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Gajah 56 (2023) 54-84

Recent Publications on Asian Elephants

Compiled by Jennifer Pastorini

Department of Evolutionary Anthropology, University of Zürich, Zürich, Switzerland and Centre for Conservation and Research, Tissamaharama, Sri Lanka
E-mail: jenny@aim.uzh.ch

If you need additional information on any of the articles, please feel free to contact me. You can also let me know about new (2023) publications on Asian elephants.

N.K. Abram, B. Skara, N. Othman, M. Ancrenaz, K. Mengersen & B. Goossens
Understanding the spatial distribution and hot spots of collared Bornean elephants in a multi-use landscape
Scientific Reports 12 (2022) e12830
Abstract. In the Kinabatangan floodplain, Sabah, Malaysian Borneo, oil palm and settlements have reduced and fragmented lowland tropical forests, home to around 200 endangered Bornean elephants (*Elephas maximus borneensis*). In this region, elephants range within forests, oil palm and community areas. The degree to which elephants are using these areas remains unclear. We used GPS telemetry data from 2010 to 2020 for 14 collared elephants to map their entire known ranges and highly used areas (hot spots) across four land use categories and estimate time spent within these. The use of land use types across elephants varied significantly. Typically, females had strong fidelity to forests, yet many of these forests are threatened with conversion. For the three males, and several females, they heavily used oil palm estates, and this may be due to decreased landscape permeability or foraging opportunities. At the pooled level, the entire range and hot spot extents, constituted 37% and 34% for protected areas, respectively, 8% and 11% for unprotected forests, 53% and 51% for oil palm estates, and 2% for community areas. Protecting all forested habitats and effectively managing areas outside of protected areas is necessary for the long-term survival of this population.

R. Ahmed & A. Saikia
Pandora's box: A spatiotemporal assessment of elephant-train casualties in Assam, India
PLoS ONE 17 (2022) e0271416
Abstract. Railways are an indispensable component of sustainable transportation systems, but also exact a toll on wildlife. Wild Asian elephants are often killed by trains in Assam, India, where we assess temporal variations in the occurrences of elephant-train collisions (ETCs) and casualties during 1990–2018. This study also assesses spatially varying relationships between elephant-train collision (ETC) rates and elephant and train densities in the adjoining 10 km^2 grid cells of 11 prioritized railroad segments using ordinary least squares (OLS) and geographically weighted regression (GWR) models. The temporal analysis indicated that ETCs spiked at certain hours and months. The adult and calf elephant casualties on the railroads were found to be two to fivefold high during the post monsoon season compared to other seasons. During the operation period of meter gauge railroads (1990–1997), the proportions of ETCs and casualties were only 15.6% and 8.7% respectively. However, these increased substantially to 84.4% and 91.3% respectively during the operation of broad gauge railroads (1998–2018). The OLS model indicated that both elephant and train densities explained 37% of the variance of ETC rate, while GWR model showed 83% of the variance of ETC rate. The local coefficient values of GWR indicated that both the predictor variables interplayed significantly and positively to determine ETC rates in the Mariani-Nakachari and Khatkhati-Dimapur railroad segments. However, the relationship between ETC rate and elephant density is significantly negative in the Habaipur-Diphu railroad, implying that the elephant population along this railroad stretch is significantly af-

fected by railways through large scale ETCs. Hence, there is an urgent need to address long-term mitigation strategies so that elephants can be conserved by providing safe passages and survival resources along railway lines. © 2022 The Authors.

R. Ahmed, A. Saikia & S.M. Robeson
Tracks of death: Elephant casualties along the Habaipur-Diphu railway in Assam, India
Annals of the American Association of Geographers 112 (2022) 1553-1575
Abstract. Railway development is an important component of sustainable transportation systems but also affects wildlife habitats worldwide. Here, we assess spatiotemporal patterns of elephant–train collisions and mortalities within the state of Assam, India, and relate them to spatial and temporal land cover change (LCC) from 1988 to 2018. The results indicate that an extension of railways into forested landscapes is associated with large-scale LCC and increased elephant–train collisions and mortality. Prior to 1997, when the railway system used narrower gauge rails, elephant deaths from collisions occurred at a rate of one or two per year. After 1997, when the system was converted to larger gauge rails, elephant deaths increased starkly and now occur at a rate approaching ten per year. While the rail gauges were being converted, the landscape around the Habaipur-Diphu railway line saw a sevenfold increase in annual net loss of dense forest. The transition from forest to croplands was the most dominant process of deforestation and forest fragmentation during the postconversion period. Although elephant-train collisions are strongly associated with the land use transitions shown here, conservation and remediation measures can help to stem further declines in forest habitats and promote safe movement by elephants between resource patches. © 2022 American Association of Geographers.

Z. Amir, J.H. Moore, P.J. Negret & M.S. Luskin
Megafauna extinctions produce idiosyncratic Anthropocene assemblages
Science Advances 8 (2022) eabq2307
Abstract. The "trophic downgrading of planet Earth" refers to the systematic decline of the world's largest vertebrates. However, our understanding of why megafauna extinction risk varies through time and the importance of site- or species-specific factors remain unclear. Here, we unravel the unexpected variability in remaining terrestrial megafauna assemblages across 10 Southeast Asian tropical forests. Consistent with global trends, every landscape experienced Holocene and/or Anthropocene megafauna extirpations, and the four most disturbed landscapes experienced 2.5 times more extirpations than the six least disturbed. However, there were no consistent size- or guild-related trends, no two tropical forests had identical assemblages, and the abundance of four species showed positive relationships with forest degradation and humans. Our results suggest that the region's megafauna assemblages are the product of a convoluted geoclimatic legacy interacting with modern disturbances and that some megafauna may persist in degraded tropical forests near settlements with sufficient poaching controls. © 2022 The Authors,

P. Amorntiyangkul, A. Pattanavibool, W. Ochakul, W. Chinnawong, S. Klanprasert, C. Aungkeaw, P. Duengkae & W. Suksavate
Dynamic occupancy of wild Asian elephant: A case study based on the SMART database from the Western Forest Complex in Thailand
Environment and Natural Resources Journal 20 (2022) 310-322
Abstract. Understanding distribution patterns is essential for the long-term conservation of megafauna, particularly the Asian elephant. We investigated the dynamic occupancy of Asian elephants in the Thung Yai Naresuan West Wildlife Sanctuary in Thailand. Asian elephant occurrences were recorded during patrol activities from 2012 to 2019. We applied a single-species dynamic occupancy model to examine the environmental factors influencing habitat occupancy of Asian elephant across multiple seasons. The best-supported model, based on the Akaike information criterion (AIC), indicated that the normalized difference vegetation index and elevation positively influenced the probability of colonization. In contrast, the distance to the nearest population source sites showed a negative association. The probability of local extinction was positively correlated with the distance to the nearest villages and population

source sites. The predictive map indicated a higher probability of colonization in a remote mountainous region of the center of the protected area. Higher extinction probability was associated with areas of dense human activity and far from population source sites connecting the Asian elephant population to the east. This is the first study to utilize a patrol database for assessing the dynamic occupancy of Asian elephants across multiple years. Our model provides insight into the dynamic distribution patterns of elephants within the wildlife sanctuary and the factors that most influence these patterns. Long-term ecological data provide crucial information for assessing biodiversity, population status, and ecological processes of focal wildlife species and are valuable for both protected area management and conservation efforts.

K.B. Anderson, J.C. Steeil, E. Latimer, V. Hall, L.-A.C. Hayek & J. Brandão

Changes in serum cardiac troponin I in Asian elephants (*Elephas maximus*) with elephant endotheliotropic herpesvirus infection

J. of Zoo and Wildlife Med. 53 (2022) 249-258

Abstract. Elephant endotheliotropic herpesvirus (EEHV) is one of the most important causes of mortality in Asian elephants. The unusual tropism of EEHV for endothelial cells of capillaries can lead to catastrophic vascular dysfunction, hemorrhage, cardiac damage, and death. Cardiac troponin I (cTnI) is an intracellular protein of cardiomyocytes that is released into circulation in levels directly correlated to the severity of cardiomyocyte damage. The purpose of this study was to assess if cTnI could be used to distinguish when EEHV viremia leads to clinical disease versus subclinical infection. Thirty-seven individual Asian elephants contributed 53 blood samples that were evaluated for EEHV viremia using quantitative polymerase chain reaction and analyzed for cTnI using a high-sensitivity assay. Viremia was categorized as none (24/53), low (< 20,000 vge/ml, 12/53) and high (≥20,000 vge/ml, 17/53). Seven of the nonviremic samples had detectable cTnI. Nine low-viremia samples were positive for EEHV1 (1A and 1B combined) and lacked a detectable cTnI. Fourteen high-viremia samples were positive for EEHV1 and had detectable cTnI. There was statistical significance between having viremia and having a detectable cTnI value (P = 0.0001), and animals with EEHV1 viremia were more likely to have a positive cTnI value (P = 0.04). The presence of cTnI was associated with the presence of clinical signs, with higher values of cTnI in the presence of clinical signs versus subclinical viremia (P = 0.0001). In addition, four elephants contributed multiple samples from a single viremic event and results displayed a trend of elevation in troponin values with progression of EEHV viremia. The association of EEHV viremia with cTnI suggests these markers might be used in conjunction to help predict when EEHV viremia is likely to progress to EEHV-HD for an individual.

D. Bai, X. Wan, L. Zhang, A. Campos-Arceiz, F. Wei & Z. Zhang

The recent Asian elephant range expansion in Yunnan, China, is associated with climate change and enforced protection efforts in human-dominated landscapes

Frontiers in Ecology and Evolution 10 (2022) e889077

Abstract. Recently, the northward movement of Asian elephants in Yunnan, China, has attracted international attention. Climate change or human disturbances have been proposed to be the key drivers, but these hypotheses have not been rigorously tested. In this study, we quantified the relationship between climate change and human impacts on the recent range expansion of Asian elephants in southwest China. We found that the first observation probability of this species in a new place during 1959–2021 had a significant and positive association with change in air temperature and human density, resulting in a movement toward a high-latitude region with a warmer climate and higher human density; however, its association with precipitation was scale-dependent in time: positive or negative during the past 10 or 5 years, respectively. Under the enforced protection policy, human-dominated areas became preferred habitats for elephants. Our results indicate that climate change and enforced protection efforts in human-dominated landscapes in the last few decades are significant drivers of the recent range expansion of Asian elephants in Yunnan, China. It is necessary to expand the current protected areas or habitat corridors toward the north or set

up new reserves in the north and set up barriers between human settlements and elephant habitats to facilitate elephant movements and minimize human-elephant conflicts under accelerated global change. © 2022 The Authors.

S. Banerjee & A. Aiyadurai

Everyday conservation': A study of actors and processes in an elephant conservation project in Assam, India

Human Dimensions of Wildlife 27 (2022) 536-553

Abstract. Existing studies on community-based conservation in India, while highlighting the results and effectiveness of conservation interventions fail to engage with the underlining social processes emerging from the interactions among conservation actors. This article demonstrates conservation as a social process in which the actors interact with each other daily. We use the notion of 'Everyday Conservation' to highlight that actors use their resources, skills and limitations to create a space where conservation processes are negotiated and shaped on an everyday basis. Using ethnographic work carried out in Assam (India), this article analyzes an Asian elephant conservation project to understand the various actors involved in the project, such as project managers, staff, local community, funding organization and forest department and their interactions, resulting in 'Everyday Conservation.' The inter-actor interactions were of varying intensity, depending upon which the actors negotiated, collaborated, or came into conflict, thereby producing conservation results embedded in contextual factors. We suggest that conservation needs rethinking and the framework of 'Everyday Conservation' can provide a fresh perspective on community-based wildlife conservation. © 2021 Taylor & Francis Group, LLC.

A. Baotic, B. Brady, E.A. Ramos & A.S. Stoeger

Elephants and sirenians: A comparative review across related taxa in regard to learned vocal behavior

*Comparative Cognition and Behavior Reviews **17** (2022) 89-108*

Abstract. Vocal production learning is the ability to modify a vocal output in response to auditory experience. It is essential for human speech production and language acquisition. Vocal learning evolved independently several times in vertebrates, indicating evolutionary pressure in favor of this trait. This enables cross-species comparative analysis to be used to test evolutionary hypotheses. Humans share this ability with a versatile but limited group of species: songbirds, parrots and hummingbirds, bats, cetaceans, seals, and elephants. Although case studies demonstrate that African savanna and Asian elephants are capable of heterospecific imitation, including imitation of human words, our understanding of both the underlying mechanisms and the adaptive relevance within the elephant's natural communication system is limited. Even though comparing phylogenetically distant species is intriguing, it is also worthwhile to investigate whether and to what extent learned vocal behavior is apparent in species phylogenetically close to an established vocal learner. For elephants, this entails determining whether their living relatives share their special ability for (complex) vocal learning. In this review, we address vocal learning in Elephantidea and Sirenia, sister groups within the Paenungulata. So far, no research has been done on vocal learning in Sirenians. Because of their aquatic lifestyle, vocalization structure, and evolutionary relationship to elephants, we believe Sirenians are a particularly interesting group to study. This review covers the most important acoustic aspects related to vocal learning in elephants, manatees, and dugongs, as well as knowledge gaps that must be filled to fully comprehend why vocal learning evolved (or did not) in these distinctive but phylogenetically related taxa.

K. Baral, S. Bhandari, B. Adhikari, R.M. Kunwar, H.P. Sharma, A. Aryal & W. Ji

Anthropogenic mortality of large mammals and trends of conflict over two decades in Nepal

Ecology and Evolution 12 (2022) e9381

Abstract. Wildlife conservation in human-dominated landscapes faces increased challenges due to rising conflicts between humans and wildlife. We investigated the human and wildlife loss rates due to human-wildlife conflict between 2000 and 2020 in Nepal. We concentrated on Asian elephant, greater one-horned rhino, tiger, and leopard mortality, as well as human mortality caused by these species. Over

the 21-year period, we recorded 1139 cases of wildlife mortality and 887 cases of human mortality. Leopard mortality was the highest, followed by that of greater one-horned rhinos, tigers, and Asian elephants. Overall, the rate of wildlife mortality has been increasing over the years. Asian elephants were found to be more responsible for crop damage than greater one-horned rhinos, while leopards were found to be more responsible for livestock depredation than tigers. The generalized linear model indicated that the mortality of wildlife in the districts is best predicted by the additive effect of human mortality, the proportion of agricultural land, and the literacy rate of the districts. Retaliatory wildlife mortality was the most challenging issue for wildlife conservation, especially for the large mammals. Findings from this study are important for mitigation of human-wildlife conflicts, controlling retaliatory killing, and conserving these threatened large mammals.

