DOI: 10.2305/PRRK7073
News and Briefs
Gajah 58 (2025) 74-102

Recent Publications on Asian Elephants

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If you need additional information on any of the articles, please feel free to contact us. You can also let us know about new (2025) publications on Asian elephants.

A. Abdelgawad, M. Nascimento, A. Prahl, M. Fluegger, C.A. Szentiks, S. Holtze, T.B. Hildebrandt & J. Trimpert

Fatal infection caused by a genetically distinct elephant endotheliotropic herpesvirus type 5 in a captive Asian elephant in Germany

Virology Journal 21(2024) e221

Abstract. Elephant endotheliotropic herpesvirus (EEHV) infection is the most common cause for lethal hemorrhagic disease in captive juvenile Asian elephants. Although EEHV1 is known as the most likely cause of fatal haemorrhagic disease in Asian elephants, EEHV5 was lately involved in lethal cases of haemorrhagic disease in captive elephants. Here we report the first death of a four-year old Asian elephant diagnosed with EEHV5 in Germany. Molecular diagnosis yielded detection of EEHV5 DNA in all tested tissues. Histopathological examination revealed typical features of hemorrhagic disease in all examined organs. EEHV5 was sequenced from total DNA isolated from heart tissue by Illumina and Nanopore sequencing. Sequencing data showed 3,881 variants, distributed across the entire genome, compared to the published EEHV5 sequence. We have detected EEHV5 in a fatal disease case of a male Asian elephant. Whole genome sequencing revealed substantial differences of our DNA isolate compared to available EEHV5 sequences. This report of fatal haemorrhagic disease associated with EEHV5 infection should raise awareness for EEHV5 as an important elephant pathogen. Genome sequencing and downstream SNPs analysis will further encourage future research to understand genetic diversity, pathogenesis and virulence of EEHVs with respect to developing new diagnostic methods, prophylactic strategies, and implementation of surveillance and control measures.

D. Abraham, P.M. Deepa, C. Purnima, K.C. Bipin, C.V. Rajani, K. Vijayakumar & T.V. Anilkumar

Histomorphological features of pulmonary tuberculosis in Asian elephants (*Elephas maximus*)

Journal of Veterinary and Animal Sciences 55 (2024) 661-663

Abstract. Tuberculosis in Asian elephants usually shows involvement of lungs and associated lymph nodes. Grossly, the affected lobes of lungs reveal circumscribed lesions of varying sizes with central areas of caseation and necrosis. This report documents histomorphological features of pulmonary tuberculosis in six Asian elephants. The important cell types present were lymphocytes, foamy macrophages, epithelioid macrophages and Langhan's type of giant cells. In addition, caseation necrosis, fibrotic capsule, and mineralisation (calcification) were also observed. Characteristic features of tuberculoid granulomas observed in the six cases showed similarities with other species. The six cases showed varying proportions of the seven defined features but all features were present together only in one case.

S. Ann Jose, K.B. Thiyagarajan, S. Ganesan, B.A. Chandrasekaran, C. Baskar, R. Singh, D.V. Kumari, M.G. Ganesan & A. Udhayan

Development of FTIR spectral library for the identification of Asian elephant ivory: An

