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 (2021) publications on Asian elephants.

U. Bechert, J.M. Christensen, J. Kottwitz, D. Boothe, S. Alshahrani & S. Mohammed

Pharmacokinetics of orally administered flunixin meglumine in African (*Loxodonta africana*) and Asian (*Elephas maximus*) elephants

Journal of Zoo and Wildlife Medicine 51 (2020) 905-914

Abstract. *Flunixin meglumine* is the most commonly used nonsteroidal anti-inflammatory drug used to treat elephants; however, no pharmacokinetic study for flunixin has yet been conducted in these species, and dosages used range widely. Pharmacokinetic parameters of flunixin were determined in African (*Loxodonta africana*) and Asian (*Elephas maximus*) elephants after single-dose oral administration of 0.8 and 1.5 mg/kg flunixin paste in each species. Elephant compliance to oral administration of banamine was occasionally challenging, especially among older, female African elephants. After administration of 0.8 mg/kg flunixin, mean serum concentrations peaked in approximately 1.3 h at 2.1 ± 0.8 μg/ml for Asian (n = 8) and 2.8 h at 2.5 ± 0.7 μg/ml for African (n = 8) elephants. Dosages of 1.5 mg/kg flunixin resulted in mean serum concentration peaks of 7.2 ± 1.5 μg/ml in Asian elephants (n = 7) and 4.4 ± 0.7 μg/ml in African elephants (n = 6). However, multiple-dose trials using 1.1 mg/kg flunixin resulted in peak serum concentrations that were again less in Asian than African elephants (2.7 μg/ml versus 4.4 μg/ml, respectively). Asian elephants consistently had lower time to maximal concentration, greater area under the curve, and longer mean residence times compared with African elephants. In other species, flunixin is excreted unchanged primarily via hepatic routes with small amounts in the urine. Asian elephants may engage in some level of enterohepatic recycling of flunixin, as was previously reported for phenylbutazone. This study supports that different oral dosing regimens should be used for Asian (1.0 mg/kg SID) and African (1.2 mg/kg SID) elephants, and oral administration techniques used should ensure complete dosage delivery. © 2020 American Association of Zoo Veterinarians.

L.E. Cartier, M.S. Krzemnicki, M. Gysi, B. Lendvay & N.V. Morf

A case study of ivory species identification using a combination of morphological, gemmological and genetic methods

Journal of Gemmology 37 (2020) 282-297

Abstract. Twenty-one items sold as mammoth ivory in China were submitted to the Zurich Institute of Forensic Medicine (University of Zurich, Switzerland) and SSEF for testing. The aim of this case study was to identify these samples using macroscopic morphological diagnostics, microscopic examination, FTIR spectroscopy, trace-element analysis and additional minimally destructive DNA analysis (of approximately 100 mg of powder) of a region of the cytochrome b gene to assign taxonomic identification. Morphological features (Schreger angles) shown by five of the samples were characteristic of extinct Proboscideans (mammoths), and one other specimen displayed unnatural layering that identified it as an ivory imitation. FTIR spectroscopy further showed the imitation was an artificial resin, while infrared spectra of the other samples displayed overlapping features characteristic of carbonated hydroxyapatite (i.e. ivory or bone). Like FTIR spectroscopy, trace-element chemistry cannot be used to separate

species. DNA analysis could in some cases differentiate extinct (mammoth) from extant (African and Asian elephant) Proboscidean species, and also identified one specimen as cattle bone. Combining morphological, gemmological and genetic approaches can increase the amount of evidence available to identify the species origin of ivory. © 2020 Gem-A.

R. Cazzolla Gatti & A. Velichevskaya

Certified "sustainable" palm oil took the place of endangered Bornean and Sumatran large mammals habitat and tropical forests in the last 30 years

Science of the Total Environment 742 (2020) e140712

Abstract. Tropical forests inhabited by endangered orangutans, rhinos, tigers, and elephants in South-east Asia are threatened by deforestation, including oil palm expansion. Certification has been proposed to label sustainable palm oil production. However, from a remotely sensed time-series and imagery analysis (1984–2020), we discovered that most of the currently certified grower supply bases and concessions in Sumatra and Borneo are located in the 1990s large mammals habitat and in areas that were biodiverse tropical forests less than 30 years ago. In light of this dramatic evidence, we suggest that certification schemes claim for the "sustainable" production of palm oil just because they neglect a very recent past of deforestation and habitat degradation. © 2020 Reprinted with permission from Elsevier.

E. Chaudhary, P. Jouquet, C. Rumpel & R. Sukumar

Chemical parameters of decomposing dung in tropical forest as indicators of feeding behaviour of large herbivores: A step beyond classical stoichiometry

Ecological Indicators 115 (2020) e106407

Abstract. Feeding behavior of large herbivores determines the composition of their dung and together with environmental factors the intensity of decomposition processes leading to the recycling of nutrients in tropical forests. Large herbivore dung and its decomposition has so far been characterized by stoichiometric analyses of elements such as C and N. The objective of our study was to examine the suitability of biomarker analyses and analytical pyrolysis to infer large herbivore feeding behavior and the decomposition of their dung in different environments. Our conceptual approach included exposure of fresh dung of a grazing ruminant (gaur, *Bos gaurus*) and a non-ruminant mixed-feeder (the Asian elephant, *Elephas maximus*) in two tropical forest types (dry and moist) and analysis of dung biochemical composition in two seasons (dry and wet). To this end we characterized the dungs' lignin and carbohydrate (sugar) signatures and pyrolysis products before and after 28 days of exposure. Our results showed that stoichiometric as well as biomarker analyses were able to differentiate gaur and elephant dung independent of season and forest type, while analytical pyrolysis products did not differ between dung types. The lignin signature of fresh dung additionally indicated the forage preference of animals in different forest types and seasons. During decomposition, C and N contents decreased and the chemical composition of both dung types converged. The lignin signature of dung at the end of the experiment showed higher lignin decomposition in moist forest and wet season than dry forest and dry season. We conclude that detailed biochemical analyses can provide deeper insights into the main controls of large herbivore dung and its decomposition in tropical forests than stoichiometric analysis. In particular lignin may be a suitable indicator to investigate large herbivore feeding behavior and the environmental conditions of their habitat. © 2020 Reprinted with permission from Elsevier.

H.M. Chel, T. Iwaki, M. Hmoon, Y.N. Thaw, N.C. Soe, S.Y. Win, S. Bawm, L.L. Htun, M.M. Win, Z.M. Oo, M.A. Masum, O. Ichii, R. Nakao, N. Nonaka & K. Katakura

Morphological and molecular identification of cyathostomine gastrointestinal nematodes of *Murshidia* and *Quilonia* species from Asian elephants in Myanmar

International Journal for Parasitology: Parasites and Wildlife 11 (2020) 294-301

Abstract. Gastrointestinal nematode parasites have long been recognized in Asian elephants. The most common parasites belong to the subfamily Cyathostominae of the family

Strongylidae, which are small to medium-sized with a cylindrical buccal capsule surrounded by coronal leaflets. Diagnostic keys of such parasites are provided from old illustrations in the form of line drawings. However, there very few photomicrographs and no genetic information of these parasites exist. In the present study we obtained adult worm specimens from faeces of Asian elephants after anthelmintic treatment in two elephant camps in Myanmar. Here, we provided photomicrographs for five cyathostomine parasites, *Murshidia falcifera*, *Murshidia indica*, *Murshidia neveulemairei*, *Quilonia renniei*, and *Quilonia travancra* almost 100 years after their original drawings. In addition, we determined the mitochondrial cytochrome c oxidase subunit I (COI) gene sequences of these species. Phylogenetic analysis of the COI genes of *Murshidia* and *Quilonia* species from Asian and African elephants revealed parasite speciation in each elephant host. The present study also indicated that several *Murshidia* and *Quilonia* species were widely distributed in Asian elephants in Myanmar, providing new insight into control strategies and evolution of cyathostomine gastrointestinal parasites in elephants.

S.E. Childs-Sanford, A.J. Makowski & J.J. Wakshlag

The vitamin D status of Asian elephants (*Elephas maximus*) managed in a northern temperate climate

J. of Zoo and Wildlife Medicine 51 (2020) 1-12

Abstract. Knowledge about the normal metabolism and involvement of vitamin D in elephant calcium homeostasis is essential to understanding the possible role of vitamin D in Asian elephant (*Elephas maximus*) health, as well as to informing accurate diet formulation. This study provides an evaluation of analytes involved in vitamin D metabolism, in conjunction with dietary intake and ultraviolet light (UV) exposure, in Asian elephants managed in a northern temperate climate. Once monthly, for a total of 12 mo, serum from six adult Asian elephants was analyzed for 25-hydroxyvitamin D [25(OH)D], 24,25-dihydroxyvitamin D [24,25$(OH)_2$D], 1,25-dihydroxyvitamin D [1,25 (OH)2D], parathyroid hormone (PTH), total calcium (Ca), ionized calcium (iCa), phosphorus (P), and magnesium (Mg). The diet was analyzed monthly for vitamin D, Ca, and P. Monthly average vitamin D–weighted UV daily sums were determined to gauge average UV light exposure within the vitamin D action spectrum. No serum or diet parameters were affected by time or season. Average serum 25$(OH)D_2$ was 7.02 ± 0.85 ng/ml. 25$(OH)D_3$ levels were nondetectable in all samples despite supplementation of the diet with recommended levels of vitamin D3, and UV exposure was at sufficient levels for cutaneous vitamin D synthesis for 6 mo of the year. Levels of 24,25$(OH)_2$D averaged 31.7% higher than 25(OH)D, and average 1,25$(OH)_2D_2$ was 11.24 ± 1.04 pg/ml. Values for PTH, Ca, iCa, P, and Mg were within expected ranges for Asian elephants. The information gained from this research expands the knowledge base for these analytes, evaluates 24,25-dihydroxyvitamin D for the first time, and provides new information regarding vitamin D metabolism and test interpretation in the Asian elephant. © 2020 by American Association of Zoo Veterinarians.

J.A.H. Crawley, M. Lahdenperä, Z.M. Oo, W. Htut, H. Nandar & V. Lummaa

Taming age mortality in semi-captive Asian elephants

Scientific Reports 10 (2020) e1889

Abstract. Understanding factors preventing populations of endangered species from being self-sustaining is vital for successful conservation, but we often lack sufficient data to understand dynamics. The global Asian elephant population has halved since the 1950s, however >25% currently live in captivity and effective management is essential to maintain viable populations. Here, we study the largest semi-captive Asian elephant population, those of the Myanma timber industry (~20% global captive population), whose population growth is heavily limited by juvenile mortality. We assess factors associated with increased mortality of calves aged 4.0-5.5 years, the taming age in Myanmar, a process affecting ~15,000 captive elephants to varying degrees worldwide. Using longitudinal survival data of 1,947 taming-aged calves spanning 43 years, we showed that calf mortality risk increased by >50% at the taming

age of four, a peak not seen in previous studies on wild African elephants. Calves tamed at younger ages experienced higher mortality risk, as did calves with less experienced mothers. Taming-age survival greatly improved after 2000, tripling since the 1970's. Management should focus on reducing risks faced by vulnerable individuals such as young and first-born calves to further improve survival. Changes associated with reduced mortality here are important targets for improving the sustainability of captive populations. © 2020 The Authors.

