypotheses or abatement practices. Our objectives were to characterize the SB forms of North American zoo elephants and use multivariable epidemiological models to test form-specific hypotheses. We videotaped 77 elephants (African: N = 5 males, 31 females; Asian N = 8 males, 33 females) at 39 zoos who performed SBs and used a novel classification scheme and 5-min instantaneous samples to characterize their SB forms. Locomotor and whole-body SBs were the most common, but most elephants who performed locomotor SBs also performed whole-body SBs. Thus, we characterized each elephant according to whether it included locomotion in its SB repertoire [Locomotor Presence (LP)] or only whole-body movements. We used binomial regression models fitted with generalized estimating equations to test hypotheses about which of 26 social, housing, management, life history, and demographic variables were most associated with LP. The odds of LP increased by 26% for every 10% increase in time housed separately (odds ratio = 1.026, p = 0.04), 96.2% for every additional social group with which an elephant had contact (odds ratio = 1.962, p = 0.01), and 46% for every 10% increase in time housed indoors (odds ratio = 1.046, p = 0.01). Age was non-significantly confounded with all three variables. We hypothesize that the social variables in our models increase LP risk because they are associated with uncontrollable social group changes, anticipation of potentially rewarding social experiences, or the frustration of social behaviors. The housing variable included in our model likely increases LP risk because indoor spaces are less complex, resulting in the channeling of walking or social avoidance behaviors into more simplistic movements. Overall, our results suggest that elephant managers may best be able to prevent locomotor SB by enhancing their elephants' social environment and the spatial complexity of their enclosures. Future research should focus on determining whether addressing the risk factors for LP results in less frequent performance and identifying other temporally proximate eliciting factors.

E.M. Gross, N. Drouet-Hoguet, N. Subedi & J. Gross

The potential of medicinal and aromatic plants (MAPs) to reduce crop damages by Asian elephants (*Elephas maximus*)

Crop Protection 100 (2017) 29-37

Abstract. In all 13 Asian range countries of the wild Asian elephant (*Elephas maximus* L.), farmers suffer from crop damages caused by this endangered and highly protected species. As elephants are lured by highly nutritional crop types into agricultural lands, measures to deter or repel them from the high attraction will always be costly and labour intensive. The cultivation of crops, which are less attractive to elephants, yet economically viable for local farmers could lead to a new direction of land-use and income generation in human-elephant conflict areas. In this study, seven medicinal and aromatic plants (MAPs) containing higher amounts of specific plant secondary compounds were explored for their attractiveness to wild

Asian elephants against a control of rice (*Oryza sativa* L.) and maize (*Zea mays* L.). The results show that chamomile (*Matricaria chamomilla* L.), coriander (*Coriandrum sativum* L.), mint (*Mentha arvensis* L.), basil (*Ocimum basilicum* L.), turmeric (*Curcuma longa* L.), lemon grass (*Cymbopogon flexuosus* (Nees ex Steud.) W. Watson) and citronella (*Cymbopogon winterianus* Jowitt.) were less attractive and were not consumed by elephants compared to rice. Damages to the MAPs occurred only through trampling, with mint being most prone to being trampled. Other wildlife species, however, were observed to feed on lemon-grass. Long-term learning effects and the eventual palatability of crops with less efficient antifeedants need to be further explored. This study, however, gives first evidence that MAPs bear a high potential for a secure income generation in and close to Asian elephant habitats. Furthermore, the strategic plantation of crops unattractive and attractive to elephants could lead to new land-use strategies and improve functionality of elephant corridors.

D. Gunaryadi, Sugiyo & S. Hedges

Community-based human-elephant conflict mitigation: The value of an evidence-based approach in promoting the uptake of effective methods

PLoS ONE 12 (2017) e0173742

Abstract. Human-elephant conflict (HEC) is a serious threat to elephants and can cause major economic losses. It is widely accepted that reduction of HEC will often require community-based methods for repelling elephants but there are few tests of such methods. We tested community-based crop-guarding methods with and without novel chili-based elephant deterrents and describe changes in farmers' willingness to adopt these methods following our demonstration of their relative effectiveness. In three separate field-trials that took place over almost two years (October 2005 – May 2007) in two villages adjacent to Way Kambas National Park (WKNP) in Indonesia, we found that community-based crop-guarding was effective at keeping Asian elephants (*Elephas maximus*) out of crop fields in 91.2% (52 out of 57), 87.6% (156 out of 178), and 80.0% (16 out of 20) of attempted raids. Once the method had been shown to be effective at demonstration sites, farmers in 16 villages around WKNP voluntarily adopted it during the July 2008 to March 2009 period and were able to repel elephants in 73.9% (150 out of 203) of attempted raids, with seven villages repelling 100% of attempted raids. These 16 villages had all experienced high levels of HEC in the preceding years; e.g. they accounted for >97% of the 742 HEC incidents recorded for the entire park in 2006. Our work shows, therefore, that a simple evidence-based approach can facilitate significant reductions in HEC at the protected area scale.

M. Gupta, A. Joshi & T.N.C. Vidya

Effects of social organization, trap arrangement and density, sampling scale, and population density on bias in population size estimation using some common mark-recapture estimators

PLoS One 12 (2017) e0173609

Abstract. Mark-recapture estimators are commonly used for population size estimation, and typically yield unbiased estimates for most solitary species with low to moderate home range sizes. However, these methods assume independence of captures among individuals, an assumption that is clearly violated in social species that show fission-fusion dynamics, such as the Asian elephant. In the specific case of Asian elephants, doubts have been raised about the accuracy of population size estimates. More importantly, the potential problem for the use of mark-recapture methods posed by social organization in general has not been systematically addressed. We developed an individual-based simulation framework to systematically examine the potential effects of type of social organization, as well as other factors such as trap density and arrangement, spatial scale of sampling, and population density, on bias in population sizes estimated by POPAN, Robust Design, and Robust Design with detection heterogeneity. In the present study, we ran simulations with biological, demographic and ecological parameters relevant to Asian elephant populations, but the simulation framework is easily extended to address questions relevant to other social species. We collected capture history

data from the simulations, and used those data to test for bias in population size estimation. Social organization significantly affected bias in most analyses, but the effect sizes were variable, depending on other factors. Social organization tended to introduce large bias when trap arrangement was uniform and sampling effort was low. POPAN clearly outperformed the two Robust Design models we tested, yielding close to zero bias if traps were arranged at random in the study area, and when population density and trap density were not too low. Social organization did not have a major effect on bias for these parameter combinations at which POPAN gave more or less unbiased population size estimates. Therefore, the effect of social organization on bias in population estimation could be removed by using POPAN with specific parameter combinations, to obtain population size estimates in a social species.

F.K. Harich & A.C. Treydte

Mammalian wildlife diversity in rubber and oil palm plantations

CAB Reviews 11 (2016) e20

Abstract. In the face of globally diminishing natural habitats in biodiversity-rich regions, agricultural landscapes around protected areas have increasingly gained importance as extended habitat for wildlife species. Rubber (*Hevea brasiliensis*) and oil palm (*Elais guineensis*) plantations are two of the dominant land-use systems in Southeast Asia that have seen a tremendous expansion over the last decades. Despite far-reaching ecological consequences of these intensively cropped monocultures on natural ecosystems, relatively little is known about their utilization by wildlife populations. With this review we want to give an overview of mammalian diversity in rubber and oil palm plantations with reference to human–wildlife conflicts occurring as a result of overlapping resource use. We searched the literature for studies on wild mammalian diversity in rubber and oil palm plantations and found 17 publications. We considered 29 additional publications that provided information on single species in such plantations. We discuss the potential of 'wildlife-friendly' farming for mammalian assemblages in plantations and its importance in the case of rubber and oil palm production. Our review showed that most wild mammal species found in these plantations were likely to be visitors that use cultivated landscapes as fringe habitat but some adapted well to plantations and few even became resident. We conclude that although plantations in the tropics and subtropics cannot substitute for forests and the preservation of natural habitats is indispensable, the reality of ongoing forest degradation and transformation into plantations will make wildlife-friendly farming a key strategy in maintaining mammalian diversity, particularly in land-use matrices surrounding natural habitats.