innovative approach in wildlife forensics
Discover Applied Sciences 6 (2024) e 586
Abstract. The illegal ivory trade remains a prime threat to elephant populations. Identification of ivory is crucial for combating illicit ivory trading. Studies have demonstrated that FTIR spectroscopy is one of the most suitable techniques for identifying ivory and its products. However, this technique could not have been fully utilized due to the lack of a reference IR spectral library/database. In light of this, the present study aimed to develop the FTIR spectral library for Asian elephant ivory. We collected eight Asian elephant ivory (n = 8) samples from our institute repository and recorded the FTIR spectrum. Further, based on the biochemical composition of ivory, we identified various characteristics, functional groups, and their respective wavenumbers. Furthermore, we used the FTIR spectrum of Asian elephant ivory as a reference to identify the fifteen carvings (n = 15) suspected to be of Asian elephant ivory. The results revealed that samples 1-13 are visibly identical to the FTIR spectrum of Asian elephant ivory; in contrast, samples 14 and 15 do not match the FTIR spectrum of Asian elephant ivory. Hence, it is confirmed that out of fifteen samples, thirteen are likely to be of Asian elephant ivory origin. To confirm this finding, we employed the PLS-DA analysis. The result showed an R Square value of 0.9 for calibration and 0.75 for validation, and the model exhibited 100% accuracy in classifying the original and fake ivory samples. The results confirmed that FTIR combined with chemometrics analysis was useful for identifying ivory and fake materials. To validate the FTIR results, we extracted the DNA from suspected samples 1-15 and amplified elephant-specific D-loop and Sry (sex-determining region on the Y chromosome) genes. Subsequently, the PCR amplicons were examined on a 2.5% agarose gel and observed for samples 1-13, one band at 137 bp (for D-loop) and another at 97 bp (for Sry). These results indicated that samples 1-13 are of elephant origin, whereas samples 14 and 15 are not of elephant origin. To confirm this finding, the PCR amplicons (D-loop) from nine samples (1-9) were sequenced, and % similarity was analyzed. The results showed 96.6 to 100% similarity to the *Mammuthus primigenius*, *Elephas maximus indicus*, and *Loxodonta africana*. The primers (D-loop and Sry) used in this study are elephant-specific and do not distinguish the elephant species. Overall, DNA-based results supported the results from FTIR analysis and confirmed that the suspected samples 1-13 are of elephant origin and 14 and 15 are not of elephant origin. The current study has demonstrated the identification of ivory substitutes through FTIR spectral library for Asian elephant ivory, which is rapid, cost-effective, and has excellent potential for forensic analysis. The FTIR spectral library was developed for Asian elephant ivory. The suspected elephant carvings were identified using the FTIR spectral library of Asian elephant ivory. The FTIR results were confirmed through PCR amplification of elephant-specific D-loop and Sry genes. © 2024 The Authors.

S. Banerjee, D. Nayak & A. Sinha
Adivasi (Tea Tribe) worldviews of living close to wild Asian elephants in Assam, India
Conservation Biology 38 (2024) e14397
Abstract. In Assam state, northeastern India, human-elephant conflict mitigation has included technocentric measures, such as installation of barriers, alternative livelihoods, and afforestation. Such measures treat conflict as a technical problem with linear cause-effect relations and are usually ineffective over the long term because they do not consider how historical conditions have shaped present interactions between humans and elephants. Human-elephant encounters in South Asia, including in Assam, have arisen from colonial and postcolonial land-use policies, ethnic relations, and capital extraction. To disentangle these relations, we conducted ethnographic fieldwork in Udalguri district of Assam among the Adivasi (Tea Tribe) to examine their interactions with wild elephants. Through socioecological ruptures, caused by displacement and deforestation, Adivasi (Tea Tribe) and elephant lives have intersected through space and time. Adivasi (Tea Tribe) life narratives and observations of daily encounters with elephants revealed that their interactions are multifaceted and motivated by multiple factors. Myths and oral testimonies revealed that the community has created conceptualizations of the elephant by closely observing their behavior, especially their movements, diets, vocalizations, and interactions with hu-

mans. These conceptualizations are filled with vignettes of shared marginalized lives, caused by the loss of homeland, food poverty, and uncertain ways of living. The empathy, expressed by the Adivasi (Tea Tribe), highlights ways of living with elephants that are affective and reach beyond technocentric interventions. For Adivasi (Tea Tribe) members, cohabitation could thus be achieved by living close to elephants as uneasy neighbors. Concepts of cohabitation, we suggest, could be harnessed to inform conservation policy and bring into focus the critically important-and yet often underutilized-values, encompassed by bottom-up, place-centric understandings of what elephants are and how coexistence may be possible in increasingly anthropogenic landscapes.