K. Denninger Snyder & D. Rentsch
Rethinking assessment of success of mitigation strategies for elephant-induced crop damage
Conservation Biology 34 (2020) 829-842
Abstract. Crop damage is the most common impact of negative interactions between people and elephants and poses a significant threat to rural livelihoods and conservation efforts. Numerous approaches to mitigate and prevent crop damage have been implemented throughout Africa and Asia. Despite the documented high efficacy of many approaches, losses remain common, and in many areas, damage is intensifying. We examined the literature on effectiveness of crop-damage-mitigation strategies and identified key gaps in evaluations. We determined there is a need to better understand existing solutions within affected communities and to extend evaluations of effectiveness beyond measurement of efficacy to include rates of and barriers to adoption. We devised a conceptual framework for evaluating effectiveness that incorporates the need for increased emphasis on adoption and can be used to inform the design of future crop-damage mitigation assessments for elephants and conflict species more widely. The ability to prevent crop loss in practice is affected by both the efficacy of a given approach and rates of uptake among target users. We identified the primary factors that influence uptake as local attitudes, sustainability, and scalability and examined each of these factors in detail. We argue that even moderately efficacious interventions may make significant progress in preventing damage if widely employed and recommend that wherever possible scientists and practitioners engage with communities to build on and strengthen existing solutions and expertise. When new approaches are required, they should align with local attitudes and fit within limitations on labor, financial requirements, and technical capacity. © 2019 Society for Conservation Biology.

G.J. Drake, J. Haycock, A. Dastjerdi, H. Davies & F.J. Lopez
Use of immunostimulants in the successful treatment of a clinical EEHV1A infection in an Asian elephant (*Elephas maximus*)
Vet Record Case Reports 8 (2020) e001158
Abstract. Elephant endotheliotropic herpesvirus haemorrhagic disease (EEHV - HD) poses a significant threat to the captive population of juvenile Asian elephants (*Elephas maximus*) and also affects elephants in the wild. In human and veterinary medicine, increasing attention is returning to the interferon system, a crucial mediator in the immune response for control of infection. We describe the first reported use of the Zelnate DNA immunostimulant and recombinant human interferon alpha (rhIFNα) as additional medications in the successful treatment of a case of EEHV1A - HD in a juvenile Asian elephant at a UK zoo. Despite an exponential rise in viraemia to a peak of 2.82×106 viral genomic equivalents/ml, only mild clinical signs developed and the calf survived with no adverse effects attributed to the novel treatments. This case is compared with a previous fatal case within the same herd where Zelnate and rhIFNα were not given. © 2020 British Veterinary Association.

S. Dror, F. Harich, O. Duangphakdee, T. Savini, Ákos Pogány, J. Roberts, J. Geheran & A.C. Treydte
Are Asian elephants afraid of honeybees? Experimental studies in northern Thailand
Mammalian Biology 100 (2020) 355-363
Abstract. In many parts of South and Southeast Asia, rural farmers living at the borders of protected areas frequently encounter Asian elephants (*Elephas maximus*) raiding their crops and threatening farmers lives and livelihoods. Traditional deterrent methods often have limited success as elephants become habituated or alternate their movement and behavior. While African bees (*Apis mellifera scutellate*) have been shown to effectively and sustainably deter African

elephants (*Loxodonta africana*) little is known about their Asian counterparts. We conducted two experiments to estimate the effectiveness of bees as an Asian elephant deterrent method. We analyzed the behavioral reaction of seven captive Asian elephants when confronted with a fence of *A. mellifera* hives blocking their way to a desired source of food. In addition, we explored the defensive reaction of five *A. cerana* hives and six *A. mellifera* hives to an artificial disturbance during both day and night time. The elephants crossed the beehive fence in 51% of the cases, the probability of crossing increased over time and the number of exposures had a significant effect on an elephant's crossing probability, indicating that elephants became habituated to the presence of the beehive fence. In the bee experiment, only one out of five *A. cerana* hives and one out of six *A. mellifera* hives reacted to the disturbance during the daytime, while during nighttime, none of them reacted defensively after being disturbed. We, therefore, conclude that neither *A. mellifera* nor *A. cerana* bees are likely to be effective in deterring wild Asian elephants from entering crop fields.

M.E. England, P. Pearce-Kelly, V.A. Brugman, S. King, S. Gubbins, F. Sach, C.J. Sanders, N.J. Masters, E. Denison & S. Carpenter

Culicoides species composition and molecular identification of host blood meals at two zoos in the UK

Parasites & Vectors 13 (2020) e139

Abstract. *Culicoides* biting midges are biological vectors of arboviruses including bluetongue virus (BTV), Schmallenberg virus (SBV) and African horse sickness virus (AHSV). Zoos are home to a wide range of 'at risk' exotic and native species of animals. These animals have a high value both in monetary terms, conservation significance and breeding potential. To understand the risk these viruses pose to zoo animals, it is necessary to characterise the *Culicoides* fauna at zoos and determine which potential vector species are feeding on which hosts. Light-suction traps were used at two UK zoos: the Zoological Society of London (ZSL) London Zoo (LZ) and ZSL Whipsnade Zoo (WZ). Traps were run one night each week from June 2014 to June 2015. *Culicoides* were morphologically identified to the species level and any blood-fed *Culicoides* were processed for blood-meal analysis. DNA from blood meals was extracted and amplified using previously published primers. Sequencing was then carried out to determine the host species. A total of 11,648 *Culicoides* were trapped and identified (n = 5880 from ZSL WZ; n = 5768 from ZSL LZ), constituting 25 different species. The six putative vectors of BTV, SBV and AHSV in northern Europe were found at both zoos and made up the majority of the total catch (n = 10,701). A total of 31 host sequences were obtained from blood-fed *Culicoides*. *Culicoides obsoletus*/*C. scoticus*, *Culicoides dewulfi*, C*ulicoides parroti* and *Culicoides punctatus* were found to be biting a wide range of mammals including Bactrian camels, Indian rhinoceros, Asian elephants and humans, with *Culicoides obsoletus*/*C. scoticus* also biting Darwin's rhea. The bird-biting species, *Culicoides achrayi*, was found to be feeding on blackbirds, blue tits, magpies and carrion crows. To our knowledge, this is the first study to directly confirm blood-feeding of *Culicoides* on exotic zoo animals in the UK and shows that they are able to utilise a wide range of exotic as well as native host species. Due to the susceptibility of some zoo animals to *Culicoides*-borne arboviruses, this study demonstrates that in the event of an outbreak of one of these viruses in the UK, preventative and mitigating measures would need to be taken.

E. Evison, A. McKenzie & L. Holmes

Social and environmental impacts on sleep in captive Asian elephants (_Elephas maximus_)

Zoo Biology 39 (2020) 397-404

Abstract. Modern zoos strive to improve standards of animal management, husbandry and welfare of their animals as part of a continual evaluation process. Elephants (Elephantidae) have received particular attention in recent years due to the challenge of providing environments which promote natural behavior and opportunities for social interaction. A number of measures have been proposed to measure wellbeing, with sleep quality increasingly being used. Sleep is a vital aspect of life for cell replenishment as well as optimal development of young. Sleep deprivation can lead to immunosuppression and illness; therefore animal managers have a responsibility

to ensure they reduce the potential for disturbance through noise, light, or other environmental factors. The social environment also plays an essential role in wellbeing, particularly for species that live in multi - generational family units. In this study the nocturnal behavior of a multi - generational captive herd was observed to determine impacts of husbandry changes on sleep duration and bout length (measured as recumbent rest). As expected, average total duration of sleep was higher in younger elephants and rates were comparable to those reported in other studies of Asian elephants. Overnight access to an outdoor paddock in warmer weather increased overall average bout length of sleep in the herd. Average total duration of sleep also increased for the herd following the movement of an unrelated adult female who had previously shown weak bonds with other herd members. This indicates that social compatibility is a vital component of elephant welfare, impacting not only behavioral interactions but sleep quality and duration.

K.M. Ewart, A.L. Lightson, F.T. Sitam, J.J. Rovie-Ryan, N. Mather & R. McEwing

Expediting the sampling, decalcification, and forensic DNA analysis of large elephant ivory seizures to aid investigations and prosecutions

Forensic Science International: Genetics 44 (2020) e102187

Abstract. The illegal ivory trade continues to drive elephant poaching. Large ivory seizures in Africa and Asia are still commonplace. Wildlife forensics is recognised as a key enforcement tool to combat this trade. However, the time and resources required to effectively test large ivory seizures is often prohibitive. This limits or delays testing, which may impede investigations and/or prosecutions. Typically, DNA analysis of an ivory seizure involves pairing and sorting the tusks, sampling the tusks, powdering the sample, decalcification, then DNA extraction. Here, we optimize the most time-consuming components of this process: sampling and decalcification. Firstly, using simulations, we demonstrate that tusks do not need to be paired to ensure an adequate number of unique elephants are sampled in a large seizure. Secondly, we determined that directly powdering the ivory using a Dremel drill with a high-speed cutter bit, instead of cutting the ivory with a circular saw and subsequently powdering the sample in liquid nitrogen with a freezer mill, produces comparable results. Finally, we optimized a rapid 2 -h decalcification protocol that produces comparable results to a standard 3-day protocol. We tested/optimised the protocols on 33 raw and worked ivory samples, and demonstrated their utility on a case study, successfully identifying 94% of samples taken from 123 tusks. Using these new rapid protocols, the entire sampling and DNA extraction process takes less than one day and requires less-expensive equipment. We expect that the implementation of these rapid protocols will promote more consistent and timely testing of ivory seizures suitable for enforcement action.

P. Fernando, S.K.K. Ekanayaka & J. Pastorini

The elephant at the fence: Almsman, panhandler, friend or foe?

European J. of Wildlife Research 66 (2020) e97

Abstract. Feeding of wild Asian elephants at the Udawalawe National Park perimeter electric fence by the general public is longstanding. We monitored the elephants and feeding activities, and conducted questionnaire surveys of stakeholders. Over 50 individual adult male elephants engaged in the activity. The exclusive male presence was consistent with a high-risk high-gain male strategy. The elephants were mostly offered fruits and vegetables. Over a thousand people a day watched and fed the elephants. Most people bought food for elephants from roadside stalls and vendors had significantly more sales if elephants were present. The feeding of elephants brought significant economic benefit to communities bordering the park. We found the impacts of feeding on the elephants and environment to be largely neutral. Impacts on people and conservation were mainly positive. Actions taken by authorities to stop the feeding have targeted the elephants and resulted in the decrease of feeding but not its elimination. Managing the activity instead would help increase economic benefits and ensure safe interaction between people and elephants. Such management, by directly benefitting local communities, could make them partners in the conservation process and form the

basis of an effective outreach program. © 2020 The Authors.