T. Ishige, M. Miya, M. Ushio, T. Sado, M. Ushioda, K. Maebashi, R. Yonechi, P. Lagan & H. Matsubayashi

Tropical-forest mammals as detected by environmental DNA at natural saltlicks in Borneo

Biological Conservation 210A (2017) 281-285

Abstract. Although tropical forests are among the most species-rich ecosystems on earth, 42% of mammal species in tropical forests are endangered because of overhunting and/or unsustainable exploitation. Camera-trap surveys have shown that natural saltlicks can be used to determine mammalian fauna, especially medium to large endangered species in tropical forests; establishment of camera traps, however, is time and effort intensive. Furthermore, the photographic range and detectable size of species are often restricted. Environmental DNA (eDNA) metabarcoding is a powerful approach that might provide a better way to study terrestrial animals in tropical forests. In this study, we examined whether eDNA from natural saltlicks comprehensively represented species composition in a Bornean tropical forest. We collected 100–150-ml water samples from natural saltlicks in Sabah, Malaysian Borneo. We constructed amplicon libraries for MiSeq sequencing using eDNA extracted from the water samples. Six endangered species were detected using this method, including Bornean orangutan (*Pongo pygmaeus*), Bornean banteng (*Bos javanicus lowi*), Asian elephant (*Elephas maximus*), Sunda pangolin (*Manis javanica*), sambar deer (*Rusa unicolor*) and bearded pig

(*Sus barbatus*). However, most small and minor species were not detected, with low sequence identity (80–96%). Therefore, we propose that more species of tropical forest mammals should have their sequences deposited in DNA databases. This study is the first to report the endangered mammals of a tropical forest detected using eDNA from natural saltlicks.

T. Janyamethakul, S. Sripiboon, C. Somgird, P. Pongsopawijit, V. Panyapornwithaya, S. Klinhom, J. Loythong & C. Thitaram

Hematologic and biochemical reference intervals for captive Asian elephants (*Elephas maximus*) in Thailand

Kafkas Univ Vet Fak Derg 23 (2017) 665-668

Abstract. Species specific blood value reference intervals are needed for the proper diagnosis, and treatment of disease, appropriate for specific populations, because age, sex, management, exercise and geographical location can all affect hematological values. The aim of this study was to establish a set of hematology and blood chemistry reference intervals for captive Asian elephants. Blood samples were collected from 149 healthy Asian elephants in 15 tourist camps in Northern Thailand. Hematological and biochemical parameters were determined. The results showed similarity of haematological and blood chemistry range to others previously published. There were no sex differences for most hematological parameters except some parameters were different i.e. MCV, MCHC, BUN, AST, and ALP. The hematology and blood chemistry reference intervals of our study can be used as the reference for hematological analysis in Thailand, and several Asian elephant range countries and zoos.

S. Jayakumar, S. Sathiskumar, N. Baskaran, R. Arumugam & V. Vanitha

Ethno-veterinary practices in southern India for captive Asian elephant ailments

J. of Ethnopharmacology 200 (2017) 182-204

Abstract. India has a long tradition of practicing Ayurvedic medicine not only for human ailments, but also for the management of livestock in the form of ethno-veterinary practices. Asian elephant is a significant part of Indian culture, and ethno-veterinary practices have extended to manage and cure various ailments of Asian elephant in captivity. Much of this knowledge has been lost in the light of modern practices. This study is aimed at documenting the existing knowledge on ethno-veterinary medicines practiced by elephant keepers (mahouts) in Tamil Nadu and Puducherry. The study was carried out between June 2015 and February 2016 employing a questionnaire survey among 50 selected informants (mahouts) with traditional knowledge on plants in veterinary medicine. Information was elicited from the informants on various diseases prevailing among captive elephants and the traditional treatment employed by them. In total, the study documented 53 plant species belonging to 29 families being used as medicine for 23 types of ailments prevailing among captive elephants. *Ferula assafoetida*, *Zingiber officinale*, *Piper longum*, *P. nigrum*, *Cuminum cyminum*, *Trachyspermum roxburghianum* and *Carum bulbocastanum* were the most commonly used plants either independently or in combination. Among them, *F. assa-foetida* (12.4%) and *Z. officinale* (10.4%) had the highest usage. Of the 23 diseases reported, constipation was the most common ailment (14.6%) followed by bloating (8.7%) and flatulence (8.7%). Documentation of this indigenous knowledge is valuable for the communities concerned, both at present and in future and for scientific consideration for wider use of traditional knowledge in treating captive elephants. The study has identified 53 medicinal plants to treat various ailments among captive elephants in southern India. The most frequently used plants in the captive elephant health care practice are *F. assafoetida*, *Z. officinale*, *P. longum* and *P. nigrum*. Among the 29 families, Apiaceae and Piperaceae are widely used. The leaves are the most useful part of the plants, while paste is the widely used form of preparation. The present findings show that mahouts have wide knowledge about elephant diseases and their treatment using herbal medicine. A more detailed investigation should be designed on priority to document the dying art of ethno-veterinary practices for the long-term conservation of the Asian elephant.

D.K. Jha, N.T. Kshetry, B.R. Pokharel, S.K. Lal & R. Panday

Identification and differentiation of the Asian elephant ivory by using Schreger lines

Journal of Institute of Science and Technology 22 (2017) 99-103

Abstract. Elephant ivory is one of the highly priced, illegally traded wildlife trophies and its identification has always been a challenging task. A total of 21 Asian elephant tusks stored at the office of the Chitwan National Park, Kasara, Nepal were morphometrically studied with an aim to typify elephant ivory by using Schreger lines. The ivory samples were cleaned, their Schreger lines were photographed and their angles were measured by using a protractor. A total of 120 Schreger angles data from both outer and inner areas were obtained resulting both concave and convex appearance. The observed maximum and minimum Schreger angles values were 125° and 50° respectively. The mean Schreger angle was found to be 95.60° (±14.23). The Schreger lines were present in all studied samples. Thus, it is concluded that the presence of Schreger line is the identifying feature of an elephant tusk. © 2017 Institute of Science and Technology.

Ritesh Joshi

Wanderers of Rajaji: Are elephants learning new lessons in the changing environment?

Current Science 112 (2017) 1808-1811

Abstract. none.

S. Kongsawasdi, S. Mahasawangkul, P. Pongsopawijit, K. Boonprasert, B. Chuatrakoon, N. Thonglorm, R. Kanta-in, T. Tajarernmuang & K. Nganvongpanit

Biomechanical parameters of Asian elephant (*Elephas maximus*) walking gait

Kafkas Univ Vet Fak Derg 23 (357-362)

Abstract. Quadruped animals have a unique mechanism of movement that minimizes energy use and allows muscles to work effectively. Elephants are the biggest quadruped animals on earth and how they stabilize their body and use energy are of interest. This study aimed to analyze the characteristics of kinematic gait in Asian elephants trained to work with a mahout for tourism activities in Thailand. Twenty-one healthy adult Asian elephants were recorded by 2 digital cameras while walking at normal speed (average 1.1 m s-1.) along a 15-meter, solid-soil path. The temporospatial parameters evaluated for each limb consisted of stride length (cm), stride time (sec), swing time (sec), stance time (sec) and stance time percentage, using 2D motion analysis software. The result revealed that the average stride length was varied between 192-199 cm with no significant difference between fore and hindlimbs on either side but the stride length on the right side was significantly longer than that on the left in both forelimbs (right 197.5 cm; left 192.6 cm, $P<0.05$) and hindlimbs (right 198.9 cm; left 193.2 cm, $P<0.01$). The mean gait cycle time (stride time) was varied between 2.26 and 2.34 seconds for each limb and mean stance time was varied between 1.67-1.80 seconds, with both parameters were longer on the forelimbs than hindlimbs significantly ($P<0.01$). Hence, swing time for the forelimb was shorter than that for the hindlimb ($P<0.001$). The calculated stance time percentage for each limb was 72.64-76.09%. Data from this study confirmed that elephants walk with a lateral sequence and footfall pattern, and distribute the center of mass proportionally between all four limbs. Gait analysis is a valuable tool for identifying and understanding the pathogenesis of gait abnormality.