P. Bharathy, S. Wijeyamohan, K. Suthakar & S. N. Surendran

Vulnerability of land use/cover associated with human-wildlife conflicts in Mullaitivu District, Sri Lanka

Geocarto International 37 (2022) 15378-15391

Abstract. Human-wildlife conflict has increased over the decades and is now considered one of the most severe challenges to the survival of threatened species and the livelihood of communities worldwide. In Sri Lanka, population growth, fragmentation of land, and conversion of natural wildlife habitats into settlement and agricultural areas are the leading causes of human-wildlife conflict. This study seeks to characterise the conflict pattern in the Mullaitivu District by identifying land use/cover changes and assessing the vulnerability of land use/cover. Primary data were collected through a field survey using a structured questionnaire and direct observation methods, and secondary data on land use/cover changes were obtained from remote sensing images. These data were analysed statistically and on the Geographic Information System (GIS) platform. The study reveals land use/cover vulnerability status over the 26 years. Dense forests are on the decline, and wild animals migrate into human settlements and agricultural sites, resulting in different types of human-wildlife conflict such as crop damage, livestock depredation, and loss of life and/or injuries to both people and wildlife in the Mullaitivu District. People employ various wildlife mitigation strategies. However, they cannot safeguard their crops or livestock from these animals. By implementing appropriate management measures to avoid wildlife infiltration into human settlements, the human-wildlife conflict in the Mullaitivu District can be minimised. © 2022 Informa UK Limited.

P. Bodesheim, J. Blunk, M. Körschens, C.-A. Brust, C. Käding & J. Denzler

Pre-trained models are not enough: Active and lifelong learning is important for long-term visual monitoring of mammals in biodiversity research – Individual identification and attribute prediction with image features from deep neural networks and decoupled decision models applied to elephants and great apes

Mammalian Biology 102 (2022) 875-897

Abstract. Animal re-identification based on image data, either recorded manually by photographers or automatically with camera traps, is an important task for ecological studies about biodiversity and conservation that can be highly automatized with algorithms from computer vision and machine learning. However, fixed identification models only trained with standard datasets before their application will quickly reach their limits, especially for long-term monitoring with changing environmental conditions, varying visual appearances of individuals over time that differ a lot from those in the training data, and new occurring individuals that have not been observed before. Hence, we believe that active learning with human-in-the-loop and continuous lifelong learning is important to tackle these challenges and to obtain high-performance recognition systems when dealing with huge amounts of additional data that become available during the application. Our general approach with image features from deep neural networks and decoupled decision models can be applied to many different mammalian species and is perfectly suited for continuous improvements of the recognition systems via lifelong learning. In our identification experiments, we consider four different taxa, namely two elephant species: African forest ele-

phants and Asian elephants, as well as two species of great apes: gorillas and chimpanzees. Going beyond classical re-identification, our decoupled approach can also be used for predicting attributes of individuals such as gender or age using classification or regression methods. Although applicable for small datasets of individuals as well, we argue that even better recognition performance will be achieved by improving decision models gradually via lifelong learning to exploit huge datasets and continuous recordings from long-term applications. We highlight that algorithms for deploying lifelong learning in real observational studies exist and are ready for use. Hence, lifelong learning might become a valuable concept that supports practitioners when analyzing large-scale image data during long-term monitoring of mammals.

Souraditya Chakraborty
Trends and patterns of elephant conservation management and human elephant conflict scenario in forests of northern West Bengal, India
Proc. of the Zoological Soc. 75 (2022) 319-332
Abstract. No permission to print abstract.

A.N. Chan, G. Wittemyer, J. McEvoy, A.C. Williams, N. Cox, P. Soe, M. Grindley, N.M. Shwe, A.M. Chit, Z.M. Oo & P. Leimgruber
Landscape characteristics influence ranging behavior of Asian elephants at the human-wildlands interface in Myanmar
Movement Ecology 10 (2022) e6
Abstract. Asian elephant numbers are declining across much of their range driven largely by serious threats from land use change resulting in habitat loss and fragmentation. Myanmar, holding critical range for the species, is undergoing major developments due to recent sociopolitical changes. To effectively manage and conserve the remaining populations of endangered elephants in the country, it is crucial to understand their ranging behavior. Our objectives were to (1) estimate the sizes of dry, wet, and annual ranges of wild elephants in Myanmar; and quantify the relationship between dry season (the period when human-elephant interactions are the most likely to occur) range size and configurations of agriculture and natural vegetation within the range, and (2) evaluate how percentage of agriculture within dry core range (50% AKDE range) of elephants relates to their daily distance traveled. We used autocorrelated kernel density estimator (AKDE) based on a continuous-time movement modeling (ctmm) framework to estimate dry season (26 ranges from 22 different individuals), wet season (12 ranges from 10 different individuals), and annual range sizes (8 individuals), and reported the 95%, 50% AKDE, and 95% Minimum Convex Polygon (MCP) range sizes. We assessed how landscape characteristics influenced range size based on a broad array of 48 landscape metrics characterizing aspects of vegetation, water, and human features and their juxtaposition in the study areas. To identify the most relevant landscape metrics and simplify our candidate set of informative metrics, we relied on exploratory factor analysis and Spearman's rank correlation coefficient. Based on this analysis we adopted a final set of metrics into our regression analysis. In a multiple regression framework, we developed candidate models to explain the variation in AKDE dry season range sizes based on the previously identified, salient metrics of landscape composition. Elephant dry season ranges were highly variable averaging 792.0 km^2 and 184.2 km^2 for the 95% and 50% AKDE home ranges, respectively. We found both the shape and spatial configuration of agriculture and natural vegetation patches within an individual elephant's range play a significant role in determining the size of its range. We also found that elephants are moving more (larger energy expenditure) in ranges with higher percentages of agricultural area. Our results provide baseline information on elephant spatial requirements and the factors affecting them in Myanmar. This information is important for advancing future land use planning that takes into account space-use requirements for elephants. Failing to do so may further endanger already declining elephant populations in Myanmar and across the species' range.

B.M. Chandranaik, V. Patil, D. Rathnamma, G.S. Mamatha, K.S. Umashankar, D.N. Nagaraju & S.M. Byregowda
Drought may severely reduce the ability of wild Asian elephants *Elephas maximus* (Mammalia: Proboscidea: Elephantidae) to resist opportunistic infections

J. of Threatened Taxa 14 (2022) 20951-20963

Abstract. The present study was conducted to assess the microbial quality of water in forest waterholes in different seasons and its possible impact on wild animals, at Bandipur and Nagarahole Tiger Reserve forests in the state of Karnataka, India, during the year 2012 which evidenced drought, and the year 2014 which witnessed normal rainfall in these forests. The forests recorded the death of 39 wild elephants during April and May of 2012. One ailing elephant was confirmed to have high fever, diarrhoea, leucocytosis, and symptoms of colic. Water samples collected from major waterholes during the peak drought showed higher numbers of coliforms and several species of opportunistic bacteria including species of Vibrio and Campylobacter. In the year 2014–15, with normal rainfall, the death of less than 10 wild elephants was documented during April to May, 2015. We collected water samples from 20 major waterholes every month from June 2014 to May 2015 and assessed the water quality. We found that the microbial water quality improved in rainy season (Jun – Sep), started deterioration in winter (Oct – Jan) and became poor in summer (Feb – May). Though, the water during the summer of 2014–15 was equally of poor microbial quality as seen during peaks of droughts, the elephant deaths were relatively lower, signifying the role of normal rainfall in forests which provides the availability of fodder and water, which determines the general body condition and ability to resist opportunistic infections. We discuss the measures suggested and implemented from this study and their utilities at ground level.

C. Cheah & K. Yoganand

Recent estimate of Asian elephants in Borneo reveals a smaller population

Wildlife Biology 2022 (2022) e01024

Abstract. Asian elephants occurring in northern Borneo form a geographically isolated and genetically distinct population. Of this, the subpopulation of Central Sabah holds the greatest opportunity for long-term survival, due to a relatively large population size and occurrence over a vast, contiguous and protected habitat. We surveyed this subpopulation in 2015 using advanced methods to obtain a population size estimate. We used the distance-sampling framework and laid out transects following a stratified random design for counting elephant dung piles; measured dung decay following the 'retrospective' method; and used Bayesian analysis to estimate dung decay rate and dung pile density. Thus, we estimated a posterior mean dung decay rate of 212 days (95% BCI: 133–319), an overall elephant density of 0.07 per km^2 (95% BCI: 0.03– 0.11) and a population size of 387 elephants (95% BCI: 169–621). These estimates were far lower than the population size of 1132 individuals and density of 1.18 per km2 estimated in 2008. It is unlikely that there has been a steep population decline, as there were no drastic land-use changes between 2008 and 2015, nor were there other identifiable causes for a population decline. Therefore, it appears that the methodological and analytical flaws in the previous estimate are the most plausible reason for this observed difference. Given that the new estimate suggests a much smaller population, it is prudent and precautionary to use the new estimate as the basis for all policy decisions and conservation actions for elephants in Sabah.

H.M. Chel, S. Bawm, L.L. Htun, M.A. Masum, O. Ichii, N. Nonaka, R. Nakao & K. Katakura

Scanning electron microscopy of *Quilonia renniei* from Asian elephants revealing variation in coronal leaflet number

Parasitology 149 (2022) 529 - 533

Abstract. Although parasitic nematodes in the genera *Murshidia* and *Quilonia* (family Strongylidae) are recognized as major gastrointestinal parasites in Asian elephants, they have been poorly studied. Recently, light micrographs of these parasites in Myanmar have been presented, almost 100 years after the original drawings. However, the number of coronal leaflets, a key taxonomic feature of *Quilonia* species, has not been precisely determined based on light microscopy. The current study aimed to determine the exact number of coronal leaflets in *Quilonia renniei* specimens from Asian elephants in Myanmar. On the basis of scanning electron micrographs, leaflet number in females (19.7) was significantly higher ($P < 0.005$) than that in males (18.1). This compares with 18 coronal leaflets indicated in the original species description. Specimens bearing 19 coronal leaflets were most numerous, followed

by those with 20 leaflets. Median-joining network analysis of mitochondrial cytochrome c oxidase subunit I gene sequences with 16 haplotypes from 19 individuals revealed no clear association between parasite populations and the number of coronal leaflets. These results highlight the importance of determining the number of coronal leaflets in the taxonomy of *Q. renniei* and other related *Quilonia* species infecting Asian elephants.

L.L. Coughlin, C.R. Sanchez, M.I. Monti, J.A. Griffioen, F.B. Nutter& G.L. Beamer

Potential diagnostic biomarkers for pulmonary tuberculosis in humans are not elevated in *Mycobacterium tuberculosis* culture–positive Asian elephants (*Elephas maximus*)

American Journal of Veterinary Research 83 (2022) e22.01.0016

Abstract. To determine (1) if chemokine (C-X-C motif) ligand 1 (CXCL1), matrix metalloproteinase 8 (MMP8), interleukin-10 (IL-10), interferon-γ (IFN-γ), and tumor necrosis factor-α (TNF-α) can be detected in serum from Asian elephants, and (2) if their concentrations are significantly elevated in *Mycobacterium tuberculosis* (*M.tb*) culture–positive elephants compared to –negative elephants. CXCL1, MMP8, IL-10, IFN-γ, and TNF-α were recently identified as potential diagnostic biomarkers for pulmonary tuberculosis in experimental studies in animals and humans. Therefore, we hypothesized that they would be detectable and significantly elevated in *M.tb* culture–positive elephants compared to *M.tb* culture-negative elephants. 101 Asian elephant serum samples, including 91 samples from 6 *M.tb*-negative elephants and 10 samples from 5 *M.tb*-positive elephants (none of which exhibited clinical signs of disease). *M.tb* status was determined by trunk wash culture. Commercially available ELISA kits were used to determine the concentrations of each biomarker in serum samples. Biomarker concentrations were below the limit of detection for the assay in 99% samples for CXCL1, 97% samples for MMP8, 85/101 (84%) samples for IL-10, 74% samples for IFN-γ, and 45% samples for TNF-α. Multiple *M.tb* culture-positive elephants did not have detectable levels of any of the 5 biomarkers. CXCL1, MMP8, IL-10, IFN-γ, and TNF-α were not elevated in *M.tb* culture-positive elephants compared to *M.tb* culture-negative elephants. This may be related to disease state (ie, clinically asymptomatic). More sensitive assays are needed to better understand the role of these biomarkers in *M.tb* infection in Asian elephants.

A. Cucina, A. Di Francesco, R. Saletti, M.G.G. Pittalà, G. Zilberstein, S. Zilberstein, A. Tikhonov, A.G. Bublichenko, P.G. Righetti, S. Foti & V. Cunsolo

Meta-proteomic analysis of two mammoth's trunks by EVA technology and high-resolution mass spectrometry for an indirect picture of their habitat and the characterization of the collagen type I, alpha-1 and alpha-2 sequence

Amino Acids 54 (2022) 935-954

Abstract. The recent paleoproteomic studies, including paleo-metaproteomic analyses, improved our understanding of the dietary of ancient populations, the characterization of past human diseases, the reconstruction of the habitat of ancient species, but also provided new insights into the phylogenetic relationships between extant and extinct species. In this respect, the present work reports the results of the metaproteomic analysis performed on the middle part of a trunk, and on the portion of a trunk tip tissue of two different woolly mammoths some 30,000 years old. In particular, proteins were extracted by applying EVA films to the surface of these tissues belonging to two *Mammuthus primigenus* specimens, discovered in two regions located in the Russian Far East, and then investigated via a shotgun MS-based approach. This approach allowed to obtain two interesting results: (i) an indirect description of the habitat of these two mammoths, and (ii) an improved characterization of the collagen type I, alpha-1 and alpha-2 chains (col1a1 and col1a2). Sequence characterization of the col1a1 and col1a2 highlighted some differences between *M. primigenius* and other Proboscidea together with the identification of three (two for col1a1, and one for col1a2) potentially diagnostic amino acidic mutations that could be used to reliably distinguish the *M. primigenius* with respect to the other two genera of elephantids (*Elephas* and *Loxodonta*), and the extinct American mastodon (*Mammut americanum*).