A. Fuery, T. Pursell, J. Tan, R. Peng, P.D. Burbelo, G.S. Hayward & P.D. Ling

Lethal hemorrhagic disease and clinical illness associated with elephant endotheliotropic herpesvirus 1 are caused by primary infection: Implications for the detection of diagnostic proteins

Journal of Virology 94 (2020) e01528-19

Abstract. Elephant endotheliotropic herpesvirus (EEHV) can cause lethal hemorrhagic disease in juvenile Asian elephants, both in captivity and in the wild. Most deaths associated with the virus are caused by two chimeric variants of EEHV1 (EEHV1A and EEHV1B), while two other EEHVs endemic within Asian elephants (EEHV4 and EEHV5) have been recognized but cause death less often. Whether lethal EEHV infections are due to primary infection or reactivation of latent virus remains unknown, and knowledge of the anti-EEHV antibody levels in young elephants is limited. To close these gaps, we sought to develop a serologic assay capable of distinguishing among infections with different EEHVs using a luciferase immunoprecipitation system (LIPS) for antibody profiling and a panel of conserved EEHV recombinant proteins and proteins unique to EEHV1. The results showed that elephants dying from EEHV1 hemorrhagic disease or ill from EEHV infection were seronegative for the EEHV species that caused the disease or illness, indicating that the events were associated with primary infection rather than reactivation of latent virus. We also demonstrated that waning of EEHV1-specific antibodies can occur in the first 2 years of life, when a threshold protective level of antibody may be needed to prevent severe EEHV1-related disease. Use of the LIPS assay to identify putative "diagnostic" proteins would be a valuable asset in determining the EEHV immune status of young elephants and responses to candidate EEHV vaccines in the future. Whether clinical illness and deaths associated with elephant endotheliotropic herpesvirus (EEHV) infection result from primary infection or reactivation of latent virus is a longstanding question in the field. By applying a relatively new assay, the luciferase immunoprecipitation system (LIPS), combined with the genomic sequences of the viruses, we gained the insights and tools needed to resolve this issue. Our EEHV1-specific LIPS assay should be useful for assessing the vulnerability of elephant calves to infection with different EEHVs and evaluating antibody responses to anti-EEHV vaccines. A significant proportion of the Asian elephant population is under some form of human care. Hence, the ability to screen for EEHV immune status in elephant calves should have a major impact on the management of these animals worldwide. © 2020 The Authors.

S.S. Glaeser, K.L. Edwards, N. Wielebnowski & J.L. Brown

Effects of physiological changes and social life events on adrenal glucocorticoid activity in female zoo-housed Asian elephants (*Elephas maximus*)

PLoS ONE 15 (2020) e0241910

Abstract. Ensuring good health and welfare is an increasingly important consideration for conservation of endangered species and includes breeding of individuals managed under human care. Understanding how factors in the captive environment affect individual animal wellbeing can be aided by long-term monitoring of biological functioning. This study involved longitudinal assessments (4 to 28 years) of reproductive and adrenal hormones in zoo-housed female Asian elephants (*Elephas maximus*) (age range 4 to ~71 years) to elucidate patterns in adrenal glucocorticoid (GC) activity in association with reproductive and demographic factors, and examine individual response to major social changes. Concentrations of serum and urinary cortisol covaried more consistently with physiological changes (ovarian cycle phase, puberty, pregnancy, lactational anestrus, and age) than with social life events (births, deaths, and facility transfers). Cortisol fluctuated across the ovarian cycle with mean concentrations being higher in the follicular than in the luteal phase, and concentrations were highest in lactational anestrous compared to all other reproductive states. The elephants in this study exhibited substantial individuality in adrenal GC response to major social change, reinforcing the need to assess welfare on an individual

basis and to consider factors influencing the impact of perceived stressors, such as social relationships, social support, temperament, and life history. Outcomes from this study deepen our understanding of Asian elephant physiology and highlight the importance of taking intrinsic patterns of hormone secretion into account when evaluating the impact of external factors. Finally, a better understanding of the impact of social change and resiliency in response to real and perceived stressors allows us to improve social management to enhance welfare in both captive settings and free-ranging environments.

B.G. Grenus, E. Latimer, A. Cullinane, P. Lyons, G. Creighton & F.B. Nutter

Evaluation of the efficacy of two different sampling sites for the detection of elephant endotheliotropic herpesvirus (EEHV) in three Asian elephant (*Elephas maximus*) in Ireland

Journal of Zoo and Wildlife Medicine 51(2020) 303-307

Abstract. Elephant endotheliotropic herpesvirus (EEHV) causes a disease that primarily affects juvenile Asian (*Elephas maximus*) elephants, causing acute hemorrhage and death. Due to the severity of the disease, many zoos have developed EEHV active surveillance programs. Currently, trunk washes are the standard for testing elephants for shedding of EEHV, but it has also been detected from other mucosal surfaces. This study compared the efficacy of oral swabs and trunk washes for the detection of EEHV shedding using previously validated quantitative polymerase chain reaction (qPCR) methods. Oral swab and trunk wash samples from three juvenile elephants at the Dublin Zoo in Ireland were collected in tandem and tested from April to September 2017. Of the 51 paired samples, 21 trunk wash samples were positive for EEHV1, while only 2 of the oral swab samples were positive for EEHV1, suggesting that trunk wash samples are more effective for detecting shedding of EEHV in Asian elephants compared with oral swabs. © 2020 American Association of Zoo Veterinarians.

C. He, J. Du, D. Zhu & L. Zhang

Population viability analysis of small population: A case study for Asian elephant in China

Integrative Zoology 15 (2020) 350-362

Abstract. Small populations are at risk of extinction from deterministic and stochastic factors. Less than 250 Asian elephants (*Elephas maximus*) remain in China, and are distributed in a few isolated areas; yet, population viability analyses of this endangered population have not been conducted. Here, the current genetic status of the Pu'Er-Mengyang Asian elephant populations in China was analyzed, and the risk of extinction was predicted over the next 500 years. Factors affecting the viability of this population were determined through simulations. The genetic diversity of the population was very low (mean allele number: 3.1; expected heterozygosity: 0.463), even though a recent population bottleneck was not detected. The effective population size was approximately 24.1 adult elephants. Enough adult breeding individuals exist to maintain population viability. VORTEX simulation model showed that this population would not go extinct in the next 500 years. However, illegal poaching and harvesting could negatively affect population size. A sensitivity analysis showed that the mean stochastic growth rate of the study population is sensitive to sex ratio, number of breeding females, mortality of females of different age classes, carrying capacity, and lethal equivalents. Based on our results, we suggest that action should be taken to alleviate inbreeding and any further loss of genetic diversity, by connecting fragmented elephant habitat or by translocating individual elephants. In addition, human-elephant conflict should be mitigated using various modern approaches, including crop guarding techniques, and by encouraging farmers to switch to crops and income sources not vulnerable to elephant raids. © 2020 International Society of Zoological Sciences, Institute of Zoology/ Chinese Academy of Sciences and John Wiley & Sons.

P. Hengtrakul, P. Sudlapa, N. Chaisurat, S. Sodsaengthien, C. Chamnankij, S. Noimoon, C. Punkong, S. Phatthanakunanan, P. Lertwatcharasarakul & S. Sripiboon

Biological and environmental factors associated with the detection of elephant endotheliotropic herpesvirus in Asian elephants (*Elephas maximus*) in Thailand

Journal of Veterinary Medical Science 82 (2020) 1808-1815

Abstract. Elephant endotheliotropic herpesvirus (EEHV) infection is one of the most common diseases in young elephants, causing severe fatal hemorrhagic disease. Subclinical infection was previously described; however, information about the factors associated with virus shedding and reactivation were scarce. To identify the biological and environmental factors related with EEHV detection, blood and oral swab samples were collected from nine captive Asian elephants in Thailand for one year and tested for EEHV presence using real-time PCR. Data including hematological values, management, environmental temperature, and serum cortisol levels were also recorded and analyzed. Results showed that the viral detection frequency ranged from 0–25%. The highest detection frequency was found in the two youngest elephants, aged less than 15 years. Three types of viruses, EEHV1, EEHV4, and EEHV5, were found in this study, which also detected mixed infection in five elephants. Additionally, the study found that sample type, changes in hematological values, management and health issues, and serum cortisol levels were not associated with herpesvirus detection in the elephants. However, EEHV detection percentage was significantly increased in the summer (mid-Feb to mid-May), possibly due to body fitness reduction from food source limitation and low nutrient content. To obtain a broad aspect of EEHV management, long-term EEHV monitoring is highly recommended in every captive elephant herd. © 2020 The Japanese Society of Veterinary Science.

C. Huang, X. Li, W. Hu & X. Jiang

Predicting indirect effects of transportation network expansion on Asian elephants: Implications for environmental impact assessments

BioTropica 52 (2020) 196-202

Abstract. The rapid proliferation of transportation networks (TNs) threatens the viability of species with wide geographic ranges via habitat fragmentation, road kill, and indirect socio-ecological interactions. Environmental impact assessments of TNs are mostly descriptive and focus on the direct impacts of the linear features of TNs, while the indirect and cumulative impacts are largely neglected. Using spatially explicit data of elephant-caused damage from 2012 to 2015 in southwest China, we quantified the barrier effects of TNs on Asian elephant populations and predicted future patterns of damage under a TN expansion scenario using maximum entropy algorithms. The TNs acted as a strong barrier for the elephants, even in herds that have inhabited highly fragmented landscapes for years. Overall damage patterns were highly asymmetric around roads, with only 18% of events occurring on the far side of roads (relative to the core home range). Models predicted that TN expansion would reduce elephant habitats, exacerbating herd isolation and human-elephant conflict locally. Thus, we suggest that future environmental impact assessments should integrate mitigation of indirect conflicts. © 2019 The Association for Tropical Biology and Conservation.