Chalita Kongrit

Genetic tools for the conservation of wild Asian elephants

International Journal of Biology 9 (2017) e2

Abstract. The distribution of the Asian elephant (*Elephas maximus*) has been limited to the remaining discontinuous forests, mainly in the South and Southeast Asia. A global number of wild Asian elephants have been declining due to habitat loss, forest fragmentation, and anthropogenic disturbance. Acquiring information of wild populations is important for effective conservation and management plan. This article reviews the applications of noninvasive genetic method as a tool for studying wild Asian elephants. Noninvasive genetic method has been introduced to the field of wildlife conservation for more than two decades. The method provides reliable information of a population and facilitates investigation of genetic effects on small and fragmented populations. Various DNA markers for the Asian elephant, those include mitochondrial DNA, microsatellite

DNA, and sex determination markers, have been developed and used to study wild elephant populations across the distribution range. Most of the studies revealed the issues of low genetic diversity in the small populations and interruption of gene flow among the fragmented populations. Tracking of ivory poaching has not yet been done in the Asian elephant. It could be carried out if a reference genetic database of the natural populations is available. Noninvasive genetic method has been proved to be a promising tool for conservation of the wild Asian elephants. Transboundary collaboration would give hope for a successful long-term conservation of this charismatic species in their natural habitats.

C. Kongrit & C. Siripunkaw

Determination of age and construction of population age structure of wild Asian elephants based on dung bolus circumference

Thai Journal of Veterinary Medicine 47 (2017) 145-153

Abstract. Estimating the age of wildlife is an important technique for the construction of a population age structure that could be useful for the prediction of population change. The age of wild elephants can be reliably estimated from the size of dung bolus circumference, which correlates with elephant growth. This research aimed to determine a cut-off bolus circumference for the mature age class of wild Asian elephants at Salakphra Wildlife Sanctuary as inferred from the social behavior of male elephants. Males living within their natal groups were considered immature males, whereas solitary males were considered mature males. The largest bolus circumference of the immature males was used as a cut-off criterion for age class determination. Noninvasive molecular sexing was applied to determine the sex of elephant samples. From a total of 225 dung samples, 96% were successfully sex determined; 90 and 126 samples were identified as male and female, respectively. Among the male samples, 49 samples were from males living within their natal groups and 41 samples were from solitary males. The cut-off bolus circumference was determined to be 42.5 cm. The dung samples with bolus circumferences larger than the cut-off size were classified as belonging to mature elephants. The same criterion was applied to females as well. A population age structure of Salakphra elephants was created based on the bolus circumferences regardless of individual identification. The construction of population age structure based on dung sampling could be useful for a rapid population survey.

H. Kuhrt, A. Bringmann, W. Härtig, G. Wibbelt, L. Peichl & A. Reichenbach

The retina of Asian and African elephants: Comparison of newborn and adult

Brain, Behavior and Evolution 89 (2017) 84-103

Abstract. Elephants are precocial mammals that are relatively mature as newborns and mobile shortly after birth. To determine whether the retina of newborn elephants is capable of supporting the mobility of elephant calves, we compared the retinal structures of 2 newborn elephants (1 African and 1 Asian) and 2 adult animals of both species by immunohistochemical and morphometric methods. For the first time, we present here a comprehensive qualitative and quantitative characterization of the cellular composition of the newborn and the adult retinas of 2 elephant species. We found that the retina of elephants is relatively mature at birth. All retinal layers were well discernible, and various retinal cell types were detected in the newborns, including Müller glial cells (expressing glutamine synthetase and cellular retinal binding protein; CRALBP), cone photoreceptors (expressing S-opsin or M/L-opsin), protein kinase Cα-expressing bipolar cells, tyrosine hydroxylase-, choline acetyltransferase (ChAT)-, calbindin-, and calretinin-expressing amacrine cells, and calbindin-expressing horizontal cells. The retina of newborn elephants contains discrete horizontal cells, which coexpress ChAT, calbindin, and calretinin. While the overall structure of the retina is very similar between newborn and adult elephants, various parameters change after birth. The postnatal thickening of the retinal ganglion cell axons and the increase in ganglion cell soma size are explained by the increase in body size after birth, and the decreases in the densities of neuronal and glial cells are explained by the postnatal expansion of the retinal surface area. The expression of glutamine synthetase and CRALBP in the Müller cells of newborn elephants

suggests that the cells are already capable of supporting the activities of photoreceptors and neurons. As a peculiarity, the elephant retina contains both normally located and displaced giant ganglion cells, with single cells reaching a diameter of more than 50 μm in adults and therefore being almost in the range of giant retinal ganglion cells found in aquatic mammals. Some of these ganglion cells are displaced into the inner nuclear layer, a unique feature of terrestrial mammals. For the first time, we describe here the occurrence of many bistratified rod bipolar cells in the elephant retina. These bistratified bipolar cells may improve nocturnal contrast perception in elephants given their arrhythmic lifestyle. © 2017 S. Karger AG, Basel.

A. Kumar, H.S. Bargali, A. David & A. Edgaonkar
Patterns of crop raiding by wild ungulates and elephants in Ramnagar Forest Division, Uttarakhand
Human-Wildlife Interactions 11 (2017) 41-49
Abstract. Crop raiding is a major form of human–wildlife conflict that not only affects livelihoods of farmers living close to forest areas but also jeopardizes the objective of wildlife conservation. In this study, we report patterns associated with crop raiding based on periodic field inspections of 95 crop fields spread across 16 villages in India. Average raided area of the field was highest in seedling stage (21%). Fields closer to the forest edge incurred higher damage in the seedling (22%) and mature stages (7%) than fields farther from the forest edge, although this was not statistically significant. Guarding was found to be ineffective in decreasing crop raiding, with no statistical difference in the mean area of damage between guarded and unguarded fields. Cheetal (*Axis axis*), sambar (*Rusa unicolor*), nilgai (*Boselaphus tragocamelus*), and wild pig (*Sus scrofa*) were the main raiders in fields close to the forest edge whereas nilgai and wild pig were chief raiders in fields farther from the forest edge. Results of this study suggest that in the study area, wild pig and nilgai are more problematic species than elephants (*Elephas maximus*), which are reported to cause the most damage in other landscapes.

S. Liu, Y. Dong, F. Cheng, Y. Zhang, X. Hou, S. Dong & A. Coxixo
Effects of road network on Asian elephant habitat and connectivity between the nature reserves in Xishuangbanna, Southwest China
J. for Nature Conservation 38 (2017) 11-20
Abstract. Evaluating road effects on the ecological status and landscape connectivity is critical for animal corridor design. Taking the fragmented nature reserves in Xishuangbanna as a case, road impacts on Asian elephant habitats were determined based on a suitability analysis. Potential corridors between different sub-reserves were located using "least-cost" method as a systematic way incorporating remote sensing (RS) and geographic information system (GIS). Our results revealed that road networks, especially high-level roads (expressway, national road and city-county city road), had the largest effects on the suitability according to the sensitivity analysis. Suitability (> 40) area will increase about 40% if there were no high-level roads. In total, seven potential linkages were located and found to be capable of connecting the habitats of the four sub-reserves. We suggested the Menglun reserve could serve as a stepping-stone for elephant migration. Four further conservation priorities were also identified between the Menglun reserve and the Mengla reserve where the road impacts were intensive. Our study provided information for the development of an efficient reserve network for elephant conservation between existing nature reserves in China and neighboring provinces in Lao PDR. © 2017 Reprinted with permission from Elsevier.