The results were validated through the level of deamidation and other diagenetic chemical modifications of the sample peptides, which were used to discriminate the "original" endogenous peptides from contaminant ones. © 2022 The Authors.

Yunchuan Dai
The overlap of suitable tea plant habitat with Asian elephant (*Elephus maximus*) distribution in southwestern China and its potential impact on species conservation and local economy
Environmental Science and Pollution Research 29 (2022) 5960-5970
Abstract. No permission to print abstract.

P. Das, A. Kshettry & H.N. Kumara
Trunk picking from a truncating menu: Dry season forage selection by Asian elephant in a multi-use landscape
PLoS ONE 17 (2022) e0271052
Abstract. Elephants show a strong selection towards areas with high foraging opportunities at the landscape level making top-down decisions by first selecting patch types within landscapes and finally species within them. Understanding forage selection in a multi-use landscape is critical for prioritising patches for habitat management, ensuring availability of selected forage, helping in minimizing pressure on food crops and subsequent negative interactions with people. We assessed dry season forage selection in a multi-use landscape of West Bengal state, India. Relative forage use and relative plant species availability ratio were calculated to assess forage selection in a multi-use landscape comprising of the forest, tea estates, agricultural land, and human settlement. Forage use was assessed using the opportunistic feeding trail observation method (150 km). Stratified random sampling was used to assess plant species availability using the quadrat method (123 plots of 0.1 ha each). Among 286 plant species recorded, 132 plant species were consumed by elephants. A majority (80.21%) of plant species were consumed more than the proportional availability thereby showing selective foraging during the dry season in the study area. From forest to semi-open forest and open forest, canopy layer tree density and the total number of species decreased whereas invasive species density increased. This indicates the high impact on the forage species availability for elephants and the requirement of appropriate habitat management strategies. The presence of 32.14% of the selected forage species in human-use landscape alone demands the development of conservation interventions. This is the first study to assess forage selection by elephants in a multi-use landscape and used to prioritise conservation and management strategies at a landscape level. © 2022 The Authors.

R. De, P. Nigam, A.C. Williams & S.P. Goyal
Beyond consensus genotyping: A case study on the Asian elephant *Elephas maximus*
Conservation Genetics Resources 14 (2022) 403-411
Abstract. No permission to print abstract.

J.A. de la Torre, C. Cheah, A.M. Lechner, E.P. Wong, A. Tuuga, S. Saaban, B. Goossens & A. Campos-Arceiz
Sundaic elephants prefer habitats on the periphery of protected areas
J. of Applied Ecology 59 (2022) 2947-2958
Abstract. Protected areas (PAs) are a cornerstone of global conservation strategies. PAs, however, are not equally effective for all threatened taxa, and it is important to understand taxa-specific effectiveness of PAs networks. In this study, we evaluate the role of the PAs network on the protection of Asian elephants and their habitats in Southeast Asia's Sundaic region. Since Asian elephants tend to prefer secondary forests or forest gaps, we predicted that PAs would not represent the species preferred habitats. We conducted the most comprehensive analysis of Asian elephant space and habitat use to date through home range estimations and step selection function analyses using over 600,000 Global Positioning System locations from 102 different elephants from Peninsular Malaysia and Borneo. Our results revealed important similarities in the habitat use of elephants in both regions, with both females and males in Peninsular Malaysia and Sabah preferring secondary forest, forest gaps and areas of regrowth and new plantations. Our results supported our prediction that PAs do not represent Asian elephants' preferred habitats, since for most of the elephants, more than half of their ranges were outside PAs and the probability of

selection values for both sexes in both geographical areas were lower inside than outside the PAs. Our analysis suggests that conservation strategies need to acknowledge that the long-term survival of Asian elephants in the Sundaic region relies on our capacity to promote human-elephant coexistence at the boundaries of PAs. We advocate that Asian elephant conservation strategies should be based on the following three key points: (1) large PAs with core areas where elephants can find safety and potentially survive in the long term; (2) promoting connectivity among PAs using a system of wildlife corridors; and (3) effective human-elephant conflict management outside PAs. © 2022 The Authors.

M. De Silva, P. Kumarasinghe, K. De Zoysa & C. Keppitiyagama
Reidentifying Asian elephants from ear images using a cascade of convolutional neural networks and explaining with GradCAM
SN Computer Science 3 (2022) e192
Abstract. No permission to print abstract.

E.M.K. de Silva, P. Kumarasinghe, K.K.D.A.K. Indrajith, T.V. Pushpakumara, R.D.Y. Vimukthi, K. de Zoysa, K. Gunawardana & S. de Silva
Feasibility of using convolutional neural networks for individual-identification of wild Asian elephants
Mammalian Biology 102 (2022) 931-941
Abstract. No permission to print abstract.

A. Devi, S.A. Hussain, M. Sharma, G.V. Gopi & R. Badola
Seasonal pattern of food habits of large herbivores in riverine alluvial grasslands of Brahmaputra floodplains, Assam
Scientific Reports 12 (2022) e482
Abstract. Jarman-Bell (1974) hypothesized that in the dry savanna of Africa, small-bodied herbivores tend to browse more on forage with high protein and low fibre content. This implies browsing on high nutritive forage by meso-herbivores, and grazing and mixed feeding on coarse forage by mega-herbivores. We tested this hypothesis in the riverine alluvial grasslands of the Kaziranga National Park (KNP), where seasonal flood and fire play an important role in shaping the vegetation structure. We analyzed the feeding habits and quality of major forage species consumed by three mega-herbivores, viz. greater one-horned rhino, Asian elephant, and Asiatic wild buffalo, and three meso-herbivores, viz. swamp deer, hog deer, and sambar. We found that both mega and meso-herbivores were grazers and mixed feeders. Overall, 25 forage plants constituted more than 70% of their diet. Among monocots, family Poaceae with *Saccharum* spp. (contributing > 9% of the diet), and, among dicots, family Rhamnaceae with *Ziziphus jujuba* (>4%) fulfilled the dietary needs. In the dry season, the concentration of crude protein, neutral detergent fibre, calcium, sodium, and phosphorous varied significantly between monocots and dicots, whereas only calcium and sodium concentrations varied significantly in the wet season. Dicots were found to be more nutritious throughout the year. Compared to the dry season, the monocots., with their significantly high crude protein, were more nutritious during the wet season. Possibly due to the availability of higher quality monocots in the wet season, both mega and meso-herbivores consume it in high proportion. We concluded that the Jarman-Bell principle does not apply to riverine alluvial grasslands as body size did not explain the interspecific dietary patterns of the mega and meso-herbivores. This can be attributed to seasonal floods, habitat and forage availability, predation risk, and management practices such as controlled burning of the grasslands. The ongoing succession and invasion processes, anthropogenic pressures, and lack of grassland conservation policy are expected to affect the availability of the principal forage and suitable habitat of large herbivores in the Brahmaputra floodplains, which necessitates wet grassland-based management interventions for the continued co-existence of large herbivores in such habitats. © 2022 The Authors.

A. Domínguez-Oliva, M.D. Ghezzi, P. Mora-Medina, I. Hernández-Ávalos, J. Jacome, A. Castellón, I. Falcón, F. Reséndiz, N. Romero, R. Ponce & D. Mota-Rojas
Anatomical, physiological, and behavioral mechanisms of thermoregulation in elephants
Journal of Animal Behaviour and Biometeorology 10 (2022) e2233
Abstract. Elephants use different thermoregulatory mechanisms that depend on the anatom-

ical and morphological characteristics of the species. The crevices and wrinkles of the skin enhance the water-retention capacity of the epidermis. The highly vascularized ear is another region of particular interest, as its movement and vasomotor changes promote heat dissipation. Generally, these mechanisms are modulated by the hypothalamic thermoregulatory center and by the peripheral response of animals. Nonetheless, elephants are currently exposed to alterations in their habitats, such as global warming and climatic changes, which challenge their homeothermy. This article aims to discuss the thermoregulation mechanisms of African and Asian elephants from an anatomical, physiological, and behavioral basis. The practical implications of these elements will be analyzed to implement tools, such as infrared thermography, or environmental enrichment, as strategies to promote the thermal balance of elephants.

J.J. Figel, M. Hambal, I. Krisna, R. Putra & D. Yansyah

Malignant snare traps threaten an irreplaceable megafauna community

Tropical Conservation Science 14(2021) 17 February 2021

Abstract. Tropical forests are under severe threat from over-hunting. Subsistence harvests and poaching have decimated wildlife populations to the extent that nearly 50% of Earth's tropical forests are partially or fully devoid of large mammals. Declines are particularly acute in Southeast Asia where ongoing defaunation, largely attributable to indiscriminate snare trapping, is widespread. Using the extensively forested Aceh province in northern Sumatra as a case study, we document rampant snaring, which threatens Earth's last sympatric population of tigers, rhinoceros, elephants, and orangutans. To prevent catastrophic hunting-induced impacts already experienced in mainland Southeast Asia, we call for more comprehensive conservation planning assessments that strengthen wildlife law enforcement, promote collaborative anti-poaching, and research species-specific snaring impacts, particularly in the context of human-wildlife conflict. We conclude with a discussion of the important linkages between poaching, wildlife trade, and zoonotic disease risk. © 2021 The Authors.

R. Ghimire, S. Regmi, R. Shrestha, A. Sadaula & J.D. Joshi

Hematological value of captive Asian elephants *Elephas maximus* around Chitwan National Park, Sauraha, Nepal

J. of Threatened Taxa 14 (2022) 21811-21817

Abstract. Veterinary hematology serves as an important screening procedure to assess general health conditions, diagnosis, and treatment of disease. This study aims to interpret and establish a set of hematology reference ranges for Asian elephants managed by private and government facilities in Nepal. Blood samples from 50 elephants around Chitwan National Park, Sauraha were collected and hematological parameters such as total erythrocyte count and total leukocyte count were determined. The results show that the majority of hematological values were in line with the values previously published by different authors. The mean erythrocyte and leukocyte counts were reported as 3.32 ± 0.93 × 10^6 cell/μL and 10448 ± 335.49 cells /μL respectively. No sex-associated difference was observed in the case of total erythrocyte count, whereas total leukocyte counts varied significantly within sexes. Our findings revealed no significant difference in hematological parameters between government and privately owned elephants. The hematological values from our study can be used as reference for assessing the health condition of elephants in Nepal. Further research work should be conducted to evaluate the factors affecting hematological parameters. © 2022 The Authors.

S. Gupta, N. Mohan, P. Nayak, K.C. Nagaraju & M. Karanam

Deep vision-based surveillance system to prevent train-elephant collisions

Soft Computing 26 (2022) 4005-4018

Abstract. No permission to print abstract.

N.L. Hammond, A. Dickman & D. Biggs

Examining attention given to threats to elephant conservation on social media

Conserv. Science and Practice 4 (2022) e12785

Abstract. Although social media is growing rapidly as a news source, including for disseminating conservation information, studies comparing attention given to differing threats to species on social media are almost non-existent. As the amount of attention given to differing

threats can influence what people perceive to be important and impact the formation of environmental policies, it is vital that conservationists understand which issues are being discussed online. Using elephants (*Loxodonta africana*, *Loxodonta cyclotis*, and *Elephas maximus*) as test species, we conducted a content analysis of tweets about elephants posted to Twitter during 2019. According to the global conservation authority IUCN the most pressing threats to the conservation of wild elephant populations are habitat loss, human-elephant conflict, and poaching, with the magnitude of each threat differing between the three species of elephants. Our Twitter analysis revealed that these major threats were infrequently discussed, with habitat loss being the most infrequently discussed (<1% of all tweets). Instead, elephant welfare issues, such as tourist elephant rides, were the most frequently discussed topic (23%). Users from non-elephant range countries were the dominant voice on Twitter (72% of tweets with an identifiable location), with these tweets likely to discuss elephant welfare concerns and trophy hunting, which is not a threat to elephant conservation. Conversely, tweets from users from African elephant range countries (14%) were more likely to discuss human-elephant conflict, poaching, and promote elephant tourism. Similarly, users from Asian elephant range countries (13%) were likely to discuss human-elephant conflict and elephant tourism but unlikely to tweet about poaching. Given the relatively low representation of local stakeholders and the limited coverage of key conservation threats, there is a need to ensure that social media discussions do not overly influence decision-makers.

D.K. Hewavithana, M.R. Wijesinghe & P.V. Udagama

Gastrointestinal parasites of six large mammals in the Wasgomuwa National Park, Sri Lanka

International Journal for Parasitology: Parasites and Wildlife 17 (2022) 1-6

Abstract. Gastrointestinal (GI) parasites may impose detrimental consequences on wildlife populations due to their capacity to cause mortality and reduce fitness. Additionally, wild animals play an important role in the transmission of zoonoses. Despite this importance, information on GI parasites of tropical wild mammals is critically lacking. The present study aimed to document GI parasites of six wild-dwelling large mammal taxa in Sri Lanka: Asian elephant, sloth bear, civet, leopard , grey langur and buffalo. Fresh faecal samples (n = 56) collected from the Wasgomuwa National Park, Sri Lanka were subjected to coprological examination using faecal smears, and the brine floatation technique followed by microscopic identification; quantitative data were accrued using the formol-ether method. The survey revealed a high prevalence of GI parasites, where 86% of faecal samples screened positive for parasitic infections. Faecal samples of the civet, buffalo and leopard recorded 100% prevalence, while the lowest (40%) was recorded for the grey langur. Eight types of GI parasites were documented: protozoan cysts, platyhelminth ova (three types of digenean and a single cyclophillidean type), nematode ova (strongyle, strongyloid, ascarid, and trichuroid types) and rhabditiform larvae. The buffaloes and civets had a comparatively high number and diversity of GI parasites (buffalo: 7 types, H' = 1.02; civet: 6 types, H' = 1.52), whilst only a single type (digenean) was detected in the grey langur. Likewise, parasite loads were also highly variable; highest in the bear (486 per g faeces) and lowest in the monkey (10 per g faeces). The outcome of this survey is important on two accounts; i) to fill the knowledge gap on GI parasites of tropical wild mammals, and ii) the revelation of many first-time parasite-host records for some of the threatened wild-dwelling large mammals in Sri Lanka.