J. Jackson, K.U. Mar, W. Htut, D.Z. Childs & V. Lummaa

Changes in age-structure over four decades were a key determinant of population growth rate in a long-lived mammal

Journal of Animal Ecology 89 (2020) 2268-2278

Abstract. A changing environment directly influences birth and mortality rates, and thus population growth rates. However, population growth rates in the short term are also influenced by population age-structure. Despite its importance, the contribution of age-structure to population growth rates has rarely been explored empirically in wildlife populations with long-term demographic data. Here we assessed how changes in age-structure influenced short-term population dynamics in a semi-captive population of Asian elephants *Elephas maximus*. We addressed this question using a demographic dataset of female Asian elephants from timber camps in Myanmar spanning 45 years (1970–2014). First, we explored temporal variation in age-structure. Then, using annual matrix population models, we used a retrospective approach to assess the contributions of age-structure and vital rates to short-term population growth rates with respect to the average environment. Age-structure was highly variable over the study period, with large proportions of juveniles in the years 1970 and

1985, and made a substantial contribution to annual population growth rate deviations. High adult birth rates between 1970 and 1980 would have resulted in large positive population growth rates, but these were prevented by a low proportion of reproductive-aged females. We highlight that an understanding of both age-specific vital rates and age-structure is needed to assess short-term population dynamics. Furthermore, this example from a human-managed system suggests that the importance of age-structure may be accentuated in populations experiencing human disturbance where age-structure is unstable, such as those in captivity or for endangered species. Ultimately, changes to the environment drive population dynamics by influencing birth and mortality rates, but understanding demographic structure is crucial for assessing population growth.

S. Jakeer, M. Varma, J. Sharma, F. Mattoo, D. Gupta, J. Singh, M. Kumar & N.A. Gaur

Metagenomic analysis of the fecal microbiome of an adult elephant reveals the diversity of CAZymes related to lignocellulosic biomass degradation

Symbiosis 81 (2020) 209-222

Abstract. No permission to print abstract.

A. Jeffrey, T.S. Evans, C. Molter, L.L. Howard, P. Ling, T. Goldstein & K. Gilardi

Noninvasive sampling for detection of elephant endotheliotropic herpesvirus and genomic DNA in Asian (*Elephas maximus*) and African (*Loxodanta africana*) elephants

Journal of Zoo and Wildlife Medicine 51 (2020) 433-437

Abstract. Elephant endotheliotropic herpesvirus (EEHV) hemorrhagic disease (EEHV-HD) threatens Asian elephant (*Elephas maximus*) population sustainability in North America. Clusters of cases have also been reported in African elephants (*Loxodonta africana*). Risk to range country elephant populations is unknown. Currently, EEHV detection depends upon sampling elephants trained for invasive blood and trunk wash collection. To evaluate noninvasive sample collection options, paired invasively collected (blood, trunk wash and oral swabs), and noninvasively collected (chewed plant and fecal) samples were compared over 6 wk from 9 Asian elephants and 12 African elephants. EEHV shedding was detected simultaneously in a paired trunk wash and fecal sample from one African elephant. Elephant γ herpesvirus-1 shedding was identified in six chewed plant samples collected from four Asian elephants. Noninvasively collected samples can be used to detect elephant herpesvirus shedding. Longer sampling periods are needed to evaluate the clinical usefulness of noninvasive sampling for EEHV detection. © 2020 American Association of Zoo Veterinarians.

F. Jiang, P. Song, J. Zhang, Z. Cai, X. Chi, H. Gao, W. Qin, S. Li & T. Zhang

Assessing the impact of climate change on the spatio-temporal distribution of foot-and-mouth disease risk for elephants

Global Ecology and Conservation 23 (2020) e01176

Abstract. Elephants are the largest extant terrestrial animals and are important for maintaining regional ecosystem balance and community diversity. However, poaching, population growth, habitat fragmentation, and viruses are major threats to global elephant populations. Foot-and-mouth disease (FMD) is one of the major threats to the health of elephants. Global warming has a serious impact on wildlife and accelerates the spread of viruses. In this study, the effects of climate change on the risk of disease in elephants were evaluated based on 1833 sites with reported FMD cases. Maximum entropy (MaxEnt) was used to model the current and future geographic distributions of FMD and to assess the risk of FMD in elephants under climate change. The results showed that the average annual temperature and annual precipitation were higher in elephant habitats than in the range of the FMD virus. The mean temperature in the driest quarter, temperature seasonality, annual mean temperature, and precipitation in the driest month had relatively large contributions to the risk of FMD, with a cumulative contribution rate of 82.8%. Both Asian elephants and African elephants had high overlap with the FMD virus with respect to altitude, annual mean temperature, and annual precipitation. An overall high risk of disease was detected at a certain band, mainly concentrated from 10°N to 50°N in the

northern hemisphere and from 10°S to 35°S in the southern hemisphere. The risk of FMD was higher for the Asian elephant than the African elephant. The FMD risk increased gradually from the southeast to northwest in habitats of the Asian elephant, and presented a pattern of high north–south risk and low intermediate risk in the habitats of the African elephant. The area proportions of high risk, medium risk, and low risk in the distribution of both the Asian elephant and African elephant were all higher than the proportions of all risk types worldwide. Under global warming, the FMD risk was not expected to change significantly in most of the habitat areas of the Asian elephant or the African elephant in the 2050s and 2070s. Moreover, the areas and proportions of high risk, medium risk, and low risk were likely to change slightly. These results could benefit the conservation of elephants and provide relevant data for the prevention of FMD in high-risk areas under climate change.

T. Kalam, T.A. Puttaveeraswamy, R.K. Srivastava, J.-P. Puyravaud & P. Davidar

Spatial aggregation and specificity of incidents with wildlife make tea plantations in southern India potential buffers with protected areas

Journal of Threatened Taxa 12 (2020) 16478-93

Abstract. Many wildlife species survive in human-modified landscapes and understanding the opinions of those who share space with wildlife will aid conservation efforts. Using a questionnaire, we assessed the presence of 12 mammal species in 78 tea plantations in the Nilgiris, southern India. We obtained data on (i) plantation size, location, and elevation, (ii) species presence over a year, (iii) type and number of wildlife incidents caused, (iv) financial cost of wildlife damage, and (v) support for wildlife conservation. We used a generalized linear model to assess whether the distance to protected areas, elevation, and plantation size influenced species presence and the effect of these variables and wildlife incidents on support for conservation. Among all species reported, Bonnet Macaque, Wild Boar, and Porcupine were the most widespread, and the former two and the Gaur reportedly caused >50% of damages. Crop damage was the most frequent (74%, n = 244), whereas livestock predation, attacks on people, and infrastructure damage constituted <10% of incidents reported. The cost of wildlife damage was negligible for 72 estates and significant for six. The number of species increased with proximity to protected areas, with increasing elevation and plantation area. Plantation management (62%) supported wildlife conservation, and support increased with decreasing plantation size, increasing distance to protected areas, and with a higher number of species reported, but decreased with increasing incidents of wildlife damage. Mitigating impacts of a few widely distributed species that cause disproportionate damage and compensating those that incur disproportionately high costs could increase support for conservation. Education and awareness programs for the plantation community can further help increase support and participation in wildlife conservation activities. Plantations can thus serve as supplementary habitats for wildlife in regions where hard boundaries between protected areas and human settlements prevail.

T. Kanazawa, N. Nishimura, S. Hanzawa, M. Andou, Y. Shoji, M. Senzaki & K. Murata

Changes in the activity budget of captive Asian elephants (*Elephas maximus*) after introducing an automatic feeder

Animal Behaviour and Management 56 (2020) 63-70

Abstract. [Main text in Japanese] Introduction of feeding enrichment for captive elephants is necessary during the time zone (17:00 to 8:00 the next morning) when there are no staff working. The effects of an unmanned feeding device (automatic feeder) were verified for individuals housed and managed at the Kanazawa Zoological Gardens at Yokohama. The automatic feeder was designed such that, when activated, the branches and leaves that were hung from chains were fed in front of the indoor enclosure. The feeder was activated twice, once each in the night (18:00-20:00) and the early morning (5:00-7:00). Treatment 1 was performed at a fixed time and Treatment 2 was performed at varying times every day. In both treatments, no effect was observed at night. In the early morning, an increase in feeding and decrease in stereotypical behavior were

observed, confirming the effectiveness of the automatic feeder. In addition, at night, the later the activation time of the automatic feeder, the less effective it was. Therefore, it was considered necessary to improve the timing of operation and the frequency of use for better efficiency of the automatic feeder.

P. Keerthipriya, S. Nandini, H. Gautam, T. Revathe & T.N.C. Vidya

Musth and its effects on male-male and male-female associations in Asian elephants

Journal of Mammalogy 101 (2020) 259-270

Abstract. Musth is an annual, asynchronous, rut-like phenomenon observed in male elephants. We examined whether musth is a roving strategy, and whether musth provides a temporary advantage to young males through increased access to female groups. We collected long-term data on the musth status, associations, and locations of male elephants in the Kabini population in southern India. We sighted older males more frequently in musth than younger males. We found a greater turnover of musth than non-musth males in the study area, suggesting that musth is a roving strategy, enabling males to travel widely and away from their non-musth range. Contrary to our expectation, young (15–30 years old) males spent a smaller proportion of their musth time than their non-musth time associating with females, and associated with similarly sized female groups irrespective of musth status. Old (> 30 years old) males spent only a slightly higher proportion of their musth time than non-musth time with female groups, but associated with larger female groups during musth. Although old males in musth associated with young non-musth males more often in the presence, than in the absence, of females, young males in musth were never sighted with old non-musth males in the presence of females. Therefore, the payoff from musth, as a strategy to gain access to females, was age-specific; musth in old males allowed for increased association with females, while musth in young males restricted their access to females. There was no spatial avoidance between musth and non-musth adult males at scales larger than immediate associations. Our results suggest that musth seems to be primarily a roving strategy for old males to find and associate with females and not a strategy for young males to gain a temporary advantage over old males, within the broad age-classes that we examined.

D. Naha, S.K. Dash, A. Chettri, A. Roy & S. Sathyakumar

Elephants in the neighborhood: Patterns of crop-raiding by Asian elephants within a fragmented landscape of Eastern India

PeerJ 8 (2020) e9399

Abstract. Loss of forest cover, rise in human populations and fragmentation of habitats leads to decline in biodiversity and extinction of large mammals globally. Elephants, being the largest of terrestrial mammals, symbolize global conservation programs and co-occur with humans within multiple-use landscapes of Asia and Africa. Within such shared landscapes, poaching, habitat loss and extent of human-elephant conflicts (HEC) affect survival and conservation of elephants. HEC are severe in South Asia with increasing attacks on humans, crop depredation and property damage. Such incidents reduce societal tolerance towards elephants and increase the risk of retaliation by local communities. We analyzed a 2-year dataset on crop depredation by Asian elephants (N = 380) events in North Bengal (eastern India). We also explored the effect of landscape, anthropogenic factors (area of forest, agriculture, distance to protected area, area of human settlements, riverine patches and human density) on the spatial occurrence of such incidents. Crop depredation showed a distinct nocturnal pattern (22.00–06:00) and majority of the incidents were recorded in the monsoon and post-monsoon seasons. Results of our spatial analysis suggest that crop depredation increased with an increase in the area of forest patches, agriculture, presence of riverine patches and human density. Probability of crop depredation further increased with decreasing distance from protected areas. Villages within 1.5 km of a forest patch were most affected. Crop raiding incidents suggest a deviation from the "high-risk high-gain male biased" foraging behavior and involved proportionately more mixed groups (57%) than lone bulls (43%). Demographic data suggest that mixed groups comprised an average of 23 individuals with adult and sub adult females, bulls

and calves. Crop depredation and fatal elephant attacks on humans were spatially clustered with eastern, central and western parts of North Bengal identified as hotspots of HEC. Our results will help to prioritize mitigation measures such as prohibition of alcohol production within villages, improving condition of riverine patches, changing crop composition, fencing agriculture fields, implement early warning systems around protected areas and training local people on how to prevent conflicts. © 2020 The Authors.