M. Lynch, K. McGrath, K. Raj, P. McLaren, K. Payne, R. McCoy & U. Giger
Hereditary factor VII deficiency in the Asian elephant (*Elephas maximus*) caused by a F7 missense mutation
Journal of Wildlife Diseases 53 (2017) 248-257
Abstract. Hereditary disorders and genetic predispositions to disease are rarely reported in captive and free-ranging wildlife, and none have been definitively identified and characterized in elephants. A wild-caught, 41-yr-old male Asian elephant (*Elephas maximus*) without an apparent increased bleeding tendency was consistently

found to have prolonged prothrombin times (PTs, mean=55±35 s) compared to 17 other elephants (PT=10±2 s). This elephant's partial thromboplastin times (PTT) fell within the normal range of the other elephants (12–30 s). A prolonged PT in the presence of a normal PTT suggests disruption of the extrinsic pathway via deficiency of coagulation Factor VII (FVII). This elephant's plasma FVII activity was very low (2%) compared to that of 15 other elephants (57–80%), but other coagulation factors' activities did not differ from the control elephants. Sequencing of genomic DNA from ethylenediaminetetraacetic acid blood revealed a single homozygous point mutation (c.202A>G) in the F7 gene of the FVII deficient elephant that was not present in unrelated elephants. This mutation causes an amino acid substitution (p.Arg68Gly) that is predicted to be deleterious. Two living offspring of the affected elephant were heterozygous for the mutation and had normal plasma FVII activities and coagulation profiles. Tissue from a third offspring, a deceased calf, was utilized to show that it was also a heterozygote. A DNA test has been developed to enable the screening of additional elephants for this mutation. Consistent with FVII deficiency investigations in other species, the condition did not cause a serious bleeding tendency in this individual elephant. © 2017 Wildlife Disease Association.

R.N. Makecha & R. Ghosal

Elephant conservation: Reviewing the need and potential impact of cognition-based education

International Journal of Comparative Psychology 30 (2017) 1-6

Abstract. Conservation education programs centered on animal cognition seem to be effective in bringing humans closer to non-human species and thereby, influencing their conservation attitudes. Systematic evaluation of the impact of cognition-based education programs on the attitudes of participants has revealed positive feedback and an appreciation towards the species of interest. However, such evaluations are rare for species like elephants, which suffer severe conservation challenges such as high degrees of conflict with the local community. In this paper, we review the need for cognition-based education programs in elephant conservation as well as the need to evaluate these programs to assess their impact on conservation attitudes. In particular, we emphasize the need for such programs in the native ranges of elephants, which are more prone to human-elephant conflict, and argue that exposure to such programs may potentially increase the collaboration of the local community towards conservation efforts. © 2017 The Authors.

S. Mendis, N.K. Jayasekera, R.C. Rajapakse & J.L. Brown

Endocrine correlates of puberty in female Asian elephants (*Elephas maximus*) at the Pinnawala Elephant Orphanage, Sri Lanka

BMC Zoology 2 (2017) 1

Abstract. Previous studies have established ovarian cycle characteristics of adult Asian elephants using progestagen analyses, but little work has been done on young elephants to determine age at puberty. Demographic studies of wild Asian elephants suggest females give birth at about 12–18 years of age (conceiving at 10–16 years of age based on a 2-year gestation). However, there are a few examples of zoo elephants giving birth at only 5–6 years of age, so they would have started cycling much earlier. This study was carried out at the Pinnawela Elephant Orphanage (PEO) in Sri Lanka, where a herd of >80 captive elephants breeds successfully, resulting in a unique opportunity to monitor hormones and document initiation of ovarian cyclicity in young females, thus contributing to the normative reproductive database for this species. We measured serum progestagens in samples collected every 10 days for 18–24 months from 11 females (3.5–15 years of age), and found six (5.5–12 years of age) already were cycling at study onset. Four females started cycling during the study at 4.5, 5.5, 7.5 and 15 years of age. There were no quantitative or qualitative differences between the first pubertal luteal phase and those of subsequent cycles. Of the 46 ovarian cycles observed, 78% were associated with clear behavioral signs of estrus (heightened bull attentiveness, and willingness of females to be mounted) during the late non-luteal period when progestagens were low. The average body weight at puberty was ~48% of that

of adult female elephants at PEO. Asian elephants under human care, including under semi-captive conditions, may reach puberty earlier than those in the wild, perhaps due to better nutrition and reaching a body weight capable of supporting reproductive activity at a younger age. Thus, facilities with bulls need to carefully manage elephants to avoid accidental pregnancies in young females that may be too small to safely carry a pregnancy to term. © 2017 The Authors.

M. Meyer, E. Palkopoulou, S. Baleka, M. Stiller, K.E.H. Penkman, K.W. Alt, Y. Ishida, D. Mania, S. Mallick, T. Meijer, H. Meller, S. Nagel, B. Nickel, S. Ostritz, N. Rohland, K.Schauer, T. Schüler, A.L. Roca, D. Reich, B. Shapiro & M. Hofreiter

Palaeogenomes of Eurasian straight-tusked elephants challenge the current view of elephant evolution

eLife 6 (2017) e25413

Abstract. The straight-tusked elephants *Palaeoloxodon* spp. were widespread across Eurasia during the Pleistocene. Phylogenetic reconstructions using morphological traits have grouped them with Asian elephants (*Elephas maximus*), and many paleontologists place *Palaeoloxodon* within *Elephas*. Here, we report the recovery of full mitochondrial genomes from four and partial nuclear genomes from two *P. antiquus* fossils. These fossils were collected at two sites in Germany, Neumark-Nord and Weimar-Ehringsdorf, and likely date to interglacial periods ~120 and ~244 thousand years ago, respectively. Unexpectedly, nuclear and mitochondrial DNA analyses suggest that *P. antiquus* was a close relative of extant African forest elephants (*Loxodonta cyclotis*). Species previously referred to *Palaeoloxodon* are thus most parsimoniously explained as having diverged from the lineage of *Loxodonta*, indicating that *Loxodonta* has not been constrained to Africa. Our results demonstrate that the current picture of elephant evolution is in need of substantial revision. © 2017 The Authors.

D. Neupane, S. Kunwar, A.K. Bohara, T.S. Risch & R.L. Johnson

Willingness to pay for mitigating human-elephant conflict by residents of Nepal

J. for Nature Conservation 36 (2017) 65-76

Abstract. Human-elephant conflict (HEC) is a significant problem in Nepal, with approximately two-thirds of households being impacted by elephants (*Elephas maximus*), particularly during the winter. In addition to elephant casualties, more than 10% of the households surveyed have had human casualties (injury or death) during the past 5 years. This study evaluates the economic viability of elephant conservation in Nepal within the context of current and proposed HEC mitigation scenarios. Face-to-face interviews were carried out using a structured questionnaire to elicit the residents' willingness to pay (WTP) for elephant conservation and HEC mitigation programs using seemingly unrelated regression (SUR). Residents' WTP was found to be positively related to income and education, and negatively related to damage-related programs. Local stakeholders were willing to pay about 42% more to programs that were economically transparent and improved upon existing management. Residents' WTP were also greater if they have had previous HEC-related injuries or deaths. © 2017 The Authors. Reprinted with permission from Elsevier.

G. Pant, M. Dhakal, N.M.B. Pradhan, F. Leverington & M. Hockings

Nature and extent of human–elephant *Elephas maximus* conflict in central Nepal

Oryx 50 (2016) 724-731

Abstract. Human–elephant conflict is one of the main threats to the long-term survival of the Asian elephant *Elephas maximus*. We studied the nature and extent of human–elephant interactions in the buffer zones of Chitwan National Park and Parsa Wildlife Reserve in Nepal, through household questionnaire surveys, key informant interviews, site observations, and analysis of the reported cases of damage during January 2008–December 2012. During this 5-year period 290 incidents of damage by elephants were reported, with a high concentration of incidents in a few locations. Property damage (53%) was the most common type of damage reported. Crop damage was reported less often but household surveys revealed it to be the most frequent form of conflict. There were also human casualties, including 21 deaths and four serious injuries.

More than 90% of the human casualties occurred during 2010–2012. More than two thirds of the respondents (70%) perceived that human–elephant conflict had increased substantially during the previous 5 years. Despite the increase in incidents of human–elephant conflict in the area, 37% of respondents had positive attitudes towards elephant conservation. Our findings suggest that public awareness and compensation for losses could reduce conflict and contribute to ensuring coexistence of people and elephants in this human-dominated landscape. © 2015 Fauna & Flora International.