T.E. Hoornweg, V.P. Perera, R.N.S. Karunarathne, W. Schaftenaar, T.A.N. Mahakapuge, A.W. Kalupahana, V.P.M.G. Rutten & C.A.M. de Haan

Young elephants in a large herd maintain high levels of elephant endotheliotropic herpesvirus-specific antibodies and do not succumb to fatal haemorrhagic disease

Transboundary and Emerging Diseases 69 (2022) 3379-3385

Abstract. Elephant endotheliotropic herpesviruses (EEHVs) have co-existed with elephants for millions of years, yet may cause fatal haemorrhagic disease (EEHV-HD), typically in elephants between 1 and 10 years of age. EEHV is

omnipresent in (sub)adult elephants, and young elephants with low EEHV-specific antibody levels are at risk for EEHV-HD, suggesting that fatal disease may occur due to an insufficiently controlled primary infection. To further address this hypothesis, sera of three large elephant cohorts were subjected to a multiple EEHV species ELISA: (I) 96 Asian elephants between 0 and 57 years, including 13 EEHV-HD fatalities, from European zoo herds typically sized five to six elephants, (II) a herd of 64 orphaned elephants aged 0–15 years at the Elephant Transit Home in Sri Lanka and (III) 31 elephants aged 8–63 years, part of a large herd of 93 elephants at Pinnawala Elephant Orphanage, Sri Lanka. All Sri Lankan elephants showed high EEHV-specific antibody levels regardless of their age. While antibody levels of most European zoo elephants were comparable to those of Sri Lankan elephants, the average antibody level of the European juveniles (1–5 years of age) was significantly lower than those of age-matched Sri Lankan individuals. Moreover, European juveniles showed a gradual decrease between 1 and 4 years of age, to be attributed to waning maternal antibodies. Maintenance of high levels of antibodies in spite of waning maternal antibodies in young Sri Lankan elephants is likely due to the larger herd size that increases the likelihood of contact with EEHV-shedding elephants. Together with the observation that low levels of EEHV-specific antibodies correlate with increased numbers of EEHV-HD fatalities, these results suggest that infection in presence of high maternal antibody levels may protect calves from developing EEHV-HD, while at the same time activating an immune response protective in future encounters with this virus.

S. Ishikawa, Y. Ozeki, S. Suga, Y. Mukai, H. Kobayashi, E. Inouchi, S.A. Kaboso, G. Gebretsadik, D.N.S.S. Dewi, A. Nishiyama, Y. Tateishi, H. Takihara, S. Okuda, S. Yoshida, N. Misawa & S. Matsumoto

Monitoring IgG against *Mycobacterium tuberculosis* proteins in an Asian elephant cured of tuberculosis that developed from long-term latency

Scientific Reports 12 (2022) e4310

Abstract. Tuberculosis (TB) is fatal in elephants, hence protecting elephants from TB is key not only in the conservation of this endangered animal, but also to prevent TB transmission from elephants to humans. Most human TB cases arise from long-term asymptomatic infections. Significant diagnostic challenges remain in the detection of both infection and disease development from latency in elephants due to their huge bodies. In this study, we assessed cryopreserved sera collected for over 16 years, from the first Japanese treatment case of elephant TB. Semi-quantification of IgG levels to 11 proteins showed high detection levels of 3 proteins, namely ESAT6/CFP10, MPB83 and Ag85B. The level of IgG specific to these 3 antigens was measured longitudinally, revealing high and stable ESAT6/CFP10 IgG levels regardless of onset or treatment. Ag85B-specifc IgG levels were largely responsive to onset or treatment, while those of MPB83 showed intermediate responses. These results suggest that ESAT6/CFP10 is immunodominant in both asymptomatic and symptomatic phases, making it useful in the detection of infection. On the other hand, Ag85B has the potential to be a marker for the prediction of disease onset and in the evaluation of treatment effectiveness in elephants. © 2022 The Authors.

Akira Ito

Description of eight *Triplumaria* species (Ciliophora, Entodiniomorphida) found in Asian elephants

European J. of Protistology 84 (2022) e125881

Abstract. Five new *Triplumaria* species were described from Asian elephants (*T. avis*, *T. cryptopteron*, *T. takakoae*, *T. soichii*, *T. cataphracta*) as well as three species described by Timoshenko and Imai (1995), namely *T. asiatica*, *T. nucleocaudata*, and *T. ovina*. The new species have distinct skeletal plate structures: *T. avis* and *T. cryptopteron* have the ventral wing, grooves lined with lobes, and posterior fin; *T. takakoae*, the dorsal oar-shaped stick; *T. soichii*, the ventral spine and dorsal turn back fringed with lobes; *T. cataphracta*, two rows of bollard-shaped lobes and two folds composed of a smooth edge and lobes. These eight *Triplumaria* species have various buccal infraciliary bands. *T. avis*, *T. cryptopteron*, *T. asiatica*, and *T. nucleocaudata* have the perivestibular polybrachykinety connected only to the right end of adoral polybrachykinety. *T. takakoae*

and *T. soichii* have the perivestibular polybrachykinety that connects to both ends of adoral polybrachykinety and has a loop along the vestibular left slit. *T. cataphracta* and *T. ovina* have the vestibular polybrachykinety connected to the right end of the twisted adoral polybrachykinety. *Triplumaria* species are highly differentiated ciliates in elephants; 23 of the 28 species described so far have been found in Asian elephants.

M.L. Iyer, C.M. Molter, J.P. Flanagan, K.L. Bauer, R. Bernardy, D. Hoffman, L. Parkinson, B.M. Brainard, T.S. Evans, T. Pursell & P.D. Ling

Novel diagnostic and therapeutic approaches to elephant endotheliotropic herpesvirus 1A hemorrhagic disease in a captive juvenile Asian elephant (*Elephas maximus*)

Journal of Zoo and Wildlife Medicine 53 (2022) 232-240

Abstract. Novel diagnostic and therapeutic methods were utilized in the successful management of severe elephant endotheliotropic herpesvirus hemorrhagic disease (EEHV-HD) in a 1.9-yr-old captive Asian elephant. High levels of EEHV1A viremia were detected for 12 d. In addition to established EEHV treatments, therapies included famciclovir-fortified elephant whole blood and plasma, mesenchymal stem cells harvested from elephant umbilical tissue, and aminocaproic acid. Testing conducted to examine the effects of EEHV infection on hemostasis suggested marked intravascular coagulation with decreased plasminogen activity and increased D-dimer concentrations. Thromboelastography was used to assess the efficacy of aminocaproic acid and demonstrated hypofibrinolysis on samples taken after drug administration, as compared with samples from healthy adult elephants. A serological assay for a novel EEHV1A-specific antibody marker (E52) was developed due to lack of seroconversion to a previously established EEHV1A-specific antibody marker (ORFQ) and showed a sustained increase after EEHV-HD illness. © 2022 American Assoc. of Zoo Veterinarians.

S.L. Jacobson, A. Puitiza, R.J. Snyder, A. Sheppard & J.M. Plotnik

Persistence is key: Investigating innovative problem solving by Asian elephants using a novel multi-access box

Animal Cognition 25 (2022) 657-669

Abstract. No permission to print abstract.

G. Li, Y. Jiang, Q. Li, D. An, M. Bao, L. Lang, L. Han, X. Huang & C. Jiang

Comparative and functional analyses of fecal microbiome in Asian elephants

Antonie van Leeuwenhoek 115 (2022) 1187-1202

Abstract. No permission to print abstract.

S. Kajaria, N. Sekar & S. Sharma

Charisma failure: Understanding differences in support for conservation of Asian elephants compared to tigers and African elephants

Biological Conservation 276 (2022) e109745

Abstract. The disproportionately high support for conservation of charismatic species is well-documented. However, available data demonstrate substantial discrepancies in funding for conservation even among charismatic species, and these differences are poorly understood. We use two survey experiments to explore explanations for differences in demand for conservation between charismatic species by comparing Asian elephants with tigers in India and with African elephants globally. Through social media, we collect data from conservation enthusiasts to measure (a) relative demand for conservation, (b) awareness about conservation status, (c) relative favourability, and (d) perception of which species faces greater conservation challenges ("risk perception"). Overall, respondents allocated significantly more funds to the species/taxon they perceive to be more at risk and 41–54% more to the species/taxon they say they like more (though about 70% of respondents claimed to like both species/taxa presented equally). On average, respondents in India allocated 5.6 % more for tigers than Asian elephants, a far smaller discrepancy than found in public data from key real-life funders. Internationally, respondents allocated 14% more funds for African than Asian elephants (despite there being fewer Asian elephants) and generally overestimated how endangered African elephants are compared to Asian elephants. Our study suggests (i) conservation enthusiasts wish

to donate more to more endangered charismatic species but are sometimes misinformed about the level of endangerment of even very well-known species, and (ii) discrepancies in actual funding levels across charismatic species appear to be greater than conservation enthusiasts believe they should be. © 2022 Reprinted with permission from Elsevier.

D. Karki, N. Poudel, S. Dixit, S. Bhatta, B. Gotame, M.K. Dhamala & D. Khadka
Human-wildlife conflicts in Paschim Kusaha village of Koshi Tappu Wildlife Reserve, Sunsari District, Nepal
Journal of Resources and Ecology 13 (2022) 1022-1029
Abstract. Human-wildlife conflict has been one of the most trouble-causing issues in many areas of Nepal including Eastern Nepal. This study assessed the human-wildlife conflict status in Paschim Kusaha Village of Koshi Tappu Wildlife Reserve (KTWR), Sunsari District, Nepal. Data were collected from 47 respondents of different households through questionnaire surveys and formal and informal interviews. Results revealed that the most destructive wild animals were wild elephants, wild boar, and wild water buffalo and the most raided crops were paddy (63.83 %), maize (19.15%), and potato (17.02%). Most of the encounters between humans and wildlife were recorded at night (after dusk and before dawn) (78.72%). Local people were suffering from damage of physical properties, human harassment or nuisance, and depredation of cropland due to wild animals. A total of 70% of respondents had a positive attitude towards conservation despite disturbing human mortality records (22 deaths in the last five years) from the reserve area and surrounding. Awareness of wildlife behavior together with conservation and easy access to compensation schemes were suggested to minimize conflicts in the area.

G. Katlam, S. Prasad, A. Pande & N. Ramchiary
Plastic ingestion in Asian elephants in the forested landscapes of Uttarakhand, India
J. for Nature Conservation 68 (2022) e126196
Abstract. Ecological impacts of plastic contamination on marine environment have been documented extensively, however its spread and impacts on terrestrial and freshwater fauna are still poorly understood. In the present study, we investigated diet of Asian elephant for plastic ingestion around forested habitats of Uttarakhand state in India. We quantified plastic particles and other anthropogenic waste from elephant dung samples collected from edges and interiors of forest areas, confirming plastic ingestion by this endangered mammal species. Each human-derived item was identified, measured, and sub-categorized into plastic or other anthropogenic waste. About one-third (32%) of the elephant dung samples showed presence of anthropogenic waste. Plastic particles ranging from size 1–355 mm, comprised of 85% of the waste recovered from elephant dung samples (47.08 ± 12.85 particles per sample). We found twice as many plastic particles (85.27 ± 33.7/100 g) in samples collected from inside forest as compared to forest edge (35.34 ± 11.14 plastic particles/100 g). A higher count (34.79 ± 28.41 items/100 g sample) of non-biodegradable anthropogenic waste (glass, metal, rubber bands, clay pottery and tile pieces) was obtained from samples collected inside the forest area samples as compared to forest edge samples (9.44 ± 1.91 items/100 g). There were higher proportion of macroplastic (>5 mm) retrieved than microplastic (1–5 mm) in the elephant dung. The present study is the first systematic documentation of non-biodegradable waste ingestion by Asian elephants. High plastic presence in elephant dung highlights its widespread use near protected habitats and lack of waste segregation practices underlining the vulnerability of wild animals to plastic ingestion risk. We provide recommendations for developing a comprehensive solid waste management strategy to mitigate the threat of plastic pollution around critical elephant habitats in India. © 2022 Reprinted with permission from Elsevier.

K.T. Kavitha, C. Sreekumar & B.R. Latha
Case report of hook worm *Grammocephalus hybridatus* and stomach bot *Cobboldia elephantis* infections in a free-ranging Asian elephant *Elephas maximus* in Tamil Nadu, India
J. of Threatened Taxa 14 (2022) 20915-20920
Abstract. Elephants in the wild are susceptible to many gastrointestinal parasites. In the present study, necropsy was conducted on a free-ranging Asian elephant female aged about 15 years which died at Coimbatore forest range,

Tamil Nadu state, India. The necropsy revealed that the liver was infected with round worms and the stomach was heavily infested with dipteran larvae. These round worms and larvae were collected and processed by dehydrating in ascending grades of alcohol and then cleared in carbolic acid. The cleared samples were mounted and examined under light microscopy for species identification. Faecal samples collected from the rectum were analysed by sedimentation for the presence of helminth eggs. On microscopic examination, the head end of the round worms showed a buccal capsule which possessed a pair of semilunar ventral cutting plates. Male worms showed well-developed bursa at the posterior end. The anterior end of the dipteran larvae showed two powerful oral hooks with cephalopharyngeal skeleton. Anterior spiracle appeared as a short club-shaped tube with 12 lobes. The abdominal segments of the larvae had a row of belt-like triangular spines. The posterior spiracles of the larvae had three longitudinal parallel slits in each spiracle with closed peritreme. Based on the above morphological characters, the round worms and larvae were identified as *G. hybridatus* and *C. elephantis*, respectively. Strongyle eggs were identified in the faecal sample based on the morphology of thin shell and segmented yolk. This appears to be the first report of *G. hybridatus* infection in a free-ranging elephant in Tamil Nadu state, India.