Alireza Nasoori

Tusks, the extra-oral teeth

Archives of Oral Biology 117 (2020) e104835

Abstract. The present review aims to: a) describe the features that support tusks in extra-oral position, and b) represent distinctive features of tusks, which provide insights into tusks adaptation to ambient conditions. A comprehensive review of scientific literature relevant to tusks and comparable dental tissues was conducted. The oral cavity provides a desirable condition which is conducive to tooth health. Therefore, it remains questionable how the bare (exposed) tusks resist the extra-oral conditions. The common features among tusked mammals indicate that the structural (e.g. the peculiar dentinal alignment), cellular (e.g. low or lack of cell populations in the tusk), hormonal (e.g. androgens), and behavioral traits have impact on a tusk's preservation and occurrence. Understanding of bare mineralized structures, such as tusks and antlers, and their compatibility with different environments, can provide important insight into oral biology. © 2020 Reprinted with permission from Elsevier.

D. Neupane, Y. Kwon, T.S. Risch & R.L. Johnson

Changes in habitat suitability over a two decade period before and after Asian elephant recolonization

Global Ecology and Conservation 22 (2020) e01023

Abstract. Habitat degradation has caused a significant threat to wildlife, particularly to megafauna including the Asian elephant that has a large home range. Recolonization of Asian elephants in 1994 in and around Bardia National Park (BNP) has provided a unique study setting to address habitat change over two decades (1990–2013). Elephant presence data in 2013 was modeled using Ecological Niche Factor Analysis (ENFA), which identified the influential ecogeographical variables for elephant habitat. These variables were further used in a regression model to determine habitat suitability for 1990. We found that elephant suitable habitat has been lost between pre-recolonization (1990) and the year 2013 in and around BNP. Unsuitable elephant habitat increased overall by 22% in Bardia District and 20% inside BNP. Central to elephant habitat loss has been a large human population growth, re-forestation efforts with an increase in sal forests, and elephant alteration of vegetation by grazing. Available suitable habitat for elephants in and around BNP should be conserved and managed to prevent further degradation for the maintenance of the elephant population, which will help mitigate human-elephant conflict in the region. © 2020 The Authors.

S. Ngamkala, T. Angkawanish, W. Nokkaew & N. Thongtip

Serological study on brucellosis in captive elephants (*Elephas maximus*) and stray dogs in North Thailand

Veterinary World 13 (2020) 1992-1997

Abstract. Brucellosis is considered as an important zoonotic disease caused by various strains of *Brucella* in numerous host species. Although brucellosis has been reported in almost animal species, the relevance of brucellosis infection and diagnostic technique in Asian elephant (*Elephas maximus*) has been limited. The present serological investigation aimed to investigate the antibody response to *Brucella abortus* in captive Asian elephants in North Thailand. Moreover, further serological survey was also conducted to detect the antibody response to *Brucella canis* in stray dogs cohabiting the same area as the elephant herd. Serum samples were collected from 40 captive Asian elephants and submitted for serological analysis based on *B. abortus* antigen using Rose Bengal plate test (RBPT) in combination with ethylenediaminetetraacetic acid-tube agglutination test (EDTA-TAT) as a supplementary test and by commercial indirect enzyme-linked immunosorbent assay (iELISA). In addition, serum samples were also obtained

from 16 stray dogs that live nearby the elephant-raising area and were tested using commercial Dot-ELISA based on *B. canis* antigen. Serological analysis in captive Asian elephants showed 100% seronegative (40/40) from all serological tests response to *B. abortus*. For stray dogs, 12.5% (2/16) had a low positive reaction response to *B. canis*. The serological survey for brucellosis in Asian elephant was adapted and applied using RBPT, EDTA-TAT, and iELISA in the present study. For future evaluation, we recommended the use of a combination of serological tests with validation together with comparing by direct detection such as bacterial isolation to provide an appropriate brucellosis surveillance program in Asian elephants. In addition, the surveillance of stray dogs or multispecies habitation should be kept into considerations.

I.M. Permata & E. Wahyuni

Behind the Ivory Trade Shutdown in China

Journal of International Wildlife Law & Policy 23 (2020) 151-165

Abstract. Despite being a party to CITES, China remains active in the ivory trade. A Chinese norm identifies ivory as "white gold," resulting in China becoming a main destination market for illegal ivory. Not only is ivory a form of investment in China, but it is also a part of cultural heritage. As a result, the government continues to support preservation of ivory in the country. This activity will trigger the high rate of elephant ivory hunting in the world, which frustrates the goal of CITES regulations. Finally, in December 2017, China claimed to have officially closed the ivory market. This article discusses what conditions drove China to close its ivory trade. This article applies a data-driven, qualitative approach. This article argues that China decided to close its ivory market to convince the world that China respects and complies with international norms, especially regarding animal protection.

K.L. Perrin, A.T. Kristensen, C. Gray, S.S. Nielsen, M.F. Bertelsen & M. Kjelgaard-Hansen

Biological variation of hematology and biochemistry parameters for the Asian elephant (*Elephas maximus*), and applicability of population-derived reference intervals

Journal of Zoo and Wildlife Medicine 51 (2020) 643-651

Abstract. The aim of this study was to objectively evaluate the biological variation of healthy Asian elephant (*Elephas maximus*) hematology and biochemistry parameters, therefore enabling evidence-based clinical decision-making to improve patient management. Ten clinically healthy elephants had blood samples collected weekly for 5 wk under standardized conditions. The analytical, between- and within-individual variation, index of individuality, and reference change values were calculated using previously reported methods. Large between-individual variation and small within-individual variation for almost all parameters indicated that individual normal values should be used for interpreting blood results from Asian elephants.

A. Pinto, M. Stelvig, C. Costa, J. Colaço & B. Colaço

Influence of male presence on female Asian elephants (*Elephas maximus*) behaviour in captivity

Journal of Zoo and Aquarium Research 8 (2020) 45-49

Abstract. The maintenance of natural behaviour in captivity is relevant for optimizing animal welfare and reproductive efficiency. In captivity, few studies have evaluated the male's influence on the behaviour of Asian females' elephants (*Elephas maximus*). Therefore, we investigated foraging, standing, elimination, vocalization, courtship, mating and stereotypic behaviours in four female Asian elephants after the recent introduction of a dominant male. Elephant activity was video recorded and behavioural data were collected through observing video footage. In male's presence, females spent less time foraging and more time standing ($p<0.05$). Although differences were not statistically significative, an increased elimination behaviour frequency was also observed when the male was present. Females also performed more vocalisations ($p<0.05$) in male's presence. Behaviours, such as courtship and mating, were highly correlated ($r=0.793$ and $p<0.05$), demonstrating that both sexes were performing sexual behaviours. The females also exhibited less frequently stereotypic

behaviours when the male was present (5.6% of the time) than when he was absent (26.8% of the time) ($p<0.05$). Therefore, we have shown that in captivity female elephants behave in a male's presence as their wild conspecifics, which is beneficial for their conservation and well-being. It can be concluded that temporary integration of a male elephant in a female group in captivity has a positive influence on females, leading them to perform less stereotypies and to promote their reproductive behaviours. Further studies should be performed to enhance the knowledge on male's influence in female welfare in captivity.

T.G.S.L. Prakash, W.A.A.D.U. Indrajith, A.M. C.P. Aththanayaka, S. Karunarathna, M. Botejue, V. Nijman & S. Henkanaththegedara

llegal capture and internal trade of wild Asian elephants (*Elephas maximus*) in Sri Lanka

Nature Conservation 42 (2020) 51-69

Abstract. The illegal wildlife trade is considered one of the major threats to global biodiversity. Asian elephants (*Elephas maximus*) have been highly valued by various cultures for use in religious and spiritual contexts, as a draft animal, and more recently, as a tourist attraction. Thus, the demand for captive elephants is high. Wild Asian elephants are taken from the wild, often illegally, to maintain these captive populations due to the unviability of captive breeding programs. For the first time, we documented the extent to which wild elephants are being illegally captured and traded in Sri Lanka between January 2008 and December 2018. We collected data from case records maintained by the Sri Lanka court system where the suspects of illegal elephant trade were prosecuted in addition to information gathered by archives and interviews with various stakeholders. We documented 55 cases where elephants were illegally traded. This is probably an underestimate due to the mortality rate of elephants during capture operations, and challenges in collecting data on this highly organized illicit trade. Nearly equal numbers of male and female elephants were traded and more than 50% of them were juveniles, aged ≤5 years. Significantly more elephants were found to be seized in 2014–2015 than in the other time periods combined. We found evidence of the illegal capture of wild elephants from wildlife protected areas and state forests. More importantly, we identified evidence of corruption of wildlife officers, involvement of politicians and other high-ranking personnel in the illegal wildlife trade, and lack of active enforcement of wildlife law as major challenges to overcome if the illegal capture and domestic trade of wild elephants in Sri Lanka are to be halted. Based on our study, we make a series of recommendations that should result in implementing policy to reduce the trafficking of Asian elephants in Sri Lanka and improve the conservation management of the species.

K. Puri, R. Joshi & V. Singh

Open garbage dumps near protected areas in Uttarakhand: An emerging threat to Asian Elephants in the Shivalik Elephant Reserve

Journal of Threatened Taxa 12 (2020) 16571-75

Abstract. Waste dumping sites near protected areas are a growing issue, which may affect the activities and behaviour of wildlife, more than what we notice. Here, we present two of our case studies, where Asian elephants were found feeding at garbage dumps in Haridwar and Ramnagar forest divisions in the Shivalik Elephant Reserve in Uttarakhand State. Since garbage dumps may spread bacterial infection and induce adverse changes in the health conditions of the elephant population, we draw the attention of planners to develop a plan of action for proper disposal of the garbage through these preliminary observations, without affecting protected areas and wildlife species, including elephants. Moreover, collection of data on the presence of garbage dumps across the reserve and a study on the behavioural responses of scavenging and non-scavenging animals visiting the dumps would give us a better understanding of the level of impact of garbage dumps for disposal planning. It is to emphasize that garbage does not constitute a part of natural food for elephants. There are restrictions and guidelines in the Indian Wildlife (Protection) Act 1972, Solid Waste Management Rules, 2016 and Guidelines for Declaration of Eco-Sensitive Zones around National Parks and Wildlife Sanctuaries.