S. Paudel, J.L. Brown, S. Thapaliya, I.P. Dhakal, S.K. Mikota, K.P. Gairhe, M. Shimozuru & T. Tsubota

Comparison of cortisol and thyroid hormones between tuberculosis-suspect and healthy elephants of Nepal

Journal of Veterinary Medical Science 78 (2016) 1713-1716

Abstract. We compared cortisol and thyroid hormone (T3 and T4) concentrations between tuberculosis (TB)-suspected (n=10) and healthy (n=10) elephants of Nepal. Whole blood was collected from captive elephants throughout Nepal, and TB testing was performed using the ElephantTB STAT-PAK® and DPP VetTB® serological assays that detect antibodies against *Mycobacterium tuberculosis* and *M. bovis* in elephant serum. Cortisol, T3 and T4 were quantified by competitive enzyme immunoassays, and the results showed no significant differences in hormone concentrations between TB-suspect and healthy elephants. These preliminary data suggest neither adrenal nor thyroid function is altered by TB disease status. However, more elephants, including those positively diagnosed for TB by trunk wash cultures, need to be evaluated over time to confirm results. © 2016 Japanese Society of Veterinary Science.

K.U.E. Perera, S. Wickramasinghe, B.V.P. Perera, K.B.A.T. Bandara & R.P.V.J. Rajapakse

Redescription and molecular characterization of *Anoplocephala manubriata*, Railliet et al., 1914 (Cestoda: Anoplocephalidae) from a Sri Lankan wild elephant (*Elephas maximus*)

Parasitology International 66 (2017) 279-286

Abstract. The present work provides a detailed morphological and molecular description of *Anoplocephala manubriata* in elephants. Adult worms were recovered during an autopsy of a wild elephant in Elephant Transit Home, Udawalawe, Sri Lanka. Necropsy findings revealed a severe cestode infection in the small intestine. These tapeworms were tightly attached to the intestinal mucosae, resulted in hyperemic thickened intestinal mucosae, variable size irregular well-demarcated multifocal ulcerative regions sometimes covered with necrotic membranes and variable size, diffuse, well-demarcated raised nodular masses were evident in the small intestine. The article provides an account of the biology of *A. manubriata* and a comparative analysis of the morphology and morphometrics of Anoplocephala species that occur in different hosts. Phylogenetic analysis of the second internal transcribed spacer region (ITS-2), a portion of the 28S region and cytochrome oxidase subunit 1 (COX1) genes revealed that *A. manubriata* is closely associated with Anoplocephala species in horse in comparison to other Anoplocephalines. This study will enhance the current knowledge in taxonomy of elephant tapeworms and contribute to future phylogenetic studies. © 2017 Reprinted with permission from Elsevier.

S.S. Pokharel, P.B. Seshagiri & R. Sukumar

Assessment of season-dependent body condition scores in relation to faecal glucocorticoid metabolites in free-ranging Asian elephants

Conservation Physiology 5 (2017) cox039

Abstract. We studied seasonal and annual changes in visual body condition scores (BCSs), and assessed how these scores were related to levels of faecal glucocorticoid metabolites (fGCMs) in free-ranging Asian elephants (*Elephas maximus*) in the seasonally dry tropical forests of the Mysore and Nilgiri Elephant Reserves in southern India. We assessed the animals' BCS visually on a scale of 1 to 5; where 1 represents a very thin and 5 represents a very fat elephant. To understand the influence of seasonality on BCS, we sampled the population during dry (n = 398) and wet seasons (n = 255) of 2013 and 2015 while, for annual changes in BCS, we sampled nine free-ranging adult females from different family groups that had been repeatedly sighted over seven years.

To evaluate the influence of body condition on fGCM, 307 faecal samples were collected from 261 different elephants and were analysed. As a parameter of adrenocortical activity, and thus stress, fGCM was measured (μg/g) in the ethanol-extracted samples using a group-specific 11-oxoaetiocholanolone EIA (antibody raised against 11-oxoaetiocholanolone-17-CMO:BSA and biotinylated-11-oxoaetiocholanolone as a label). Effect of age and season on BCS in relation to fGCM was also studied. A seasonal shift in BCS was observed as expected, i.e. individuals with low BCS were more frequent during the dry season when compared with the wet season. Concentrations of fGCM were highest in individuals with lowest BCS (BCS 1) and then significantly declined till BCS 3. fGCM levels were almost comparable for BCS 3, 4 and 5. This pattern was more conspicuous in female than in male elephants. Season-dependent BCS, hence, reflect the stress status as measured by fGCM, especially in female Asian elephants. This could be used as an important non-invasive approach to monitor the physiological health of free-ranging elephant populations. © 2017 The Authors.

J.-P. Puyravaud, S.A. Cushman, P. Davidar & D. Madappa

Predicting landscape connectivity for the Asian elephant in its largest remaining subpopulation

Animal Conservation 20 (2017) 225-234

Abstract. Landscape connectivity between protected areas is crucial for the conservation of megafauna. But often, corridor identification relies on expert knowledge that is subjective and not spatially synoptic. Landscape analysis allows generalization of expert knowledge when satellite tracking or genetic data are not available. The Nilgiri Biosphere Reserve in southern India supports the largest wild populations of the endangered Asian elephant *Elephas maximus*. Current understanding of connectivity in this region is based on corridors identified by experts, which are not empirically validated and incongruent with each other. To more rigorously assess population connectivity for the Asian elephant, we evaluated a combination of three resistance layers and three dispersal abilities. The resistance models were based on the combined contributions of land cover, topographical slope, elevation, roads and buildings. A spatially explicit connectivity modeling tool predicted optimal movement corridors as a function of factorial least-cost routes across the resistance maps. A resistant kernel approach produced maps of the expected frequency of elephant movement through each cell to define core areas. We conducted a sensitivity analysis to determine the influence of resistance and dispersal. We selected the resistance surface and dispersal ability that produced the highest correlation with observed elephant densities. We evaluated the optimality of expert corridors by using a path randomization method. Eleven out of 24 expert corridors had connectivity values significantly higher than expected by chance, while only two corridors were spatially congruent between expert teams. Areas with the highest connectivity corresponded well with priority areas identified by conservationists and elephant density predicted by the resistant kernel connectivity model correlated significantly with surveys (Spearman's $\varrho = 0.85$, $n = 500$, $P \ll 0.001$). The results provide the first rigorous, spatially synoptic and empirically validated evaluation of the connectivity of the elephant population across the reserve. © 2016 Zoological Society of London.

M. Rebein, C. N. Davis, H. Abad, T. Stone, J. del Sol, N. Skinner & M.D. Moran

Seed dispersal of *Diospyros virginiana* in the past and the present: Evidence for a generalist evolutionary strategy

Ecology and Evolution 7 (2017) 4035-4043

Abstract. Several North American trees are hypothesized to have lost their co-evolved seed disperser during the late-Pleistocene extinction and are therefore considered anachronistic. We tested this hypothesis for the American persimmon (*Diospyros virginiana*) by studying the effects of gut passage of proposed seed dispersers on seedling survival and growth, natural fruiting characteristics, and modern animal consumption patterns. We tested gut passage effects on persimmon seeds using three native living species, the raccoon (*Procyon lotor*), Virginia opossum (*Didelphis virginiana*), and coyote (*Canis latrans*), and two Pleistocene

analogs; the Asian elephant (*Elephas maximus*) and alpaca (*Vicugna pacos*). Persimmon seeds excreted by raccoons, coyotes, and elephants survived gut transit. Gut passage did not affect sprouting success, but did tend to decrease time to sprout and increase seedling quality. Under field conditions, persimmon fruits were palatable on the parent tree and on the ground for an equal duration, but most fruits were consumed on the ground. Seven vertebrate species fed upon persimmon fruits, with the white-tailed deer (*Odocoileus virginianus*)—a species not capable of dispersing persimmon seeds—comprising over 90% of detections. Conversely, potential living seed dispersers were rarely detected. Our results suggest the American persimmon evolved to attract a variety of seed dispersers and thus is not anachronistic. However, human-induced changes in mammal communities could be affecting successful seed dispersal. We argue that changes in the relative abundance of mammals during the Anthropocene may be modifying seed dispersal patterns, leading to potential changes in forest community composition.