S. Khammesri, C. Ampasavate, D. Hongwiset, R. Mektrirat, S. Sangsrijan, J.L. Brown & C. Thitaram

Pharmacokinetics and analytical determination of acyclovir in Asian elephant calves (*Elephas maximus*)

Vet. and Animal Science 15 (2022) e100227

Abstract. A therapeutic regimen that includes antiviral drugs is critical for the survival of Asian elephant calves infected with elephant endotheliotropic herpesvirus hemorrhagic disease (EEHV-HD), with acyclovir showing considerable promise. The purpose of this study was to determine the pharmacokinetics and bioavailability of acyclovir following intravenous (IV) and oral (PO) administration in Asian elephants. A single dose of acyclovir (15 mg/kg, IV or 45 mg/kg, PO) was administered to four healthy elephant calves, with a minimum 2-week washout period between treatments. Serial plasma samples were collected after each injection for acyclovir analysis using a validated liquid chromatography-tandem mass spectrometry (LC-MS/MS) technique. Maximum plasma acyclovir concentrations were 27.02 ± 6.79 μg/mL at 0.94 ± 0.31 h after IV administration, and 1.45 ± 0.20 μg/mL at 3.00 ± 0.70 h after PO administration. The half-life of the elimination phase (T1/2) was 5.84 ± 0.74 and 8.74 ± 2.47 h after IV and PO administration, respectively. After IV administration, acyclovir concentrations were higher than the half-maximal inhibitory concentration (IC50) of those found for herpes simplex virus (HSV) 1 and 2 in humans, and equid alpha herpesvirus-1 (EHV-1) for at least 12 h. By contrast, the bioavailability of oral administration was low, only 6.03 ± 0.87%, so higher doses by that route likely are needed to be effective. Due to the high concentration of plasma acyclovir after IV administration, the dose may need to be adjusted to prevent any negative side effects. © 2021 The Authors.

N. Kitratporn & W. Takeuchi

Human-elephant conflict risk assessment under coupled climatic and anthropogenic changes in Thailand

Science of the Total Env. 834 (2022) e155174

Abstract. As natural resources decrease, competition between humans and large endangered wildlife increases, hindering the sustainability of animal conservation and human development. Despite the multi-dimensional nature of such interactions, proactive assessments that consider both the biosphere and anthroposphere remain limited. In this study, we proposed a human elephant conflict risk assessment framework and analyzed the spatial distribution of risk at the baseline (2000–2019) and in the near future (2025–2044) for Thailand, so that it may address the multifaceted characteristics and impending effects of climate change. Future scenarios were based on the combination of RCP45/SSP2 or RCP85/SSP5 and spatial policy, with or without elephant buffer zones. The composite risk index, comprised of hazard, exposure, and vulnerability, was constructed using the geometric mean, and validation was performed with the area under the curve (AUC). Our results projected a shift with increasing future risk

toward higher latitudes and altitudes. Increasing future risk (average +1.7% to +7.4%) in the four forest complexes (FCs) in northwestern regions was a result of higher hazard and vulnerability from more favorable habitat conditions and increasing drought probability, respectively. Reduction in future risk (average −3.1% to −57.9%) in other FCs in lower regions was mainly due to decreasing hazard because of decreasing habitat suitability. Our results also highlight geographically explicit strategies to support long-term planning of conservation resources. Areas with increasing future risk are currently facing low conflict; hence it is recommended that future strategies should enhance adaptive capacity and coexistence awareness. Conversely, areas with lowering future risk from a decrease in habitat quality are recommended to identify buffer strategies around protected areas to support existing large elephant populations. © 2022 Reprinted with permission from Elsevier.

C.A. LaDue, K.E. Hunt, M.G.S.M. Samaraweera, R.P.G. Vandercone, W.K. Kiso & E.W. Freeman

Physical and behavioral indicators associated with hormonal changes during musth in zoo-housed and free-ranging Asian elephants (*Elephas maximus*)

Theriogenology Wild 1 (2022) e100011

Abstract. In-situ and ex-situ Asian elephant populations are threatened with extinction, and male elephants pose unique challenges to long-term sustainability. The heightened sexual state of "musth" is accompanied by a suite of physical, behavioral and physiological changes. Furthermore, musth is unique to male elephants and requires special consideration when developing short- and long-term management strategies for elephants in the wild and in human care. The purpose of this study was to identify associations between fecal hormone metabolites [fecal androgen metabolites, FAM; fecal glucocorticoid metabolites, FGM; and fecal triiodothyronine (T3) metabolites, FT3] and visible musth indicators [temporal gland secretions (TGS) and urine dribbling (UD)], and behavioral changes around musth. From fecal samples collected non-invasively from wild elephants in Wasgamuwa National Park, Sri Lanka, and zoo-housed elephants in the United States, we hypothesized that (1) TGS and/or UD would be associated with changes in FAM, FGM, and/or FT3 concentrations; (2) variation in fecal hormone metabolites would be associated with increased locomotion and chemosensory behavior, and decreased foraging; and (3) relationships we identified would be similar between wild and zoo-housed elephants. We found that FAM concentrations changed significantly with TGS and UD activity in both wild and zoo elephants. Further while FGM concentrations were higher with increased TGS and UD in zoo elephants, the opposite pattern occurred in wild elephants. We did not identify substantial change in FT3 concentrations with TGS/UD activity. Behavioral changes in zoo elephants were significantly associated with FAM concentration as predicted, but these relationships were more difficult to identify in wild elephants due to lower sample availability. Further, FGM concentration was directly related to time spent locomoting in zoo elephants, but no other apparent association existed between FGM concentration with other behaviors in zoo elephants, or in any behaviors in wild elephants. Likewise, we did not report associations between FT3 and any behaviors we measured. This study contributes to our understanding of the complex response patterns that male Asian elephants exhibit around musth, and it provides another example of complementary in-situ–ex-situ research that can be directly applied to improve the well-being of elephants and other wildlife. © 2022 The Authors.

C.A. LaDue, B.A. Schulte, W.K. Kiso & E.W. Freeman

Musth and sexual selection in elephants: A review of signalling properties and potential fitness consequences

Behaviour 159 (2022) 207-242

Abstract. Sexual selection mediated by multimodal signals is common among polygynous species, including seasonally breeding mammals. Indirect benefit models provide plausible explanations for how and why mate selection can occur in the absence of direct benefits. Musth – an asynchronous reproductive state in male elephants – facilitates both inter- and intrasexual selection via indirect benefits, and it is further communicated through a multimodal signal. In this review, we synthesise existing ev-

idence that supports the hypothesis that musth is a multimodal signal subject to sexual selection and that male elephants increase their direct fitness by propagating this signal while females accrue indirect benefits. Musth is characterised by a suite of physiological and behavioural changes, serving to facilitate copulation between the sexes, and via multisensory modalities musth conveys honest information about the condition of a male. Female elephants mate preferentially with musth males, increasing their own fitness in the absence of direct benefits. In addition, musth resolves dynamic dominance hierarchies among male elephants and often eliminates the need for costly physical combat. Future work in this field should investigate potential postcopulatory selection mechanisms in elephants, including sperm competition and cryptic female choice. These topics join other fundamental questions related to sexual selection, signalling, and indirect benefits that are still unanswered in elephants.

C.A. LaDue, R.P.G. Vandercone, W.K. Kiso & E.W. Freeman

Behavioral characterization of musth in Asian elephants (*Elephas maximus*): Defining progressive stages of male sexual behavior in in-situ and ex-situ populations

Applied Animal Behaviour Science 251 (2022) e105639

Abstract. Complementary studies of wild and zoo-housed animals offer insight into behavioral variation across a range of conditions including the context under which various behaviors evolved in natural settings. This information can be used to improve the sustainability of in-situ and ex-situ populations and enhance the well-being of individuals. Managed ex-situ populations are critical to the long-term existence of Asian elephants, yet relatively little is known about male reproductive behavior compared to females. Male elephants undergo a unique sexual state called "musth" that further complicates in-situ and ex-situ management strategies. The ability to manage musth males to enhance breeding success and overall wellness of elephants is dependent upon better understanding how intrinsic and extrinsic factors influence male behavioral variation around musth. Here, we observed 62 free-ranging male Asian elephants in Sri Lanka and compared their behavior to observations from 26 elephants managed in facilities around the US. We hypothesized that musth is associated with significant behavioral changes that can be used to define distinct stages in the progression of musth. During observations, we quantified environmental variables and recorded musth status of each focal elephant using visual indicators (temporal gland secretions and urine dribbling). We showed that musth's behavioral correlates (including changes in locomotion, foraging, alertness, and chemosensory behavior) were remarkably similar in wild and zoo-housed elephants. We also found that behavioral variation around musth was also associated with intrinsic (e.g., musth stage, age) and extrinsic factors (e.g., space availability, temperature) in zoo-housed, but not wild, elephants, indicating that musth is potentially plastic in changing environments. As musth progressed, we noted distinct behavioral signatures that define four stages of sexual activity in male elephants: non-musth, early musth, full musth, and post-musth. Finally, although we did not observe significant changes in overall social behavior (including aggression) during musth, we found that elephants increased the frequency with which they displayed certain behaviors associated with communication (e.g., alertness, chemosensory behavior, ear-flapping) in both populations. Together, these results indicate the significant behavioral changes that occur during musth in wild and zoo-housed elephants, and that musth progresses in distinct behavioral stages that can be easily distinguished by visual indicators. Studies like these serve to provide wildlife managers with information about a species' unique, evolved behavioral strategies and how these seemingly fixed behaviors may be influenced by intrinsic and extrinsic factors in predictable ways.

G. Li, Y. Jiang, Q. Li, D. An, M. Bao, L. Lang, L. Han, X. Huang & C. Jiang

Comparative and functional analyses of fecal microbiome in Asian elephants

Antonie van Leeuwenhoek 115 (2022) 1187-1202

Abstract. No permission to print abstract.

L.-L.Li, R. He, R. Pansini & R.-C. Quan

Prolonged proximity to humans ensures better performance of semi-captive Asian elephants at discriminating between human individuals by voice

Frontiers in Ecology and Evolution 10 (2022) e963052

Abstract. To avoid risks, organisms must recognize threatening heterospecies from non-threatening ones via acoustic cues from a distance. With land-use change, humans have encroached considerably into natural areas. Therefore, it is beneficial to animals to use acoustic cues to discriminate between different levels of threats posed by humans. Our study aims at testing this discriminatory ability in Asian elephants, animals that have been for long history subjected to human interaction. We tested whether eighteen semi-captive elephants could discriminate between voices of their own mahouts (i.e., who take care of the elephants exclusively) and of other mahouts (unfamiliar individuals). The results showed that elephants responded successfully to the commands from their own mahouts, with an average response rate as high as 78.8%. The more years the mahouts had been as their caretakers, the more the elephant showed active responses toward the commands. Female elephants responded to the commands more frequently and faster than males. Also younger elephants responded more frequently and faster than older elephants. We argue that Asian elephants can discriminate between familiar and unfamiliar humans by acoustic cues alone. Proximity with humans may be a factor, as fundamental as domestication, for animals to develop heterospecies discriminatory ability. © 2022 The Authors.

I. Lueders & C. Stremme

Construction of a full mouth speculum facilitating oral examinations, bronchoscopy and gastric tubing in elephants

Tierärztliche Praxis Ausgabe G: Grosstiere / Nutztiere 50 (2022) 86-90

Abstract. Here we tested the application of a full mouth speculum to sedated elephants in human care to gain access to the oral cavity, the trachea (bronchi) and esophagus (stomach) and therefore improve diagnostic and therapeutic options in elephant medicine. The construction of this oral speculum for elephants and the procedure are described. The oral speculum is a steel construction consisting of 2 bite plates attached between 2 threaded guiding poles. Through crank handles, the metal plates are dispersed once placed between the elephant‘s jaws in front of the molars. The oral speculum was applied in 26 elephants (6,16 Asian elephants, and 1,3 African elephants) during standing sedation. All sedated elephants tolerated the positioning of the mouth opener and subsequent manipulations well. The mouth opener was applied for the following procedures: inspection of the oral cavity (n = 2), placing a stomach tube (n = 16), and/or performing endoscopic examinations such as bronchoscopy (n = 20) and/or gastroscopy (n = 8). This method provides a new possibility to open the jaws to gain access to the molars, larynx and pharynx in captive elephants without full immobilization. Valuable samples for diagnostics may be obtained or animals medicated via stomach tube with this application. The mouth opener provides veterinarians with a new option to perform necessary diagnostic and therapeutic procedures around the oral cavity, airways and stomach in captive elephants during standing sedation with no need for a full anaesthesia. © 2021 Thieme.

L. Luo, X. Wang, H. Guo, L. Zhu, Y. Ma, R. Yang, S. Wang, G. Wang, M. Wang, J. Shao & C. Liu

Eighteen years (2001–2018) of forest habitat loss across the Asian elephant’s range and its drivers

Science Bulletin 67 (2022) 1513-1516

Abstract. none.

C.L. Lynsdale, M.W. Seltmann, N.O. Mon, H.H. Aung, U.K. Nyein, W. Htut, M. Lahdenperä & V. Lummaa

Investigating associations between nematode infection and three measures of sociality in Asian elephants

Behavioral Ecology and Sociobiology 76 (2022) e87

Abstract. Frequent social interactions, proximity to conspecifics, and group density are main drivers of infections and parasite transmissions. However, recent theoretical and empirical studies suggest that the health benefits of sociality and group living can outweigh the costs of infection and help social individuals fight infec-

tions or increase their infection-related tolerance level. Here, we combine the advantage of studying artificially created social work groups with different demographic compositions with free-range feeding and social behaviours in semi-captive Asian elephants, employed in timber logging in Myanmar. We examine the link between gastro-intestinal nematode load (strongyles and *Strongyloides* spp.), estimated by faecal egg counts, and three different aspects of an elephant's social world: individual solitary behaviour, work group size, and work group sex ratio. Controlling for sex, age, origin, time since last deworming treatment, year, human sampler bias, and individual identity, we found that infection by nematodes ranged from 0 to 2720 eggs/g between and within 26 male and 45 female elephants over the 4-year study period. However, such variation was not linked to any investigated measures of sociality in either males or females. Our findings highlight the need for finer-scale studies, establishing how sociality is limited by, mitigates, or protects against infection in different ecological contexts, to fully understand the mechanisms underlying these pathways. © The Authors 2022.