S. Reichert, V. Berger, J. Jackson, S.N. Chapman, W. Htut, K.U. Mar & V. Lummaa

Maternal age at birth shapes offspring life-history trajectory across generations in long-lived Asian elephants

Journal of Animal Ecology 89 (2020) 996-1007

Abstract. Advanced maternal age at birth can have pronounced consequences for offspring health, survival and reproduction. If carried over to the next generation, such fitness effects could have important implications for population dynamics and the evolution of ageing, but these remain poorly understood. While many laboratory studies have investigated maternal age effects, relatively few studies have been conducted in natural populations, and they usually only present a "snapshot" of an offspring's lifetime. In the present study, we focus on how maternal age influences offspring life-history trajectories and performance in a long-lived mammal. We use a multigenerational demographic dataset of semi-captive Asian elephants to investigate maternal age effects on several offspring life-history traits: condition, reproductive success, and overall survival. We show that offspring born to older mothers display reduced overall survival but higher reproductive success, and reduced survival of their own progeny. Our results show evidence of a persistent effect of maternal age on fitness across generations in a long-lived mammal. By highlighting transgenerational effects on the fitness of the next generation associated with maternal age, the present study helps increase our understanding of factors contributing to individual variation in ageing rates and fitness. © 2019 The Authors & British Ecological Society.

M. Ruetten, H.W. Steinmetz, M. Thiersch, M. Kik, L. Vaughan, S. Altamura, M.U. Muckenthaler & M. Gassmann

Iron regulation in elderly Asian elephants (*Elephas maximus*) chronically infected with *Mycobacterium tuberculosis*

Frontiers in Veterinary Science 7 (2020) e596379

Abstract. Restriction of nutrients to pathogens (nutritional immunity) is a critical innate immune response mechanism that operates when pathogens such as *Mycobacterium tuberculosis* have the potential to evade humoral immunity. Tuberculosis is of growing concern for zoological collections worldwide and is well-illustrated by infections of Asian and African elephants, where tuberculosis is difficult to diagnose. Here, we investigated hematological parameters and iron deposition in liver, lung, and spleen of three Asian elephants (*Elephas maximus*) infected with *Mycobacterium tuberculosis*. For reference purposes, we analyzed tissue samples from control *M. tuberculosis*-negative elephants with and without evidence of inflammation and/or chronic disease. Molecular analyses of bacterial lesions of post mortally collected tissues confirmed *M. tuberculosis* infection in three elephants. DNA sequencing of the bacterial cultures demonstrated a single source of infection, most likely of human origin. In these elephants, we observed moderate microcytic anemia as well as liver (mild), lung (moderate) and spleen (severe) iron accumulation, the latter mainly occurring in macrophages. Macrophage iron sequestration in response to infection and inflammation is caused by inhibition of iron export via hepcidin-dependent and independent mechanisms. The hepatic mRNA levels of the iron-regulating hormone hepcidin were increased in only one control elephant suffering from chronic inflammation without mycobacterial infection. By contrast, all three tuberculosis-infected elephants showed low hepcidin mRNA levels in the liver and low serum hepcidin concentrations. In addition, hepatic ferroportin mRNA expression was high. This suggests that the hepcidin/ferroportin regulatory system aims to counteract iron restriction in splenic macrophages in *M. tuberculosis* infected elephants to provide iron for erythropoiesis and to limit iron availability for a pathogen that predominantly proliferates in macrophages. Tuberculosis infections appear to have lingered for more than 30 years in the three infected elephants, and decreased iron availability for mycobacterial proliferation may have forced the bacteria into a persistent, non-proliferative state. As a result, therapeutic iron substitution may not have been beneficial in these elephants, as this therapy may have enhanced progression of the infection. © 2020 The Authors.

Sanjit Kumar Saha

Innovative way of human-elephant com-

petition mitigation
Journal of Threatened Taxa 12 (2020) 16494-501
Abstract. The negative interaction between humans and elephants is often referred to as conflict, however it is also seen as competition. Human-elephant competition (HEC) is a major protection threat in the fringe villages of the Jaldapara National Park (JPNP) of West Bengal, India. JPNP is facing challenges from the highly populated fringe villages, which exist in elephant corridors. Between 2015 and 2018 there were 12 elephant deaths. During the same period elephants caused 34 human deaths. As per data, most of the elephant interactions occurred in the fringe villages of Madarihat and Jaldapara North Range. Per reports of human deaths, Chekamari and Khairbari villages of Madarihat Range are in the most vulnerable list. Most of the human deaths occurred in the early morning (05.00–06.00 h) and in the evening, when people are going outside for open defecation (OD). On a pilot basis Chekamari and Khairbari villages of Madarihat Range were selected for a door to door household survey with the objective to develop an innovative strategy as a mitigation measure of HEC. The results of the survey show that both villages are tribal and minority population, the socio-economic condition of the people is very poor, on an average 5–6 members are in each household, the source of drinking water is a community well for most of the households, and 50 households are devoid of toilet facilities so automatically the members of those households go outside for OD. Out of the total human deaths, 16 occurred in the Madarihat area; out of these 16 cases, six were from the Chekamari and Khairbari villages. For this reason, between April 2019 to September 2019, with available funds 20 toilets with tube-well were built in the 20 neediest households of these two villages. Due to the communication with the community, behavioural changes were made and their participation for 100% usage of those toilets was assured. After the construction of the toilets until now, no human death cases have been reported.

O. Saif, R. Kansky, A. Palash, M. Kidd & A.T. Knight
Costs of coexistence: Understanding the drivers of tolerance towards Asian elephants *Elephas maximus* in rural Bangladesh
Oryx 54 (2020) 603-611
Abstract. Habitat degradation and fragmentation have heightened the importance of understanding human tolerance towards wildlife, as the fate of wildlife in multi-use landscapes depends on people's capacity for coexistence. We applied the wildlife tolerance model to examine drivers of tolerance towards Asian elephants *Elephas maximus* in rural Bangladesh, interviewing local people in 17 villages. We used structural equation modelling to identify causal pathways in which elephant-related exposure, positive and negative interactions, costs and benefits (tangible and intangible) contributed to tolerance. Contrary to expectations, monetary costs were non-significant in shaping tolerance despite major impacts on livelihoods. Instead, intangible costs and intangible benefits were significant factors determining tolerance. Furthermore, reducing people's exposure to elephants would not necessarily affect tolerance, nor would increasing positive interactions. We discuss how the socio-economic and bio-cultural dynamics of local communities can explain these results, and demonstrate how our model can be used to incorporate such complexities into conservation decision-making. For instance, compensation schemes aim to recompense monetary losses and direct damages, to improve tolerance, whereas our results suggest a more effective approach would be to enhance resilience to non-monetary costs and improve perceived benefits. We conclude that future studies should pay increased attention to intangible costs and consider the less direct drivers of tolerance. Through repeated testing of universal models such as that presented here, broad trends may emerge that will facilitate the application of policies across contexts and landscapes.

D.J.F. dos Santos, V. Berger, R. Cristofari, W. Htut, UK.N., H.H. Aung, S. Reichert & V. Lummaa
Seasonal variation of health in Asian elephants
Conservation Physiology 8 (2020) coaa119
Abstract. Long-lived species are often predicted to be buffered against seasonal variation: longevity means low annual mortality

and reproductive rates and annual variability in climate may therefore have a smaller impact on population growth rates of long-lived species in comparison to short-lived ones. However, little is known of the physiological mechanisms underlying such patterns in long-lived species. In this study, we investigated seasonal variation in the health of Asian elephants living in a seasonal monsoon climate. We used two complementary methods: (i) global and (ii) trait-by-trait analyses of seasonal effects on 23 health parameters of 225 individually marked elephants with known age and reproductive and health history, with repeated measures per individual over a 26-month period. The global analysis highlighted the biggest differences in health between the hot and monsoon seasons. Our trait-specific analyses identified the physiological functions underlying such health variation in different ecological settings, including haematological, immunological, muscular, kidney and liver functions, as well as protein balance and electrolytes. Overall, the results suggest that even long-lived, large mammals may experience physiological changes in response to seasonal variation that in extreme circumstances can pose a significant health risk.

D.J.F. dos Santos, J. Jackson, H.H. Aung, U.K. Nyein, W. Htut & V. Lummaa

Sex differences in the reference intervals of health parameters in semicaptive Asian elephants (*Elephas maximus*) from Myanmar

J. of Zoo and Wildlife Medicine 51 (2020) 25-38

Abstract. The reference intervals of health parameters are valuable tools for veterinarians and conservationists to monitor the health status and viability of endangered species. Natural variation in the health of the long-lived Asian elephant (*Elephas maximus*) is poorly understood, particularly in relation to differences between males and females. Longitudinal health data were collected from clinical examination, hematology, and serum chemistry analyses over 3 yr from 227 healthy individually marked Asian elephants varying in age and sex. The study population was semicaptive and used in Myanmar's timber industry, but maintained natural feeding and breeding behavior. Body condition score (BCS) and blood pressure were investigated in clinical examinations. Hematological parameters included hematocrit, hemoglobin, total white blood cell count, and differential blood cell counts. Serum chemistry parameters included blood urea nitrogen, creatinine, total protein, albumin, globulins, aspartate aminotransferase, alkaline phosphatase, triglycerides, creatine kinase, glucose, calcium, potassium, sodium, and chloride. To the knowledge of the authors, this is the first description of BCS in an elephant population outside of zoos, and of blood pressure in this species using a novel adaptation of the Intelli Wrap Cuff pressure monitor. Several differences between the sexes were observed, with females generally having higher BCS and triglycerides, and males displaying higher alkaline phosphatase and glucose levels. This study provides important clinical tools that can be used to assess the health status and improve management in this endangered species. © 2020 American Association of Zoo Veterinarians.

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

Weigh and see – Body mass recordings versus body condition scoring in European zoo elephants (*Loxodonta africana* and *Elephas maximus*)

Zoo Biology 39 (2020) 97-108

Abstract. Regular body mass (BM) monitoring plays a key role in preventative health care of zoo animals. In some species, including African (*Loxodonta africana*) and Asian elephants (*Elephas maximus*), the process of weighing can be challenging, and alternative methods such as visual body condition scoring (BCS) have been developed. We investigated the temporal development of both parameters regarding correlation patterns between them, and their suitability as monitoring measures in dependence of an elephant's life stage. While BM is more suitable in calves and juveniles under the age of 8 years, both BM and BCS are considered equally reliable in adult elephants. In elephants over the age of 40 years, BCS might be more suitable for assessing the physical status. Independent of species and sex, juvenile zoo elephants grow in BM nearly linearly with age, and reach a higher BM at an earlier age compared with conspecifics of free-ranging and semi-captive populations in the countries of origin.