S. Regnault, J.J.I. Dixon, C. Warren-Smith, J.R. Hutchinson & R. Weller

Skeletal pathology and variable anatomy in elephant feet assessed using computed tomography

PeerJ 5 (2017) e2877

Abstract. Foot problems are a major cause of morbidity and mortality in elephants, but are underreported due to difficulties in diagnosis, particularly of conditions affecting the bones and internal structures. Here we evaluate post-mortem computer tomographic (CT) scans of 52 feet from 21 elephants (seven African *Loxodonta africana* and 14 Asian *Elephas maximus*), describing both pathology and variant anatomy (including the appearance of phalangeal and sesamoid bones) that could be mistaken for disease. We found all the elephants in our study to have pathology of some type in at least one foot. The most common pathological changes observed were bone remodelling, enthesopathy, osseous cyst-like lesions, and osteoarthritis, with soft tissue mineralisation, osteitis, infectious osteoarthriti, subluxation, fracture and enostoses observed less frequently. Most feet had multiple categories of pathological change (81% with two or more diagnoses, versus 10% with a single diagnosis, and 9% without significant pathology). Much of the pathological change was focused over the middle/lateral digits, which bear most weight and experience high peak pressures during walking. We found remodelling and osteoarthritis to be correlated with increasing age, more enthesopathy in Asian elephants, and more cyst-like lesions in females. We also observed multipartite, missing and misshapen phalanges as common and apparently incidental findings. The proximal (paired) sesamoids can appear fused or absent, and the predigits (radial/tibial sesamoids) can be variably ossified, though are significantly more ossified in Asian elephants. Our study reinforces the need for regular examination and radiography of elephant feet to monitor for pathology and as a tool for improving welfare.

C.K. Rohini, T.l Aravindan, K.S.A. Das & P.A. Vinayan

Patterns of human-wildlife conflict and people's perception towards compensation program in Nilambur, Southern Western Ghats, India

Conservation Science 4 (2016) 1-6

Abstract. The aim of this research was to examine patterns of human-wildlife conflict and assess community perception towards compensation program implemented to ameliorate human-wildlife co-existence. Data were collected from the official archives of applications made by victims or their families at Divisional Forest Office, Nilambur North and South Forest Division, for the period 2010–2013. The data included (a) types of conflict, (b) wildlife species involved in the conflict, (c) dates of application made by applicants, (d) dates of final decision made by concerned authority and (d) relief amount sanctioned. People's perceptions towards compensation program were gathered using a questionnaire survey (n=179). Crop damage was the most common type of conflict, followed by property damage, injury and death by wildlife attack. Crop damage was contributed mainly by elephant (*Elephas maximus*) (59%) and wild boar (*Sus scrofa*) (32%). On average, people took 13 days to claim compensation, which received

decisions in 90 days. The majority of respondents (67%) were not satisfied with the compensation schemes. The main causes of such dissatisfaction were (a) allocation of insufficient money for the compensation (46.6%), (b) prolonged and difficult administrative procedures to make claims (20%), (c) people's convictions that compensation scheme does not eradicate the conflict (20%) and (d) disbelief on the officials involved in compensation program (6.6%). Our results suggest that compensation program has not gained acceptance among local community as an effective strategy to mitigate human-wildlife conflict. Although it may reduce hostile attitude towards wildlife, alternative approaches are needed that avoid conflicts.

A.H. M.R. Sarker, A. Hossen, M. Suza & E. Røskaft

Protected area versus people conflict and a co-management programme: A case study from the Dhudpukuria-Dhopachari Wildlife Sanctuary, Bangladesh

Environment and Natural Resources Research 7 (2017) 1927-0488

Abstract. Conflicts over the conservation of natural resources at the community level occur in different forms and at various levels of severity. These conflicts can be defined as situations in which the allocation, management or use of natural resources results in attacks on human rights or denial of access to natural resources to an extent that considerably diminishes human welfare. However, the conflict between the authorities of the Dhudpukuria-Dhopachari Wildlife Sanctuary (DDWS) and local people over wildlife conservation is one of the most serious conservation issues in Chittagong region of Bangladesh. The DDWS is managed under a co-management programme, but there are many questions that have already been asked about the success of co-management in the study area. A total of 195 standardized, structured and semi-structured questionnaires were administered randomly to villagers. The majority of respondents reported that they did not receive any potential benefit from the DDWS, and almost one-third of respondents reported that they had problems with the DDWS. Almost all respondents reported that they were unable to control the damage caused by wildlife. More than 80% of respondents reported that the co-management approach was not effective in mitigating conflict between people and protected areas. More than 45% of the participants in co-management program reported greater effectiveness of the co- management approach than non-participants. Moreover, the respondents who received more benefits from the Protected Areas (PA) reported more effectiveness of the co-management approach than those who received less or no benefits from the protected area. Integration of local knowledge and preferences into the co-management process will ensure the sustainability of the co-management programme by minimizing the conflict between people and protected areas.

C. Schiffmann, M. Clauss, S. Hoby & J.-M. Hatt

Visual body condition scoring in zoo animals – composite, algorithm and overview approaches in captive Asian and African elephants

J. of Zoo and Aquarium Research 5 (2017) 1-10

Abstract. Various body condition scoring (BCS) methods have been developed as management tools in zoo animal husbandry. In contrast to BCS for farm animals, where visual and palpable features are used, these protocols are mainly restricted to visual cues. Considering their inherent subjectivity, such methods face scepticism as their reliability is questioned. In terms of their respective methodology, composite BCS (where individual body regions are scored and a sum or mean is calculated), algorithm BCS (where a score is achieved by following a flow chart) and overview BCS protocols (where a score is given based on overall appearance) can be distinguished. In order to compare their practicability and consistency, we conducted a test with veterinary students (n=18) scoring an equal number (n=15) of African (*Loxodonta africana*) and Asian elephant (*Elephas maximus*) photographs using three different protocols. The composite approach showed least inter-observer consistency, while the overview protocol led to the highest differentiation of individual elephant condition. When regularly assessed, visual body condition scoring may serve as an important tool for the health surveillance and complete the medical history of individual zoo animals. Nonetheless, a validation process for

each protocol developed should be carried out before its application. Further research might concentrate on long-term, individual-based body condition monitoring, using archives of standardised photographs. © 2017 The Authors.

M. Seguel & N. Gottdenker

The diversity and impact of hookworm infections in wildlife

International Journal for Parasitology: Parasites and Wildlife 6 (2017) 177-194

Abstract. Hookworms are blood-feeding nematodes that parasitize the alimentary system of mammals. Despite their high pathogenic potential, little is known about their diversity and impact in wildlife populations. We conducted a systematic review of the literature on hookworm infections of wildlife and analyzed 218 studies qualitative and quantitatively. At least 68 hookworm species have been described in 9 orders, 24 families, and 111 species of wild mammals. Black bears, red foxes, and bobcats harbored the highest diversity of hookworm species and *Ancylostoma pluridentatum*, *A. tubaeforme*, *Uncinaria stenocephala* and *Necator americanus* were the hookworm species with the highest host diversity index. Hookworm infections cause anemia, retarded growth, tissue damage, inflammation and significant mortality in several wildlife species. Anemia has been documented more commonly in canids, felids and otariids, and retarded growth only in otariids. Population- level mortality has been documented through controlled studies only in canines and eared seals although sporadic mortality has been noticed in felines, bears and elephants. The main driver of hookworm pathogenic effects was the hookworm biomass in a population, measured as prevalence, mean burden and hookworm size (length). Many studies recorded significant differences in prevalence and mean intensity among regions related to contrasts in local humidity, temperature, and host population density. These findings, plus the ability of hookworms to perpetuate in different host species, create a dynamic scenario where changes in climate and the domestic animal-human-wildlife interface will potentially affect the dynamics and consequences of hookworm infections in wildlife. © 2017 The Authors.

G. Simpson, R. Zimmerman, E. Shashkina, L. Chen, M. Richard, C.M. Bradford, G.A. Dragoo, R.L. Saiers, C.A. Peloquin, C.L. Daley, P. Planet, A. Narachenia, B. Mathema & B.N. Kreiswirth

***Mycobacterium tuberculosis* infection among Asian elephants in captivity**

Emerging Infectious Diseases 23 (2017) 513-516

Abstract. Although awareness of tuberculosis among captive elephants is increasing, antituberculosis therapy for these animals is not standardized. We describe *Mycobacterium tuberculosis* transmission between captive elephants based on whole genome analysis and report a successful combination treatment. Infection control protocols and careful monitoring of treatment of captive elephants with tuberculosis are warranted.