A.E. Madsen, C. Minge, T.V. Pushpakumara, U.S. Weerathunga, U.K. Padmalal, D.K. Weerakoon & S. de Silva

Strategies of protected area use by Asian elephants in relation to motivational state and social affiliations

Scientific Reports 12 (2022) e18490

Abstract. Animals' space requirements may vary according to life-history and social considerations. We observed 516 wild adult Asian elephants from both sexes, over 9 years, to investigate how life-history traits and social behavior influence protected-area (PA) use at Udawalawe National Park, Sri Lanka. Male PA-use, quantified in terms of average between-sightings-interval (BSI), was significantly influenced by the interaction of age class and motivational state (i.e. reproduction vs. foraging). Musth lengthened with age, with a median of 24.5 days for ages 21–30, 32.5 days for ages 31–40, and 45 days for those > 40. A minority (11%) used it exclusively during musth, while others used it exclusively for foraging (44%) or both (45%). Males using it in both states and older musth-only males were more likely to be seen across years. There were 16 social communities containing between 2–22 adult females. Females' BSI was significantly influenced by social ties, but this relationship was weak, because members of social communities do not necessarily disperse together, resulting in high individual variation in space-use. Inter-annual variability in sightings among individuals of both sexes indicates that around ¾ of the population is likely non-residential across years, challenging the prevailing fortress-conservation paradigm of wildlife management. © 2022 The Authors.

Rajib Majumder

Human-elephant conflict in West Bengal, India: Present status and mitigation measures

European J. of Wildlife Research 68 (2022) e33

Abstract. No permission to print abstract.

R.N. Makecha, S. Phalke & Y. Nakai

Assessing the effects of a cognition-based education program on attitudes of villagers toward Asian elephants (*Elephas maximus*) in conflict-prone areas

Journal of Applied Animal Welfare Science 25 (2022) 368-381

Abstract. A vital role in mitigating human-elephant conflict (HEC) involves conservation education programs in local communities. It is therefore important to assess the types of information that make conservation education programs effective. Given the public's fascination with animal minds, the elephant being a cognitively complex species, and the high occurrence of HEC surrounding Asian elephants, the current research assessed whether using information on elephant cognition in a conservation education program increased positive attitudes toward elephants/elephant conservation in Bannerghatta National Park (BNP). BNP, located in Karnataka, India, is an area reporting high HEC. Results indicated no significant difference in adult male villagers' attitudes toward elephants/elephant conservation when exposed to one of two educational programs, one of which included information on elephant cognition. However, a significant difference in attitudes between the two programs and a control group was discovered, suggesting the importance of an educational intervention in the communities surrounding BNP. © 2021 Informa UK Limited.

R. Manuel, P.M. Deepa, R.U. Ashok, Rajeshkumar, K. Vijayakumar, K. Karthiayini & A. Janus

Galactosylgalactosylxylosylprotein 3-beta-glucuronosyltransferase – A potent biomarker for the diagnosis of tuberculosis in elephants

European Journal of Wildlife Research 68 (2022) e49

Abstract. No permission to print abstract.

A. Mohanarangan, S. Chinnaiyan, S. Kaliyaperumal, S. Shanmugavelu & A.A. Desai

Age-specific differences in Asian elephant defecation, dung decay, detection and their implication for dung count

Ecol. Solutions and Evidence 3 (2022) e12145

Abstract. In vertebrate population estimation, converting faecal density into animal density requires information on the faecal production rate, decay rate and faecal density. Differences in the above factors for long-lived species across age classes were not evaluated. We have evaluated these factors associated with the dung count of Asian elephants in the tropical forest of southern India. The defecation rate of elephants was determined in semi-wild elephants at the Mudumalai elephant camp. The relationship between dung bolus diameter and age was determined to estimate the age of the elephant. The total and age-specific elephant density based on dung bolus diameter was estimated. A total of 24 transect lines of 2–4 km (125 km) were sampled in the study area. An experiment was conducted to assess the detection probability across the age classes of dung piles. The dung decay rates across age classes and seasons were determined by marking fresh dung piles (n = 1551). The dung-based age structure assessment and its limitations were evaluated. The mean defecation rate was 13.51 ± 0.51 per day. The defecation rate was significantly lower for the younger age class and increased with the age of elephants. Defecation rates were significantly lower in the wet season than in the dry. The dung bolus diameter positively increased with the age of elephants, and the growth curve can be used to predict the age and age structure of elephant populations. The disparity in the dung production rate results in the lower availability of younger age class (juvenile and calf) dung in the transect for counting, which results in lower dung abundance. The detection probability of dung piles of younger age classes was low (0.58). The survival rates of dung piles of younger age classes were lower and increased with the age of elephants in the wet season. Hence, the demographic assessment of the population based on dung needs to consider age-specific differences in dung production, decay and detection probability. Although the demographic assessment using dung provides insight into population age structure, it has limitations in predicting age structure for young elephants.

R.A. Montgomery, J. Raupp, M. Mukhwana, A. Greenleaf, T. Mudumba & P. Muruthi

The efficacy of interventions to protect crops from raiding elephants

Ambio 51 (2022) 716-727

Abstract. Both African elephants and the Asian elephant across their range come into conflict with people because of their crop-raiding behavior, which presents profound impediments to farmer livelihoods. In response, a series of interventions, designed to reduce elephant crop raiding have been applied. Based on an extensive review of elephant crop-raiding studies published over a 31-year period, we identified four primary categories of interventions including: (i) detection efforts; (ii) preemptive measures; (iii) fencing and trenches; and (iv) deterrent techniques. The interventions reported to be most effective involved chili peppers (i.e., fences, spray, and briquettes) and crop guarding coupled with deterrents. The extent to which these interventions can be applied more widely is unclear as only two studies examined efficacy across sites in more than one country. Thus, future inquiry should evaluate the ability of effective interventions, or indeed a combination of interventions, to be applied across the range of elephants to reduce crop raiding at scale.

A.D. Moudgil & L.D. Singla

Haemato-biochemical responses in *Trypanosoma evansi* infected Indian elephants (*Elephas maximus indicus*)

Biologia 77 (2022) 1089-1094

Abstract. No permission to print abstract.

D. Neupane, S. Baral, T.S. Risch & A. Campos-Arceiz

Broad scale functional connectivity for Asian elephants in the Nepal-India transboundary region

Journal of Environmental Management 321 (2022) e115921

Abstract. The Nepal-India transboundary region hosts one of Asia's most complex large mammal assemblages, including a small (but growing) population of Asian elephants. These elephants occur in four widespread and geographically disjunct subpopulations, and some of them undergo seasonal transboundary movements. We conducted a broad-scale evaluation of the amount and quality of elephant habitat available in the region and of functional landscape connectivity between and within subpopulations using Maxent, circuit theory, and least-cost path analysis. Habitat suitability was highly influenced by abiotic geographical factors (altitude and precipitation) and less by ecological factors (habitat heterogeneity, plant productivity) and human disturbance (distance to settlements). The region had a relatively small amount of high and optimal suitability habitat (12.6% out of 93,700 km^2) but all subpopulations seem to be far from carrying capacity, suggesting ample potential for further population growth. Landscape connectivity was higher between and within the west and far-west subpopulations, which should be considered a single subpopulation. The central and east subpopulations, however, had low to very low between-subpopulation connectivity. Conservation priorities include maintaining the current connectivity in the west subpopulation and across the border in the east, and protecting high-quality habitats in eastern Nepal. Restoring connectivity between the central and other subpopulations is possible if the number of elephants continues growing, and it should be a long-term conservation aspiration. Maintaining and enhancing landscape connectivity in this region requires transboundary cooperation and coordination between Nepali and Indian authorities. If successful, it will bring considerable benefits for the conservation of elephants and other wildlife.

V.V. Nguyen, T.T.T. Phan & L. Chun-Hung

Integrating multiple aspects of human-elephant conflict management in Dong Nai Biosphere Reserve, Vietnam

Global Ecology and Conservation 39 (2022) e02285

Abstract. Human-elephant conflict (HEC) is a multifaceted complex phenomenon, and managing it requires multiple strategies. However, HEC remains prevalent in tropical areas due to a lack of "synergy of options". Establishing synergistic HEC management strategies is thus crucial. We applied a choice experiment to capture the preference heterogeneity of the human population in Dong Nai Biosphere Reserve, Vietnam, regarding synergistic HEC management strategies and evaluate their marginal willingness to participate (MWTP) under multiple scenarios of HEC management. The following characteristics were found to affect this human population's preferences regarding a HEC management program: 1) their attitude toward elephant conservation, 2) education and income level, and 3) employment status. Three promising guide scenarios were suggested based on the positive-preference attributes regarding HEC management. Among these, the scenario of a human-elephant coexistence program generated the highest MWTP compared to the scenarios of 'building HEC prevention and mitigation' and 'protecting elephants and forest'. These outcomes can help managers adopt sustainable policies for mitigating HEC and facilitating human-elephant coexistence.

W. Nokkaew, A. Intarapuk, A. Sakulthai, W. Wajjwalku & N. Thongtip

Study of fecal glucocorticoid metabolites in captive Asian elephants in Kanchanaburi Province, Thailand

Veterinary World 15 (2022) 647-654

Abstract. Over the past two decades, the number of elephant camps in Thailand has increased considerably, and captive elephants have become more popular within the tourism industry. Tourist activities involving elephant exhibitions and trekking potentially affect animal health and welfare. This study aimed to investigate the relationships between a novel stress biomarker, fecal glucocorticoid metabolites (fGCM), and various factors (sex, age, weather season, tourist

season, and elephant usage patterns), monitoring the fGCM concentration during and after trekking activities ceased. Fecal samples of 20 captive Asian elephants from two camps in Kanchanaburi Province were collected monthly for 1 year. The fGCM concentrations were measured using enzyme immunoassay and evaluated relative to individual demography, season, and tourist trekking activity. The mean differences of fGCMs concentrations were compared by analysis of variance and t-test statistics according to data types with $p<0.5$. Significant differences in mean fGCM concentrations were found between age categories, trekking and non-trekking animals, and during and after trekking. The mean fGCM concentration of elephants aged 0–44 years was significantly higher than for animals over 44 years old, and the elephant trekking group was significantly higher than the other group. Within the trekking group, the mean fGCM concentrations gradually declined to 129.13 ng/g within 8 months of trekking cessation. Elephant's ages and activities co-influenced the variance of fGCM concentrations. In addition, permanent tourist activity, especially trekking, can increase elephant stress. This study's findings can be applied to the health status monitoring of captive elephants and result in improved animal welfare. © 2022 The Authors.

K.L. Perrin, J. Lopez, F. Molenaar, S. Eriksson Titus, J. Trimpert, A. Abdelgawad, M. Clauss & C. Schiffmann

Current surveillance practices for shedding of elephant endotheliotropic herpesviruses in breeding and bachelor Asian elephant *Elephas maximus* herds in Europe

Journal of Zoo and Aquarium Research 10 (2022) 183-187

Abstract. Elephant endotheliotropic herpesvirus-haemorrhagic disease (EEHV-HD) is the most common cause of death in juvenile captive Asian elephants. Currently, weekly whole blood screening is recommended for the detection of viraemia, which occurs prior to the development of clinical disease, but there are no recommendations for monitoring viral shedding into the environment. The aims of this study were to evaluate current EEHV shedding surveillance protocols in Asian elephant herds in Europe, as well as to collate and describe existing EEHV shedding data from these herds. Results from a European Association of Zoos and Aquaria Taxon Advisory Group-approved survey revealed that as of January 2021, 42% of breeding institutions had a protocol for screening for EEHV viraemia, while 30% monitored viral shedding. Shedding data were available from 12 institutions, where a total of 2,863 samples had been collected for polymerase chain reaction (PCR) analysis. Overall, 13.9% of all tested samples were positive for EEHV and 48.9% of elephants tested positive for EEHV. EEHV-1 was both the most common genotype detected and the most commonly tested for. Evidence of the presence of EEHV was reported in 12/12 (100%) of breeding herds. Routine monitoring of EEHV shedding is recommended to enable better understanding of the dynamics of EEHV infection and disease.

J.M Plotnik & S.L Jacobson

A "thinking animal" in conflict: Studying wild elephant cognition in the shadow of anthropogenic change

Current Opinion in Behavioral Sciences 46 (2022) e101148

Abstract. While researchers interested in the evolution of human intelligence have traditionally focused on the psychology of other primates, a growing field aims to understand how similar cognitive abilities emerge in evolutionarily distant taxa. Here, we briefly review what we know, and why we do not know more, about the 'mind' of one such animal — the elephant — as well as its relevance to understanding convergent cognitive evolution across species. We also discuss the importance of studying animals such as elephants in the wild to better identify expressions of cognitive flexibility in human-impacted environments. Finally, as researchers invested in the study of an endangered species, we emphasize the need to contribute to the management of conservation-related problems from novel, cognitive perspectives. © 2022 Reprinted with permission from Elsevier.

S.S. Pokharel, N. Sharma & R. Sukumar

Viewing the rare through public lenses: Insights into dead calf carrying and other thanatological responses in Asian elephants using YouTube videos

Royal Society Open Science 9 (2022) e211740

Abstract. Documenting the behavioural repertoire of an animal species is important for understanding that species' natural history. Many behaviours such as mating, parturition and death may be observed only rarely in the wild due to the low frequency of occurrence, short duration and the species' elusiveness. Opportunistic documentation of rare behaviours is therefore valuable for deciphering the behavioural complexity in a species. In this context, digital platforms may serve as useful data sources for studying rare behaviours in animals. Using videos uploaded on YouTube, we document and construct a tentative repertoire of thanatological responses (death-related behaviours) in Asian elephants. The most frequently observed thanatological responses included postural changes, guarding/keeping vigil, touching, investigating the carcass, epimeletic behaviours and vocalizations. We also describe some infrequently observed behaviours, including carrying dead calves by adult females, re-assurance-like behaviours and attempts to support dying or dead conspecifics, some of which were only known anecdotally in Asian elephants. Our observations indicate the significance of open-source video data for gaining insights into rarely observed behaviours and support the accumulating evidence for higher cognitive abilities of Asian elephants in the context of comparative thanatology. © 2022 The Authors.