The BCS typically remains constant during this life stage, seemingly unaffected by growth. In adult animals, breeding females have a lower BM and BCS than nonbreeders, and BM and BCS typically indicate fluctuations in the same direction. In geriatric elephants (>40 years) a drop in BCS occurs commonly, while BM may even increase in this life stage. We recommend regular body mass recording in zoo elephants to enhance our knowledge of body mass development and allow the formulation of objective practical recommendations. BCS presents a valuable and simple tool for complementary monitoring of an elephant's condition, especially in adult and geriatric individuals.

N.P. Singh, A.M. Jukar, R. Patnaik, K.M. Sharma, N.A. Singh & Y.P. Singh

The first specimen of *Deinotherium indicum* (Mammalia, Proboscidea, Deinotheriidae) from the late Miocene of Kutch, India

Journal of Paleontology 94 (2020) 788-795

Abstract. Deinotheriidae Bonaparte, 1845 is a family of browsing proboscideans that were widespread in the Old World during the Neogene. From Miocene deposits in the Indian subcontinent, deinotheres are known largely from dental remains. Both large and small species have been described from the region. Previously, only small deinothere species have been identified from Kutch in western India. In the fossiliferous Tapar beds in Kutch, dental remains have been referred to the small species *Deinotherium sindiense* Lydekker, 1880, but the specimens are too fragmentary to be systematically diagnostic. Here, we describe a large p4 of a deinothere from the Tapar beds and demonstrate that it is morphologically most similar to *Deinotherium indicum* Falconer, 1845, a large species of deinothere, thereby confirming the identity of deinotheres at Tapar. *Deinotherium indicum* from Tapar is larger than other deinotheres identified from Kutch and is the first occurrence of the species in the region. This new specimen helps constrain the age of the Tapar beds to the Tortonian and increases the biogeographic range of this species—hitherto only known from two localities on the subcontinent. This specimen also highlights the morphological diversity of South Asian deinothere p4s and allows us to reassess dental apomorphies used to delimit Indian deinothere species. Lastly, we argue that by the late Miocene, small deinotheres in Kutch were replaced by the large *Deinotherium indicum*. © 2020 Paleontological Society.

K.D. Snyder & D. Rentsch

Rethinking assessment of success of mitigation strategies for elephant-induced crop damage

Conservation Biology 34 (2020) 829-842

Abstract. Crop damage is the most common impact of negative interactions between people and elephants and poses a significant threat to rural livelihoods and conservation efforts. Numerous approaches to mitigate and prevent crop damage have been implemented throughout Africa and Asia. Despite the documented high efficacy of many approaches, losses remain common, and in many areas, damage is intensifying. We examined the literature on effectiveness of crop-damage-mitigation strategies and identified key gaps in evaluations. We determined there is a need to better understand existing solutions within affected communities and to extend evaluations of effectiveness beyond measurement of efficacy to include rates of and barriers to adoption. We devised a conceptual framework for evaluating effectiveness that incorporates the need for increased emphasis on adoption and can be used to inform the design of future crop-damage mitigation assessments for elephants and conflict species more widely. The ability to prevent crop loss in practice is affected by both the efficacy of a given approach and rates of uptake among target users. We identified the primary factors that influence uptake as local attitudes, sustainability, and scalability and examined each of these factors in detail. We argue that even moderately efficacious interventions may make significant progress in preventing damage if widely employed and recommend that wherever possible scientists and practitioners engage with communities to build on and strengthen existing solutions and expertise. When new approaches are required, they should align with local attitudes and fit within limitations on labor, financial requirements, and technical capacity. © 2019 Society for Conservation Biology.

S. Songthammanuphap, S. Puthong, C. Pongma, A. Buakeaw, T. Prammananan, S. Warit, W. Tipkantha, E. Kaewkhunjob, W. Yindeeyoungyeon & T. Palaga

Detection of *Mycobacterium tuberculosis* complex infection in Asian elephants (*Elephas maximus*) using an interferon gamma release assay in a captive elephant herd

Scientific Reports 10 (2020) e14551

Abstract. Tuberculosis is highly contagious disease that can be transmitted between humans and animals. Asian elephants (*Elephas maximus*) in captivity live in close contact with humans in many Asian countries. In this study, we developed an interferon gamma release assay (IGRA) for elephant TB detection using antigens from the MTB complex (MTBC) and nontuberculous mycobacteria (NTM) as stimulating antigens (PPD, ESAT6, CFP10) to elicit a cell-mediated immune response (CMIR). The developed assay was applied to an elephant herd of more than 60 animals in Thailand, and the results were compared with those obtained through serological detection. IGRA has sufficient sensitivity for detecting elephant interferon gamma (eIFNγ) from specific antigen-stimulated PBMCs. Among 60 animals tested, 20 samples (33.3%) showed negative results for both MTBC and NTM infection. Eighteen samples (30%) showed positive responses against PPD from M. bovis and/or ESAT6 and CFP10, indicating MTBC infection. In contrast, only 15.6% showed seropositivity in a commercial serological test kit for elephant TB. The discrepancies between serological and CMIR highlight that the two methods may detect different stages of elephant TB. Therefore, employing both tests may enable them to complement each other in correctly identifying elephants that have been exposed to MTBC.

Foteini Spagopoulou

Transgenerational maternal age effects in nature: Lessons learnt from Asian elephants

Journal of Animal Ecology 89 (2020) 936-939

Abstract. In Focus: Reichert, S., Berger, V., Jackson, J., Chapman, S. N., Htut, W., Mar, K. U., & Lummaa, V. (2019). Maternal age at birth shapes offspring life-history trajectory across generations in long-lived Asian elephants. Journal of Animal Ecology, 89, 996-1007. Parental age can have strong effects on offspring life history, but the prevalence and magnitude of such effects in natural populations remain poorly understood. Using a multigenerational dataset of semi-captive Asian elephants, Reichert *et al*. (2019) studied the effects of maternal and grandmaternal age on offspring performance and found that offspring from old mothers have lower survival, but higher body condition and reproductive success than offspring from younger mothers. Importantly the observed consequences on survival are long-lasting and span more than one generation, with grand-offspring of old grandmothers also showing reduced survival. These findings suggest that persistent transgenerational effects of maternal age on fitness can shape the individual variation in ageing patterns in nature and ultimately the evolution of life histories.

R.B. Suba, N.G.P. Beveridge, W. Kustiawan, G.R. de Snoo, H.H. de Iongh, S.E. van Wieren, Y.H. Choi & H.K. Kim

Food preference of the Bornean elephant (*Elephas maximus borneensis*) in North Kalimantan Province, Indonesia, and its conservation implications

Raffles Bulletin of Zoology 68 (2020) 791-802

Abstract. The preference to feed on particular plant species may reflect the most desirable components that an animal perceives, in relation to what is available. The food preference of the Bornean elephant (*Elephas maximus borneensis* Deraniyagala, 1950) in the Sebuku area of North Kalimantan was studied by chemical analysis on the metabolites of several known food plant species. We analysed the chemical properties of the Bornean elephant diet from thirteen food-plant species which represented the level of food-plant categories utilised by the Bornean elephant in the study area. All samples were analysed for nutritional value, and their metabolic pro les were obtained using 1H nuclear magnetic resonance spectroscopy. These data were subjected to multivariate data analyses to identify the common components. This study confirmed that Bornean elephants tend to follow a strategy to maximise their energy intake by selecting food items rich in sugar and crude protein and minimise fibrous

elements. The fact that they also prefer food items with high glutamate suggests that taste plays a role and this element may be a cue for the Bornean elephant to assist in foraging and searching for palatable food. © 2020 National University of Singapore.

N.R. Talukdar & P. Choudhury

Attitudes and perceptions of the local people on human-elephant conflict in the Patharia Hills Reserve Forest of Assam, India

Proceedings of the Zoological Society 73 (2020) 380-391

Abstract. No permission to print abstract.

N.R. Talukdar, P. Choudhury, F. Ahmad, H. Al-Razi & R. Ahmed

Mapping and assessing the transboundary elephant corridor in the Patharia Hills Reserve Forest of Assam, India

Rangeland Ecology & Management 73 (2020) 694-702

Abstract. Asiatic elephants are facing numerous direct and indirect anthropogenic threats throughout their geographical distributional range. Consequent to the land use and land cover change, habitat loss, fragmentation, and deterioration of the corridor status are the prime threats for the species. The current study aimed to delineate the routes and migratory corridors of elephants in the Indo-Bangla forest along the Patharia Hills Reserve Forest and characterizing existing threats on the corridor for long-term conservation of the elephants using field survey and geospatial techniques. The study identified and mapped the elephant corridor for the first time in the area and named it the "Juri-Patharia-Tilbhum elephant corridor." Land use and land cover changes in the corridor were markedly observed for over 4 decades (between 1972 and 2018). Forest-covered areas in the corridor were 32.06% in 1972, which has been reduced to only 2.98% in 2018, whereas human development types have all increased, grasslands by 127.18%, plantations by 146.56%, agriculture by 279.63%, and settlements by 147.17% between 1972 and 2018. The study concluded that the corridor area is at risk because of the lack of sustainable development in the area, which deliberately undermines conservation. Human settlement, road construction, and electrification in and around habitats and the corridor are vital threats faced by elephants in the Patharia Hills Reserve Forest. Conservation of habitat and corridor through both adoption of legal measures and community participation might be a better proposition for their long-term conservation in the habitat. The study appeals to the government to take conservation initiative in the area and suggest legal protection of the corridor and provide subsidies to the local private landowner to restrict the land-use change on the corridor. © 2020 The Society for Range Management. Reprinted with permission from Elsevier

A.S.L. Tan, J.A. de la Torre, E.P. Wong, V. Thuppil & A. Campos-Arceiz

Factors affecting urban and rural tolerance towards conflict-prone endangered megafauna in Peninsular Malaysia

Global Ecology and Conserv. 23 (2020) e01179

Abstract. The long-term survival of conflict-prone megafauna such as tigers *Panthera tigris* and Asian elephants *Elephas maximus* requires people's tolerance and willingness to coexist with them. Understanding people's attitudes can help design conservation interventions that are more effective and supported by various stakeholders. We studied Malaysian citizens attitudes towards local megafauna and the influence of urbanization, conservation awareness, local context, taxonomic bias, and conflict severity on people's attitudes and tolerance towards endangered megafauna. We conducted 733 interviews in three locations with different degrees of urbanization (capital city, small town, and rural area). Interviews in the city and small town were conducted in zoos and shopping malls to investigate the role of local context. Our respondents showed relatively good knowledge of local wildlife and wildlife conservation issues and thought that wildlife conservation was predominantly the government's responsibility. People in all groups showed a taxonomic bias, expressing more tolerance towards less conflict-prone tapirs than towards potentially more dangerous elephants, and even less towards tigers. Urbanization and awareness had consistently positive effects on people's attitudes, while the local context (zoos vs shopping malls) had very minor effects.