C. Somgird, J.L. Brown & C. Thitaram

Reproductive control in elephant: A tool for population and aggression management

Thai J. of Veterinary Medicine 47 (2017) 1-6

Abstract. Although Asian elephant is listed among the endangered species, the number of populations is over the carrying capacity in some areas, resulting in human-elephant conflict, as well as African elephants. High aggression associated with musth and female reproductive pathology are observed in captive elephants. Thus, population and aggression management through reproductive control is an alternative method for mitigating these problems. This article reviews methods of reproductive control in both Asian and African elephants with an overview of male and female reproductive physiology. Hormonal control and immunocontraception, i.e. porcine zona pellucida and gonadotropin releasing hormone (GnRH), are described for the control of reproduction, musth and reproductive pathology.

R.B. Suba, J. van der Ploeg, M. van't Zelfde, Y.W. Lau, T.F. Wissingh, W. Kustiawan, G.R. de Snoo & H.H. de Iongh

Rapid expansion of oil palm is leading to human-elephant conflicts in North Kalimantan Province of Indonesia

Tropical Conservation Science 10 (2017) 1-12

Abstract. Crop raiding by Bornean elephants (*Elephas maximus borneensis*) is increasing

rapidly in North Kalimantan, mainly due to a rapid conversion of swiddens and secondary forest into oil palm plantations. In the Tulin Onsoi subdistrict, the area used by oil palm plantations has grown from 3302.71 ha in 2001 to 21,124.93 ha in 2014. Particularly from 2006 to 2010, the area covered by oil palm plantations increased rapidly (418%). Preventing further encroachment of oil palm plantations in elephant habitat and regulating land use change are keys to stop further population declines and make way for the reestablishment of a viable elephant population in Kalimantan. Crop raiding is a strong determinant of the local people's perceptions of elephants and risks eroding cultural values that enabled people to coexist with elephants. People's perception and attitude toward elephants are generally negative. Nevertheless, negative attitudes have not led to cases of retaliation in the Tulin Onsoi subdistrict. Public education at the community level could strengthen cultural values and foster coexistence between humans and elephants. © 2017 The Authors.

A. Suzuki, S. Thong, S. Tan & A. Iwata

Camera trapping of large mammals in Chhep Wildlife Sanctuary, northern Cambodia

Cambodian Journal of Natural History 2017 (2017) 63-75

Abstract. Chhep Wildlife Sanctuary in northern Cambodia comprises a large tract of deciduous dipterocarp forest (DDF). A camera trap survey was conducted in the wildlife sanctuary during two successive dry seasons, 2012–2013 and 2013–2014. A total of 7,483 camera-trap-nights yielded 3,787 records of 30 large mammal species. Our results confirm the continued occurrence of DDF-associated large mammals such as Eld's deer *Rucervus eldii*, banteng *Bos javanicus*, and jungle cat *Felis chaus*. Importantly, large-spotted civet *Viverra megaspila*, a globally Endangered species, was the fourthmost commonly photographed species in the wildlife sanctuary. This highlights the global significance of Chhep Wildlife Sanctuary for conservation of mammal assemblages in a lowland DDF-dominated landscape, given that DDF and lowland forests are under-represented by protected areas in mainland Southeast Asia. © 2017 Centre for Biodiversity Conservation.

K. Takahashi & K. Yasui

Taxonomic invalidity of Busk's elephant (*Elephas maximus buski* Matsumoto, 1927) demonstrated by AMS C dating

Paleontological Research 21 (2017) 195-202

Abstract. The ages of the holotype and a referred molar of *Elephas maximus buski* described by Matsumoto in 1927, and a molar supposedly of the same subspecies described by Makiyama in 1938 from Higashi Betsuin temple in Nagoya, were investigated by AMS (Accelerator Mass Spectrometry) dating. The holotype (IGPS 7266) may date from any of four periods between 1676 and 1941 cal AD, with 1732–1777 cal AD being the most probable (40.7% likelihood). The referred specimen (IGPS 5845) most likely dates from 1784–1796 cal AD (39.4% probability), and the specimen from Higashi Betsuin from 1454–1494 cal AD (52.9% probability). The present specimens, including the holotype are, therefore, not fossils. Historical records show that Asian elephants did not inhabit Japan at these times. These molars must have been imported into Japan in some fashion during historical times and do not represent a subspecies distinct from extant Asian elephants, *E. maximus*. Although the nominal subspecies *E. maximus buski* is clearly invalid, it is not clear which of the three extant subspecies of Asian elephant is its senior synonym in this research. © 2017 Palaeontological Society of Japan.

Z. Takatsu, M. Tsuda, A. Yamada, H. Matsumoto, A. Takai, Y. Takeda & M. Takase

Elephant's breast milk contains large amounts of glucosamine

Journal of Veterinary Medical Science 79 (2017) 524-533

Abstract. Hand-reared elephant calves that are nursed with milk substitutes sometimes suffer bone fractures, probably due to problems associated with nutrition, exercise, sunshine levels and/or genetic factors. As we were expecting the birth of an Asian elephant (*Elephas maximus*), we analyzed elephant's breast milk to improve the milk substitutes for elephant calves. Although there were few nutritional differences between conventional substitutes and elephant's breast milk, we found a large unknown peak in the breast milk during high-performance liquid

chromatography-based amino acid analysis and determined that it was glucosamine (GlcN) using liquid chromatography/mass spectrometry. We detected the following GlcN concentrations [mean ± SD] (mg/100 g) in milk hydrolysates produced by treating samples with 6 M HCl for 24 hr at 110°C: four elephant's breast milk samples: 516 ± 42, three cow's milk mixtures: 4.0 ± 2.2, three mare's milk samples: 12 ± 1.2 and two human milk samples: 38. The GlcN content of the elephant's milk was 128, 43 and 14 times greater than those of the cow's, mare's and human milk, respectively. Then, we examined the degradation of GlcN during 0–24 hr hydrolyzation with HCl. We estimated that elephant's milk contains >880 mg/100 g GlcN, which is similar to the levels of major amino acids in elephant's milk. We concluded that a novel GlcN-containing milk substitute should be developed for elephant calves. The efficacy of GlcN supplements is disputed, and free GlcN is rare in bodily fluids; thus, the optimal molecular form of GlcN requires a further study.

N.R. Talukdar & P. Choudhury

Conserving wildlife wealth of Patharia Hills Reserve Forest, Assam, India: A critical analysis

Global Ecology and Conservation 10 (2017) 126-138

Abstract. Wildlife plays an important role in maintaining the balance of various natural processes of the earth. It contributes to food security, economical growth, pollination, seed dispersal for forest regeneration. The present study was carried out at Patharia Hills Reserve Forest (RF) of southern Assam (India) with the aim to study the wildlife distribution, species trend over time and various threats to them. Semi-structure interview and secondary literature were used during the study; 83 species of mammals were found to inhabit RF. Unfortunately, the wildlife of the RF are facing numerous threats, largely due to clearing of forest, encroachment, collection of timber and non-timber forest products, habitat loss and fragmentation. People are of the opinion that the RF is their common property, which they can exploit as their wish. The study revealed the wildlife distribution and the various threats, which is the basic challenge for the conservation. Multi-action approaches for the benefit of villagers as well as wildlife are suggested. Elevating the status of the RF may be a vital solution to protect the RF in a better way.