S. Preethee, K. Saminathan, M. Chandran & P. Kathireswari

Valorization of phyto-biomass with tertiary combination of animal dung for enriched vermicompost production

Environmental Research 215 (2022) e114365

Abstract. A study was conducted for 90 days in two cycles on 45th day (Cycle I), and 90th day (Cycle II) in 144 vermibins with precomposted cow dung (T1), elephant dung (T2), cow dung + elephant dung (T3) in combination with leaf substrates of *Ficus religiosa*, *Azadirachta indica*, *Terminalia catappa*, *Carica papaya*, *Vitex negundo*, *Acalypha indica* and *Borassus flabellifer* to generate nutrient-enriched vermicompost. Different vermibin feedstock materials were retained as experimental setup in other substrates with earthworm (vermicompost) and without earthworm (compost). This method was employed in the current study to decompose environmental leaf debris into the earthworm's mass production and transform it into high-value manure for long-term soil fertility control. The majority of the substrates exhibit pH and electrical conductivity in vermicomposts showed an increment while the total organic carbon and carbon to nitrogen ratio were significantly lowered. A prominent percentage increment of total NPK contents ($P < 0.05$) in vermicompost over initial values (N: 7.09–164.03; P: 4.39–101.09; K: 0.45–84.10). Among the vermibed substrates, *Ficus religiosa* leaf litter mixed with T3 showed stabilized cocoons and juveniles in Cycle I (45 days), while sub-adults and adults growth was favored in Cycle II (90 days). The higher reproductive potential of earthworms could be due to the composition and palatability of the substrate combination. This study provides a platform for utilizing leaf wastes in combination with animal wastes amended to reproduce earthworms, nutrient enrichment which could benefit soil fertility improvement. © 2022 Reprinted with permission from Elsevier.

H.H.T. Prins, Y. Liefting & J. F. de Jong

Marginal farmers carry the burden of damage caused by Asian elephants *Elephas maximus* in Bardiya National Park, Nepal

Oryx 56 (2022) 73-81

Abstract. In areas where farmland borders protected areas, wildlife may be attracted to crops and cause substantial financial damage for farmers. Elephants, in particular, can destroy a year's harvest in a single night, and can also cause damage to buildings and other farm structures. Few studies have examined whether damage caused by wild elephants increases social inequalities in farmer communities. We interviewed settlement leaders and subsistence rice farmers living in the buffer zone of Bardiya National Park, Nepal, to examine (1) the variation and spatial distribution of wealth within the farmer community, (2) the severity and spatio-temporal distribution of damage inflicted by Asian elephants, and (3) the willingness to insure against such damage. We investigated whether particular societal strata are disproportionally affected by negative interactions with elephants. We found that farmers near the boundary between agricultural and wilderness areas were significantly poorer and had smaller

landholdings than those further into the cultivated lands. Concomitantly, damage to crops and houses was more frequent nearer the wilderness-agriculture boundary than further away from it. Hence, in the buffer zone of Bardiya National Park, farmers near the wilderness–cultivation boundary, with small landholdings, had a relatively higher cost of elephant damage, yet were less willing to pay for an insurance scheme. We infer that in areas where both social inequality and damage caused by wildlife are spatially structured, conservation success may cause economic hardship for the local community, particularly for the poorer class. We discuss causes of the current lack of communal mitigation measures against the damage caused by elephants in the Park, and potential solutions. © 2021 The Authors.

L. Purkart, J.M. Tuff, M. Shah, L.V. Kaufmann, C. Altringer, E. Maier, U. Schneeweiß, E. Tunckol, L. Eigen, S. Holtze, G. Fritsch, T. Hildebrandt & M. Brecht

Trigeminal ganglion and sensory nerves suggest tactile specialization of elephants

Current Biology 32 (2022) 904-910

Abstract. Sensory nerves are information bottlenecks giving rise to distinct sensory worlds across animal species. Here, we investigate trigeminal ganglion and sensory nerves of elephants. The elephant trigeminal ganglion is very large. Its maxillary branch, which gives rise to the infraorbital nerve innervating the trunk, has a larger diameter than the animal's spinal cord, i.e., trunk innervation is more substantive than connections of the brain to the rest of the body. Hundreds of satellite cells surround each trigeminal neuron, an indication of exceptional glial support to these large projection neurons. Fiber counts of Asian elephant infraorbital nerves of averaged 4,00,000 axons. The infraorbital nerve consists of axons that are ~10 μm thick and it has a large diameter of 17 mm, roughly 3 times as thick as the optic and 6 times as thick as the vestibulocochlear nerve. In most mammals (including tactile specialists) optic nerve fibers greatly outnumber infraorbital nerve fibers, but in elephants the infraorbital nerve fiber count is only slightly lower than the optic nerve fiber count. Trunk innervation (nerves and ganglia) weighs ~1.5 kg in elephant cows. Our findings characterize the elephant trigeminal ganglion as one of the largest known primary sensory structures and point to a high degree of tactile specialization in elephants. © 2022 The Authors.

R.M. Rajbhandari, J. de la Fuente, D. Karmacharya, S. Mathema, B. Maharjan, S.M. Dixit, N. Shrestha, J. Queirós, C. Gortázar & P.C. Alves

Understanding *Mycobacterium tuberculosis* complex in elephants through a One Health approach: A systematic review

BMC Veterinary Research 18 (2022) e262

Abstract *Mycobacterium tuberculosis* complex (MTC) that causes the chronic infectious disease- tuberculosis (TB), often presents with a complicated epidemiological pattern where the transmission chain may include humans, domestic animals and wildlife, including elephants. TB has been reported globally in both captive and wild elephants. The One Health approach might be the most effective way of understanding the shared MTC infection dynamics in captive and wild animals like Asian elephants. This systematic review accumulates evidence on occurrence, transmission pathways, and preventive measures of TB in elephants from a One Health perspective. The prevalence of TB reported in elephant populations ranges from 0 to 23.33% and high prevalence's are reported for elephants that are in close proximity to infected humans. The risk of elephant to human infection transmission increased significantly with exposure duration and contact with infected elephants. Some studies described the plausible TB transmission to captive elephants from other animals (wild and domestic), suggesting inter- and intra-species transmission. The results of this systematic review based on 27 relevant published works, suggest three overarching interrelated transmission pathways for *M. tuberculosis* infections in Asian elephants- i) humans and elephants, ii) other animals (wild or domestic) and elephants and iii) unclear sources of infection. The progress made with new TB diagnostic tools provides multiple methods to choose from. However, lack of harmonization of TB testing in elephants and their human contacts remains a challenge to prevent TB in those animals. Routine TB screening among elephants and caretakers by setting up an occupational health program for early diagnosis

of infection through combined efforts of public health, veterinary medicine, and occupational health experts is suggested. This implies the need for a One Health approach to elephant TB control. This review reveals the need for more research on *M. tuberculosis* complex transmission pathways at the human-animal interface. © 2022 The Authors.

T. Ramesh, D. Milda, R. Kalle, V. Gayathri, M. Thanikodi, K. Ashish & A.J. Giordano

Drivers of human-megaherbivore interactions in the Eastern and Western Ghats of southern India

Journal of Environmental Management 316 (2022) e115315

Abstract. The global effort to protect megaherbivore populations is largely dependent on how human-wildlife conflict is identified, prioritized, and remedied. We examined the socio-ecological and landscape-scale factors determining spatial patterns of human-megaherbivore (Asian elephant and gaur) interactions across sixteen Forest Divisions in Tamil Nadu, India. Using a systematic grid-based design, we conducted questionnaire-based surveys of 1460 households at the human-wildlife interface adjacent to protected areas, Reserve Forest and fringe areas. We specifically collected information on elephant and gaur conflict incidents (e.g., human death/injuries, property damage, and crop-raiding), cropland type, extent of crop area and area lost to crop-raiding, from each household. We found that human-elephant conflict increased with percentage of crop cover, diversity of major and minor crops grown, proximity to water source, flat terrain, and lower rates of precipitation. Human-gaur conflict was greatest with a high diversity of major crops, proximity to water source, moderate precipitation, and more undulating terrain. We identified ca. 7900 km^2 hotspot area of contiguous high-intensity elephant conflict. For gaur, we identified high-frequency conflict hotspot areas covering ca. 625 km^2, which were patchily distributed, highly localised, and attributed mostly to the recent changing land-use patterns. Our findings will help policymakers and park managers in developing landscape-scale human-wildlife conflict mitigation plans in the identified conflict hotspots. © 2022 Reprinted with permission from Elsevier.

C.W.M. Rathnayake, S. Jones, M. Soto-Berelov & L. Wallace

Human-elephant conflict and land cover change in Sri Lanka

Applied Geography 143 (2022) e102685

Abstract. Human-elephant conflict (HEC) is a key environmental issue in number of Asian countries, including Sri Lanka. Incidents of HEC have significantly increased in Sri Lanka between 1991 and 2018, with 1734 human deaths reported in this period (281% increase), 4837 elephant deaths (1172% increase), 1053 human injuries (140% increase) and more than 23,000 property damage reports (1406% increase). In this study we present a Sri Lanka wide analysis to explore the role of land use and land cover change (LULCC) in relation to HEC, using official government data and a land cover change dataset (1993–2018) recently developed by the authors using satellite imagery from the Landsat archive. We investigated rates of HEC over time and compared these to rates of LULCC over the same period. We also present spatial analytics of HEC and LULCC, as well as determining hotspots of HEC and LULCC using a kernel density estimator. Annual HEC incidents were found to broadly increase in line with land use change events ($r = 0.43$, $p < 0.05$). Human deaths, elephant deaths, human injuries and property damage hotspots show distinct spatial patterns: human deaths and injuries being more concentrated in the Northwest, Polonnaruwa and Ampara, wildlife regions; while elephant deaths are spread throughout the HEC region and property damage is high in the Central, Polonnaruwa Anuradhapura, Northwest, and Southern wildlife regions. We found a strong negative correlation between HEC location and distance to LULCC events. In total, 98% HEC occurred within 1 km of an area that experienced recent LULCC Since 2017, the primary HEC hotspots have shifted to the south and east of the country in concert with LULCC. These countrywide perspectives could help inform HEC mitigation strategies in Sri Lanka and other countries facing similar human-wildlife challenges. © 2022 Reprinted with permission from Elsevier.

S. Reichert, V. Berger, D.J.F. dos Santos, M. Lahdenperä, U.K. Nyein, W. Htut & V. Lummaa

Age related variation of health markers in Asian elephants
Experimental Gerontology 157 (2022) e111629
Abstract. Although senescence is often observed in the wild, its underlying mechanistic causes can rarely be studied alongside its consequences, because data on health, molecular and physiological measures of senescence are rare. Documenting how different age-related changes in health accelerate ageing at a mechanistic level is key if we are to better understand the ageing process. Nevertheless, very few studies, particularly on natural populations of long-lived animals, have investigated age-related variation in biological markers of health and sex differences therein. Using blood samples collected from semi-captive Asian elephants, we show that pronounced differences in haematology, blood chemistry, immune, and liver functions among age classes are also evident under natural conditions in this extremely long-lived mammal. We provide strong support that overall health declined with age, with progressive declines in immune and liver functions similarly in both males and females. These changes parallel those mainly observed to-date in humans and laboratory mammals, and suggest a certain ubiquity in the ageing patterns. © 2021 The Authors.

Jessica Bell Rizzolo
Nonhuman animal nations: Transforming conservation into wildlife self-determination
Society & Animals 29 (2021) 393-413
Abstract. Neuroscientists have recently asserted that human and nonhuman animals share comparable brain structures and processes that govern cognition, emotion, and consciousness. This unitary, species-common model of trans-species neuropsychology compels a transformation from the current model of wildlife conservation to wildlife self-determination. Self-determination supports wildlife agency and resilience at the individual and population levels and is based on principles of positive assistance and supportive intervention, parallel sovereignty, and fair terms of cooperation in wildlife-human interactions. The case of Asian elephants in Thailand illustrates how wildlife capture and domination-based captivity, even when intended to conserve animals, can impede self-determination by producing psychophysiologically traumatized wildlife. This article integrates concepts germane to individual animals (agency and trauma recovery) with characteristics of wildlife populations and species (self-determination). It contends that psychosocial data on the mental, emotional, and social functioning of wildlife societies and their members should be included in wildlife assessments and policies. © 2019 Koninklijke Brill NV, Leiden.

A. Roy, S.K. Dash & S. Sathyakumar
A combination of cultural values and economic benefits promote tolerance towards large mammals in a hotspot of human-wildlife conflicts in eastern India
Human Ecology 50 (2022) 321-329
Abstract. No permission to print abstract.

P.C. Sarmah, S. Islam, D.K. Deka, K. Bhattacharjee & K. Roy
***Elephantoloemus indicus* Austen, 1930 (Diptera: Calliphoridae) as the cause of cutaneous myiasis in captive Indian elephants from Assam, India**
Veterinary Parasitology: Regional Studies and Reports 32 (2022) e100734
Abstract. *Elephantoloemus indicus* Austen, 1930, a dipteran calliphorid fly is known to cause by its larval stage obligatory cutaneous myiasis in Indian subspecies of Asian elephants in Myanmar and Thailand. The present study was undertaken on morphological identification of some specimens of fly larvae which were recovered from the warbles detected on the skin of captive Indian elephants at the Nameri National Park and Kaziranga National Park both situated in the state of Assam, India. The larval specimens were whitish to creamy white in colour and body conformation varied from cylindrical to barrel shaped depending on their measured size (Av 6.12 ± 0.28 × 2.35 ± 0.12 mm). Microscopic examination of processed larvae revealed presence of numerous single pointed spines uniformly distributed on entire body surface, well developed mouth hooks and cephalopharyngeal skeleton at the anterior end and posterior spiracles each with lightly sclerotized peritreme enclosing three short and straight respiratory slits. Based on geographical distribution of the fly, host relation, larval parasitism and morphological characters, the larvae were determined as of the genus *Elephantoloemus*

which is represented by *E. indicus* as the only species described so far. This finding seems to be the first record in India after its report from Myanmar and Thailand. © 2022 Reprinted with permission from Elsevier.