Our results suggest that awareness campaigns can have a positive effect to promote positive attitudes towards wildlife in Malaysia and the need for stratified approaches when it comes to conservation campaigns. In urban settings, efforts should be made to enhance people's sense of ownership and responsibility in conservation, while in rural areas efforts should focus on reducing the cost of conflict on people while promoting tolerance and willingness to coexist with conflict-prone megafauna. © 2020 The Authors.

R. Tang, W. Li, Di Zhu, X. Shang, X. Guo & Li Zhang

Raging elephants: Effects of human disturbance on physiological stress and reproductive potential in wild Asian elephants

Conservation Physiology 8 (2020) e106

Abstract. Human disturbance has become a widespread threat to wildlife viability. The Asian elephant (*Elephas maximus*), an endangered and disturbance-prone species, is under severe threat from habitat loss and fragmentation, human–elephant conflict and poaching. Establishing connections between human disturbance, stress responses and reproduction is crucial for assessing the long-term survivability of a species and will provide critical information for conservation management. The current study investigated the effects of human disturbance on population-level stress responses and stress-related effects on reproductive potential of wild Asian elephants in Xishuangbanna Dai Autonomous Prefecture, China. We used a radioimmunoassay to measure the concentration of fecal cortisol and estradiol in 257 samples collected from five local populations at 15 sites over 4 years. Human disturbance in Xishuangbanna was quantified based on the Ecological-Niche Factor Analysis model. We found that fecal cortisol concentrations were strongly positively correlated with the degree of human disturbance and increased markedly with the expansion of tea plantations. Percentage of non-stressed individuals in a population was higher depending on the extend of undisturbed area in their home ranges. Fecal estradiol concentrations decreased significantly with increasing stress levels. Our results suggest that human disturbance poses environmental challenges to wild Asian elephant populations, and chronic exposure to human disturbance could lead to population decline. The study demonstrates the efficacy of non-invasive endocrine monitoring for further informing management decisions and developing conservation strategies. © 2020 The Authors.

L.D. Thewarage, D.S.B. Dissanayake, U.S. Perera, A.T. Bandara, B.V.P. Perera, S. Wickramasinghe & R.P.V.J. Rajapakse

Morphology and molecular characterization of *Parabronema smithii* (Cobbold, 1882) (Nematoda: Habronematidae) from wild Asian elephant (*Elephas maximus maximus*) of Sri Lanka

Acta Parasitologica 65 (2020) 504-517

Abstract. No permission to print abstract.

P. Toin, J.L. Brown, V. Punyapornwithay, P. Bansiddhi, C. Somgird & C. Thitaram

Reproductive performance of captive Asian elephants (*Elephas maximus*) in large tourist camps in Thailand

Animal Reproduction Science 222 (2020) e106606

Abstract. In Thailand, many elephants are used in tourism, with populations sustained by breeding of animals that are in captive habitats. Even though there are programs to promote breeding, there is not success in all camps. In this study, there was summarization of reproductive performance data of 407 elephants (150 males, 257 females) at seven tourist camps based on 4 to 21 years of breeding records. Age pyramid structures for elephants varied among camps. Reproductive rates averaged 21.6±6.17% and varied among camps (2.8%–45.0%). Based on parity, 77.4% of elephants were nulliparous, 8.2% produced one calf, and 14.3% were multiparous, with there being camp differences. There were 1.10±0.46 (range, 0.03-3.55) births per year, with a total of 19.6±9.3 (1-71) calves per camp. Age at first calving was 19.2±1.1 years (range, 8 – 40 years), mean inter-birth interval was 4.4±0.2 years (range, 1.8 – 7.9 years), and average gestation length was 653.9 ± 6.9 days (range, 578 – 743 days). Rates of abortions/stillbirths averaged 12.4% and ranged from 3.5% to 66.7%. There were no obvious differences in management (e.g., number of males, estrous

detection methods, work activities) that when evaluated explained the range in breeding success, although lack of male interest in females was a common problem. While informative and useful for designing future studies, results of this study indicate there is a lack of precise breeding records that makes it difficult to evaluate effects of management practices on reproductive performance of captive elephants in Thailand. © 2020 Reprinted with permission from Elsevier.

A. van de Water, L.E. King, R. Arkajak, J. Arkajak, N. van Doormaal, V. Ceccarelli, L. Sluiter, S.M. Doornwaard, V. Praet, D. Owen & K. Matteson

Beehive fences as a sustainable local solution to human-elephant conflict in Thailand

Conserv. Science and Practice 2 (2020) e260

Abstract. As human-elephant conflict (HEC) increases, a better understanding of the human dimensions of these conflicts and non-violent mitigation methods are needed to foster long-term coexistence. In this study, we conducted household questionnaires (n = 296) to assess the prevalence of HEC and attitudes towards elephants in four rural villages in Thailand. In addition, we evaluated a pilot beehive fence as a sustainable solution for HEC. The majority of the households reported seeing or hearing elephants near their property at least once a week (84.9%) and experienced negative impacts from elephants in the last 5 years, (81.0%). The beehive fence deterred 88.4% of individual elephants (n = 155) and 64.3% of elephant groups (n = 28) that approached the fence. Most elephants (70.7%) exhibited behaviors suggesting heightened attentiveness or alarm. The farm owner reported economic and social benefits of the beehive fence. By contributing to farmer income and reducing crop damage caused by wild elephants, beehive fencing may provide an important locally-managed complement to regional HEC mitigation methods. © 2020 The Authors.

D. Vasudev & V.R. Goswami

A Bayesian hierarchical approach to quantifying stakeholder attitudes toward conservation in the presence of reporting error

Conservation Biology 34 (2020) 515-526

Abstract. Stakeholder support is vital for achieving conservation success, yet there are few reliable mechanisms to monitor stakeholder attitudes towards conservation. Importantly, few approaches account for bias arising from reporting errors; that is, reporting a positive attitude towards conservation when the respondent actually does not have one (a false positive error), or not reporting a positive attitude when the respondent is positive towards conservation (a false negative error). We borrow from developments in applied conservation science to use a Bayesian hierarchical model to quantify stakeholder attitudes as the probability of having a positive attitude towards wildlife, notionally (or in abstract terms) and at localized scales. The model allows us to assess stakeholder attitudes, and factors influencing these attitudes, while accounting for false negative and false positive reporting errors. We show through simulations that this method has lower bias than naïve estimates of the proportion of respondents who are positive towards wildlife, or Likert-scores. We demonstrate the utility of the model by applying it to questionnaire surveys on Asian elephants *Elephas maximus* in the Kaziranga–Karbi Anglong landscape, Northeast India. After accounting for reporting errors, we estimated the probability of being positive towards elephants notionally as 0.85; at a localized scale, however, the proportion of respondents that were positive towards elephants was 50%. In comparison, without accounting for reporting errors, the proportion of respondents professing positive attitudes towards elephants in at least one of the certain questions, was 0.69 and 0.23, notionally and at local scales, respectively. False (positive and negative) reporting probabilities were consistently non-zero (0.22–0.68). We submit that regular and reliable assessment of stakeholder attitudes—combined with an understanding of factors contributing to variation in attitudes—can feed into participatory conservation monitoring programs, help assess the success of initiatives aimed at facilitating human behavioral change, and inform conservation decision-making. © 2019 Society for Conservation Biology.

P. Wendler, N. Ertl, M. Flügger, E. Sós, P. Torgerson, P.P. Heym, C. Schiffmann, M. Clauss & J.-M. Hatt

Influencing factors on the foot health of captive Asian elephants (*Elephas maximus*) in European zoos

Zoo Biology 39 (2020) 109-120

Abstract. Pathological lesions of feet occur frequently in captive elephant populations. To improve foot health, it is important to identify risk factors associated with such pathologies. Several previous studies have analyzed potentially influencing factors but were limited, for example, by small sample sizes. This study analyzed the relationship between 87 independent variables and the foot health score of 204 Asian elephants (*Elephas maximus*) in European zoos using bivariate correlation, multivariable regression models, and principal component analysis (PCA). Correlation and regression tests revealed significant results for 30 different variables, mainly with small effect sizes. Only three variables were significant in more than one test: sex, time spent indoors, and time spent on hard ground, with lower scores (i.e. less or less severe pathological lesions) in females, and when less time is spent indoors or on hard ground. Due to small effect sizes and differing results of the statistical tests, it is difficult to determine which risk factors are most important. Instead, a holistic consideration appears more appropriate. A biplot of the PCA shows that factors representing more advanced husbandry conditions (e.g. large areas, high proportions of sand flooring) were associated with each other and with decreased foot scores, whereas indicators of more limited conditions (e.g. high proportions of hard ground, much time spent indoors) were also associated with each other but increased the foot score. In conclusion, instead of resulting from just one or two factors, reduced foot health might be an indicator of a generally poorer husbandry system.

G. Wilson, R.J. Gray & H. Sofyan

Identifying the variation in utilization density estimators and home ranges of elephant clans in Aceh, Sumatra, Indonesia

E. Journal of Wildlife Research 66 (2020) e88

Abstract. No permission to print abstract.

J. Witteveen & S. Müller-Wille

Of elephants and errors: Naming and identity in Linnaean taxonomy

History and Philosophy of the Life Sciences 42 (2020) e43

Abstract. No permission to print abstract.

S. Yasui & G. Idani

The effect of proximity relations to mahouts on social behaviors among captive Asian elephants (*Elephas maximus*)

Animal Behav. and Management 56 (2020) 1-7

Abstract. Asian elephants (*Elephas maximus*) have worked with people for a long time in several Asian countries. Additionally, there are many elephants in zoos and sanctuaries all over the world. In captivity, accidents sometimes occur involving elephants and zoo keepers (mahouts). Although human-elephant relationships are very important to the management of elephants in captivity, there have not been many studies done on these to date. The objective of this study was to clarify how mahout- elephant proximity relations influence elephant behavior. Our subjects were 17 captive Asian elephants at the Elephant Study Centre in Surin Province, Thailand. We recorded all social behaviors performed by each focal animal and the distances between her and her mahout every minute. We compared the frequency with which the elephants and mahouts stayed in close proximity to one another and the frequencies of different social behaviors involving the elephants. We found that elephants that maintained close proximity to their mahouts for longer periods underwent fewer interactions with other elephants. This study may represent the first report to demonstrate the influence of mahouts on the social behavior of captive elephants.