P. Tankaew, T. Singh-La, C. Titaram, V. Punyapornwittaya, P. Vongchan, T. Sawada & N. Sthitmate

Evaluation of an in-house indirect ELISA for detection of antibody against haemorrhagic septicemia in Asian elephants

J. of Microbiological Methods 134 (2017) 30-34

Abstract. *Pasteurella multocida* causes haemorrhagic septicemia in livestock and wild animals, including elephants. The disease has been reported in Asian elephants in India and Sri Lanka, but to date there have been no reported cases in Thailand. ELISA or indirect hemagglutination assays (IHA) have been demonstrated to be able to detect the antibody against the disease in cattle, but no data are available for elephants. The present study reports a novel in-house indirect ELISA for antibody detection of haemorrhagic septicemia in Asian elephants, and evaluates the sensitivity and specificity of the method using a Bayesian approach. The characteristics of ELISA and IHA were analyzed using a one population Bayesian model assuming conditional dependence between these two diagnostic tests. The IHA was performed as recommended by the World Organization for Animal Health (OIE) manual for haemorrhagic septicemia. An in-house indirect ELISA was developed with a heat extract antigen of *P. multocida* strain M-1404 (serovar B:2) as a coating antigen and rabbit anti-immunoglobulin G conjugated with horseradish peroxidase (eIgG-HRP). The checkerboard titration method was done using elephant sera immunized with *P. multocida* bacterin and negative sera from colostrum-deprived elephant calves. The concentrations of heat extract antigen (160 μg/ml), sample serum (1:100), and eIgG-HRP (1:1000) were optimal for the assay. The calculated cut-off value was 0.103. Of the elephant sera, 50.59% (43/85) were considered seropositive by ELISA. The sensitivity of the ELISA test was higher than that of the IHA test [median = 86.5%, 95% posterior probability

interval (PPI) = 52.5–98.9%] while the specificity was lower (median = 54.1%, PPI = 43.6–64.7%). The median sensitivity and specificity of IHA were 80.5% (PPI = 43.8–98.0%) and 78.4% (PPI = 69.0–87.0%), respectively. These findings suggest that our in-house indirect ELISA can be used as a tool to detect the antibody against haemorrhagic septicemia in Asian elephants. © 2017 Reprinted with permission from Elsevier.

D.K. Tarbert, E. Behling-Kelly, H. Priest & S. Childs-Sanford

Evaluation of the i-STAT portable clinical analyzer for measurement of ionized calcium and selected blood chemistry values in Asian elephants (*Elephas maximus*)

Journal of Zoo and Wildlife Medicine 48 (2017) 319-327

Abstract. The i-STAT® portable clinical analyzer (PCA) provides patient-side results for hematologic, biochemical, and blood gas values when immediate results are desired. This analyzer is commonly used in nondomestic animals; however, validation of this method in comparison with traditional benchtop methods should be performed for each species. In this study, the i-STAT PCA was compared with the Radiometer ABL 800 Flex benchtop analyzer using 24 heparinized whole blood samples obtained from healthy *E. maximus*. In addition, the effect of sample storage was evaluated on the i-STAT PCA. Analytes evaluated were hydrogen ion concentration (pH), glucose, potassium (K^+), sodium (Na^+), bicarbonate (HCO_3^-), total carbon dioxide (TCO_2), partial pressure of carbon dioxide (PCO_2), and ionized calcium (iCa_2^+). Statistical analysis using correlation coefficients, Passing-Bablok regression analysis, and Bland-Altman plots found good agreement between results from samples run immediately after phlebotomy and 4 hr postsampling on the i-STAT PCA with the exception of K^+, which is known to change with sample storage. Comparison of the results from the two analyzers at 4 hr postsampling found very strong or strong correlation in all values except K^+, with statistically significant bias in all values except glucose and PCO_2. Despite bias, mean differences assessed via Bland-Altman plots were clinically acceptable for all analytes excluding K^+. Within the reference range for iCa_2^+, the iCa_2^+ values obtained by the i-STAT PCA and Radiometer ABL 800 Flex were close in value, however in light of the constant and proportionate biases detected, overestimation at higher values and underestimation at lower values of iCa_2^+ by the i-STAT PCA would be of potential concern. This study supports the use of the i-STAT PCA for the evaluation of these analytes, with the exception of K+, in the Asian elephant. © 2017 American Association of Zoo Veterinarians.

G.V. Venkataramana, Sreenivasa & H.G. Lingaraju

An assessment of crop damage and economic loss caused by elephants in Harohalli and Kodihalli ranges of Bannerghatta National Park, Karnataka, India

Current Science 113 (2017) 161-167

Abstract. The human–elephant conflict, which results in extensive crop damage as well as casualties (both humans and elephants) has significantly increased over the past decade. We studied the patterns of crop raiding and associated economic loss by elephants across two forest ranges of Bannerghatta National Park (BNP), Karnataka, India, namely Kodihalli and Harohalli ranges, from January 2014 to December 2014. We found that 127 villages reported crop raids by elephants during the study period. The incidence of crop raiding in villages ranged from 1 to 59 (mean = 7.17) and was highest in Kodihalli division. Maximum crop raiding incidences were recorded during the rainy season in both the ranges. Elephants with varying proportions raided all cultivated crop species in the study area. Finger millet (*Eleusine coracana*) (65 acres), banana (*Musa paradisia*) (1535 plants) and coconut (*Cocus nucifera*) (140 trees) were the most raided crop species. Crop maturity and crop raiding incidence showed positive correlation for finger millet in the Kodihalli range. In contrast, bananas were damaged throughout the year in the Harohalli range. Other crops such as red gram, paddy, sugarcane and beans were raided less in the sampling areas. In conclusion, this study reveals rising incidence of human– elephant conflicts and significant economic loss as a result of crop damage in the adjoining regions of BNP.

S. Yasui & G. Idani

Social significance of trunk use in captive Asian elephants

Ethology Ecology & Evolution 29 (2017) 330-335

Abstract. Tactile behaviour plays an important role in maintaining social relationships in several mammalian species. Touching with the tip of the trunk is a common social behaviour among Asian elephants (*Elephas maximus*). This is considered an affiliative behaviour; however, few studies have investigated it in detail. Therefore, this study aimed to determine whether this is an affiliative behaviour and whether it has other functions. We directly observed a group of captive female Asian elephants in Thailand. We found that the elephants usually touched each other with their trunks shaped in a U (U-type) or S (S-type) shape. The S-type shape was observed mainly when the elephants touched the lips of other elephants; however, this behaviour was occasionally observed in agonistic or play contexts, where it appeared to be a threat or dominant behaviour, particularly amongst adults. In contrast, the U-type shape was more frequently observed when the elephants were disturbed, where it appeared as a gesture for reassurance. We found that the U-type touch on the genitals may be used for interacting with neonates. Therefore, we suggest that despite the S-type touch having a tactile component, it may be a rare behaviour in Asian elephants that is similar to visual threat displays in other mammals. However, the U-type touch is similar to social grooming behaviour in primates or flipper rubbing in dolphins, and can be used as an indicator of affiliative relationships. Asian elephants change the shape of their trunk while touching others depending on their motivation and the situation, thereby demonstrating that the nuances of trunk use can assist in understanding the social relationships between individuals.

A. Zachariah, J. Pandiyan, G.K. Madhavilatha, S. Mundayoor, B. Chandramohan, P.K. Sajesh, S. Santhosh & S.K. Mikota

***Mycobacterium tuberculosis* in wild Asian elephants, Southern India**

Emerging Infectious Diseases 23 (2017) 504-506

Abstract. We tested 3 wild Asian elephants (*Elephas maximus*) in southern India and confirmed infection with *Mycobacterium tuberculosis*, an obligate human pathogen, by PCR and genetic sequencing. Our results indicate that tuberculosis may be spilling over from humans (reverse zoonosis) and emerging in wild elephants.

G.H. Zhao, X.F. Hu, T.L. Liu, R.S. Hu, Z.Q. Yu, W.B. Yang, Y.L. Wu, S.K. Yu & J.K. Song

Molecular characterization of *Blastocystis* sp. in captive wild animals in Qinling Mountains

Parasitology Research 116 (2017) 2327-2333

Abstract. *Blastocystis* is one common protist inhabiting in gastrointestinal tracts of animals and humans. Examining the subtypes has important implications for assessing the zoonotic potential of *Blastocystis* and intestinal health of hosts. In the present study, a total of 497 fecal samples collected from 37 wild animal species in Qinling Mountains were investigated for the presence and subtypes of *Blastocystis*. Of them, 200 (40.2%) were positive for *Blastocystis* and 13 subtypes were found, including eight known subtypes (STs1–3, 5, 10, 12–14) and five possible novel subtypes (temporarily named as STs18–22), with ST10 as the predominate subtype and the subtype ST5 was detected in an ostrich for the first time. These findings indicated the wide distribution and specific subtype characteristics of *Blastocystis* in wild animals of Qinling Mountains.

Tusker in Yala National Park (Sri Lanka).