M.W. Seltmann, J. Jackson, E. Lynch, J.L. Brown, W. Htut, M. Lahdenperäg & V. Lummaa

Sex-specific links between the social landscape and faecal glucocorticoid metabolites in semi-captive Asian elephants

General and Comparative Endocrinology 319 (2022) e113990

Abstract. Although social behaviour is common in group-living mammals, our understanding of its mechanisms in long-lived animals is largely based on studies in human and non-human primates. There are health and fitness benefits associated with strong social ties, including increased life span, reproductive success, and lower disease risk, which are attributed to the proximate effects of lowered circulating glucocorticoid hormones. However, to deepen our understanding of health-social dynamics, we must explore species beyond the primate order. Here, using Asian elephants as a model species, we combine social data generated from semi-captive timber elephants in Myanmar with measurements of faecal glucocorticoid metabolite (FGM) concentrations. These data enable a "natural experiment" because individuals live in work groups with different demographic compositions. We examine sex-specific FGM concentrations for four different aspects of an individuals' social world: general sociality, work group size, sex ratio and the presence of immatures (<5 years) within the work group. Males experienced lower FGM concentrations when engaged in more social behaviours and residing in female-biased work groups. Surprisingly, females only exhibited lower FGM concentrations when residing with calves. Together, our findings highlight the importance of sociality on individual physiological function among elephants, which may have broad implications for the benefits of social interactions among mammals. © 2022 The Authors.

Michelle Szydlowski

Elephants in Nepal: Correlating disease, tourism, and welfare

Journal of Applied Animal Welfare Science 25 (2022) 126-138

Abstract. Asian elephants and humans have long shared their lives, but recent changes in human perspectives on animal use have created ripples through the small country of Nepal. Captive elephants are caught in the crossfire between local communities, elephant owners, mahouts, and NGOs in debates over their treatment, health, welfare and use in tourism. In addition, zoonotic disease, natural disasters and political strife affect the lives of captive elephants and mahouts. For example, during the COVID-19 pandemic, elephants, caregivers and owners found themselves facing income loss, decreased welfare from housing and husbandry issues, and food shortages. Many owners sold elephants, fired mahouts, and "quit" the tourism industry. Others sought help from outside organizations, community members, and governmental agencies to retain ownership of what they viewed as valuable commodities. NGOs and grassroots organizations assisted in the hopes of keeping elephants in Nepal, thus preventing them from long, treacherous walks across the border and into situations where they might face further welfare decreases. This article combines elephant stable visits and interviews with mahouts, owners, NGO, and government staff between January 2019 and December 2021. It highlights the ongoing health and welfare challenges faced by elephants and mahouts in Nepal. © 2022 The Authors.

Z.M. Thant, R. May & E. Røskaft

Human-elephant coexistence challenges in Myanmar: An analysis of fatal elephant attacks on humans and elephant mortality

J. for Nature Conservation 69 (2022) e126260

Abstract. Understanding the underlying causes behind human-elephant conflict (HEC)-driven mortality of humans and elephants will help improve both parties' wellbeing. The objective of this study was to examine the temporal and spatial mortality patterns of humans and elephants and the influence of local attitudes, conflict factors and habitat factors on elephant poaching. We used the Myanmar Forest Department data from 2001 to 2020 for humans and 2011 to 2020 for elephants together with explanatory data on human attitudes, habitat, and conflict factors. Approximately seven persons were

killed annually in elephant attacks, with a bias towards men. The annual mortality of elephants during the study period was on average 16 individuals, and most elephants were killed by humans. There was a significant relationship between the number of killed humans and human-killed elephants around HEC villages. Villages with more property damage exhibited a higher rate of human mortality, which also correlated with negative feelings of local people towards elephants. Elephant poaching was higher in villages with less suitable habitat available for elephant use. Human encroachment is an important cause of HEC, leading to human loss and forming the main threat to the survival of wild elephants. We suggest local involvement to ensure good governance in conflict resolution and mitigation strategies and to strengthen law enforcement.

A. Thongphakdee, S. Kiatsomboon, S. Noimoon, U. Kongprom, I. Boonorana, S. Karoon, J. Thawnern, A. Sakulthai, P. Sombutputorn, M. Sukmak, C. Punkong & N. Thongtip

Semen characteristics and second successful artificial insemination of Asian elephant (*Elephas maximus*) in Thailand

Veterinary World 15 (2022) 1246-1255

Abstract. As the number of wild Asian elephants continues to decline, maintaining healthy populations under human care is vital. Male fertility assessment is essential for understanding the reproductive status, which can help to uncover underlying problems and improve the rate of pregnancy success. The objectives of this study in Asian elephants were as follows: (1) To investigate the semen characteristics; (2) to compare the relative seminal vesicle size and semen characteristics; (3) to compare the semen characteristics between good-motile (>60% progressive motility) and poor-motile (<60% progressive motility) ejaculates; and (4) to investigate the pregnancy success rate after artificial insemination (AI) with combined chilled and frozen semen. In total, 153 ejaculates were collected by manual rectal stimulation from 25 bulls. Semen ejaculates for AI were collected from three bulls. The estrous cycles of four females were monitored using an enzyme immunoassay. Seven AI attempts were conducted using frozen and/or chilled semen by endoscopic visualization. From 153 ejaculates, the mean±standard error values of progressive motility, semen volume, sperm concentration, pH, and viability were 40.18%±2.28%, 40.94±3.86 ml, 1,205.58±62.26×106 sperm/ml, 7.50±0.10, and 56.17%±1.96%, respectively. Comparing ampulla size and semen characteristics revealed that the bulls with ampullae of ≥7 cm^2 yielded significantly larger volume ejaculates. However, there were no significant differences in sperm motility and concentration. The comparison of semen characteristics between good- and poor-motile ejaculates revealed that the former had significantly higher pH, viability, normal acrosomes, intact membranes, and normal head and tail morphology but often had a significantly lower volume and sperm concentration. From seven AI attempts in four females, one female had a confirmed pregnancy (14.3% pregnancy rate), and delivered a healthy live female baby weighing 128 kg at 21 months and 12 days of gestation. The baby is now 3 years old and in a healthy condition, with normally developing growth and behavior. The semen characteristics of Asian elephants can be used as the baseline reference for further applications. The ampullae size indicates semen quantity but not quality. Our success in producing an elephant calf from AI using frozen and chilled semen demonstrated that AI can be used as an alternative approach for the breeding management of Asian elephants. However, the semen of Asian elephants is of poor quality, especially in terms of membrane integrity; thus, the improvement in semen quality through intensive and careful management of elephant health and fertility remains a challenge for the future. Furthermore, a sperm bank should be established to develop sperm cryopreservation, which will be invaluable for improving the genetic diversity of the Asian elephant.

Lucy Vigne & Vincent Nijman

Elephant ivory, rhino horn, pangolin and helmeted hornbill products for sale at the Myanmar-Thailand-China border

Environmental Conserv. 49 (2022) 187-194

Abstract. While many species are affected by trafficking in their products, some take centre stage, including elephants, rhinos, pangolins and helmeted hornbills, and we report an open

trade that continued in these items in eastern Myanmar between 2015 and 2020. We surveyed Myanmar's border towns of Tachilek and Mong La, recording volumes, prices, origins and trade routes. We observed c. 16,500 ivory items, 8 helmeted hornbill casques and 264 beads, over 100 African rhino horn items and over 250 pangolins (mainly skins and scales). In 2020, asking prices in Mong La for rhino horn tips were US$ 10,770, rhino horn bracelets US$ 5385, helmeted hornbill casques US$ 2424 and big ivory bangles c. US$ 800, with prices being stable overall since 2017. We estimate the combined monetary values at US$ 0.25–0.30 million for Tachilek and US$ 0.75–2.00 million for Mong La. Mong La's market today far surpasses Tachilek's, being on the border of mainland China. Mobile phones and online trading allow customers to order items without bothering to cross the borders. Commitment to address the illegal wildlife trade across Myanmar's borders requires a greater degree of cooperation and coordination amongst the relevant authorities in Myanmar, China and Thailand.

Y. Wang, J. Qu, Y. Han, L. Du, M. Wang, Y. Yang, G. Cao, S. Tao & Y. Kong

Impacts of linear transport infrastructure on terrestrial vertebrate species and conservation in China

Global Ecology and Conservation 38 (2022) e02207

Abstract. Two strategic documents issued by the Chinese Central Government projected that, by the mid-21st century, the linear transport infrastructure (LTI) network of China will rank at the forefront of ecological and sustainable transport networks globally. With this goal, it is urgent to summarize existing research, benchmark international research levels, and propose development directions and strategies for terrestrial vertebrate species protection around LTI in China. In this study, we searched for peer-reviewed papers before 2020 in both Chinese and international databases. A total of 170 academic articles were collected. Most focused on roads, but some focused on railways, of which the Qinghai-Tibet Railway occupied half. The most researched taxa were mammals, including the Tibetan antelope, Siberian tiger, and Asian elephant, the number of bird research papers was less than half that of mammal research papers, and fewer amphibian and reptile studies. The impact of LTI on wildlife was classified to habitat effects, roadkill, behavioral influences, and barrier effects. Wildlife preservation efforts included wildlife and habitat surveys, route selection, subgrade and pavement design, and the design and monitoring of wildlife crossing structures. Studies were concentrated in five zoogeographical regions, i.e., the Qinghai-Tibet, South China, Central China, Northeast China, and Southwest China regions. Conservation suggestions, knowledge gaps, and future research directions for China were identified through comparisons with the state of international research. These focal priorities will help guide the development of road ecology in China. Multi-disciplinary, cross-departmental, and national level research is necessary. Based on this review, a national data integration platform should be established and efforts to cooperate with international research teams to mitigate the adverse effects of LTI should be made.

S. Yasui & G. Idani

Characteristics of social relationships in a group of captive Asian elephants (*Elephas maximus*) in the elephant village in Thailand

Animal Behavior and Cognition 9 (2022) 89-105

Abstract. Wild Asian elephants (*Elephas maximus*) form complex fission–fusion societies centered on matrilineal groups. In captivity, unrelated females remain in the same group and create social relationships. To better understand well-being in captivity, it is important to investigate the social relationships between females. However, to date, little information is available on this topic. The goal of this study was to clarify the social relationships between captive female Asian elephants using social network analysis. Our subjects were 13 captive Asian elephants at the Elephant Study Center in Surin Province, Thailand. We investigated variations in the frequencies of affiliative behaviors between dyads. Individuals that stayed in the group longer tended to play a more central role in terms of group member connections. We found that two individuals played an important role in strengthening connections, and that their removal influenced group cohesion. Our results

revealed that individuals that stayed in the group long-term and that had existing relationships with others in the group tended to build better social connections, regardless of their age. In addition, the existence of some young individuals that show frequent affiliative behaviors may be important for bond strength and therefore, overall group cohesion.

O. Zehtabvar, A.R. Vajhi, H.-a. Akbarein, F.S. Ahmadian, M. Khanamooeiashi, R. Soflaei & F. Borgheie

CT anatomy of cervical vertebrae of Asian elephant (*Elephas maximus*)

Veterinary Medicine and Science 8 (2022) 1750-1768

Abstract. Elephants are currently the largest mammals on earth. A comprehensive examination of the anatomy of this animal to diagnose various disorders is required. In addition, due to the heavy head of these animals, adaptations have been made in the anatomical structure of the neck that is worth studying. This study aimed to investigate a standard morphologic and morphometric description of the elephant cervical spine. Another aim of this study was to compare the changes in the cervical skeleton of elephants with horses and cattle. For this study, the cervical vertebrae of the Asian elephant, cattle and horse were examined. CT Images were obtained. Two dorsal tubercles and a groove between them were observed on the dorsal arch of the atlas vertebra of the Asian elephant. In elephant samples, the variation of vertebral body height, spinous process height, transverse process width, vertebral body length and vertebral foramen volume indices were statistically significant. The volume of the vertebral foramen in the elephant decreases in the second vertebra compared to the first vertebra, decreases in the third vertebra, decreases in the fourth, increases in the fifth, decreases in the sixth and increases in the seventh. In this study, the structure of the cervical vertebrae of the Asian elephant was examined, and certain features were observed. One of the main features was the reduction of the length of the vertebrae, which leads to the decrease of the ratio of neck length to the size of the body. This condition can be due to the high weight of the head in the elephant. To maintain this weight, it is necessary to reduce the length of the neck and confer less mobility.

K.E. Ziegner, M.J. Sadar, J. Brandão, S. Rao, E. Ward, W. Thepapichaikul & P.M. DiGeronimo

Point-of-care and standard laboratory reference intervals for coagulation values in Asian elephants (*Elephas maximus*): Variation by age class, sex and time to centrifugation

Journal of Zoo and Wildlife Medicine 53 (2022) 291-301

Abstract. In Asian elephants , elephant endotheliotropic herpesvirus causes significant calf mortality. Coagulation testing may aid veterinarians in early identification and management of hemostatic disorders. This study sought to establish reference intervals for select coagulation and platelet values. Blood was collected from clinically healthy Asian elephants (n = 63) in juvenile (≤15 yr old, n = 9), adult (>15 to ≤50 yr old, n = 41), and geriatric (>50 yr old, n = 13) age classes at seven institutions in Kanchanaburi Province, Thailand. Activated clotting time (ACT) was immediately assessed with a handheld analyzer, whereas remaining blood was stored at 5°C in sodium citrate and potassium EDTA collection tubes and transported to a central laboratory. Coagulation values were assessed on an automated blood coagulation analyzer, and platelet values were assessed on a hematology analyzer. Reference intervals were established for ACT, prothrombin time, activated partial thromboplastin time, thrombin time, fibrinogen, platelet count, mean platelet volume, platelet distribution width, and plateletcrit according to the American Society for Veterinary Clinical Pathology guidelines. No significant differences were observed for any value when comparing sex and time to centrifugation. Plasma fibrinogen (P = 0.002) and platelets (P = 0.003) varied significantly by age class, with adults displaying the highest fibrinogen concentrations and geriatric individuals displaying the lowest platelet counts. The ACT kaolin cartridges resulted in high success rates (84.3% feasibility) compared with celite cartridges (4.8% feasibility). Further studies are warranted to stratify reference intervals in accordance with age class trends.