K. Berliani, P. Patana, W. Azmi, N.S.M. Manullang & C. Gozali

Identification and chemical composition analysis of salt licks used by Sumatran elephants *Elephas maximus sumatranus* in Tangkahan, Indonesia

J. of Threatened Taxa 16 (2024) 25639-25790

Abstract. A crucial aspect of successful conservation strategies is the identification of critical aspects of local habitats required for species preservation in a given region, such as salt licks. Tangkahan is adjacent to the Gunung Leuser National Park in North Sumatra, Indonesia. The park collaborates with the Indonesia Conservation Response Unit using captive Sumatran elephants for forest patrols, mitigation of human-elephant negative interactions, public education, and ecotourism in the area. An initial study on the daily activities of captive Sumatran elephants revealed their search for salt licks, which are essential for maintaining their optimal daily sodium intake. Information on salt licks in Tangkahan is limited and deserves further investigation. Ethical clearance is deemed unnecessary, as the research employs a non-invasive approach, exclusively observing the natural behaviors, and daily activities of elephants. The well-being of the elephants takes precedence over invasive technologies, with continuous monitoring ensuring their care throughout the research process. The study utilizes a descriptive-analytic methodology, tracking the daily movements of Sumatran Elephants to identify the locations of salt licks in the area. Four salt licks-Encepan-1, Encepan-2, Namo Cencen, and Hot Spring-were identified by participating in the elephants' territorial exploration. Although the salt licks were located adjacently, Encepan-1 was most frequently visited by the elephants. The salt licks were characterized as waterholes containing Na+ (sodium ion) rich waters from springs. However, according to the atomic absorption spectrophotometry method, the sodium concentration in these salt licks ranged 34-55 ppm, which is estimated to be insufficient for the physiological requirements of the elephants. Therefore, further investigations are needed to explore other complementary salt licks and the incidence of geophagy to support the mineral needs of Sumatran elephants in the Tangkahan region.

L. Cao, J.-F. Tan, Z.-G. Zhang, J.-W. Yang, Y. Mu, Z.-L. Zhao, Y. Jiang, X.-S. Huang & L. Han

Discovery of structurally diverse sesquiterpenoids from Streptomyces fulvorobeus isolated from *Elephas maximus* feces and their antifungal activities

Natural Products and Bioprospecting 14 (2024) e61

Abstract. Thirty-six structurally diverse sesquiterpenoids, including caryolanes (1-12), germacranes (13-16), isodaucane (17), cadinanes (18-22), epicubenols (23, 24), oplopanane (25), pallenanes (26, 27), and eudesmanes (28-36), were isolated from the fermentation broth of *Streptomyces fulvorobeus* derived from *Elephas maximus* feces. Pallenane is a kind of rarely reported sesquiterpene with a distinctive C5/C3 bicyclic skeleton and was firstly found from microbial source. The structures of fifteen new compounds (1-4, 13-15, 17, 18, 22, 23, 25-28) were established through detailed spectroscopic data analysis, which included data from experimental and calculated ECD spectra as well as Mosher's reagent derivative method. Compound 34 exhibited moderate antifungal activity against *Cryptococcus neoformans* and *C. gattii* with MIC values of 50 μg/mL. It effectively inhibited biofilm formation and destroyed the preformed biofilm, as well as hindered the adhesion of *Cryptococcus* species. The current work would enrich the chemical diversity of sesquiterpenoid family.

A.N. Chan, P. Leimgruber, C. Williams, N.M. Shwe, S.S. Aung, N. Lwin, Z.M. Oo, A.M. Chit & G. Wittemyer

Individual variation in habitat selection behavior of Asian elephants in a human-wildland interface

Global Ecology and Conserv. 53 (2024) e03025

Abstract. Habitat loss and fragmentation due to accelerated agriculture expansion is a major threat to existing wildlife populations across Asia. The human-wildlife interface mosaic across Asia is varied in terms of juxtaposition and structure, which can strongly influence biodiversity value and impacts on wildlife species. Here we analyzed habitat selection behavior of Asian elephant (*Elephas maximus*) across three study sites with different agriculture use patterns in Myanmar, a country recognized as a global biodiversity hotspot, including but not limited to, commercial palm oil and sugarcane plantations, and subsistence agriculture. These different agriculture use landscape capture landscape mosaic structure found across Asia. Given elephants exhibit heterogeneous spatial behavior, we fitted individual step selection and resource selection models to gain insight into the diversity of strategies employed at the local (step) and home range (third-order) scale. We used variance partitioning analysis to quantify the explanatory contribution of individual and study sites across both scales. We found that the variation in the resource selection behavior was mainly due to individual differences, and the configuration of agriculture present in an individual 's range was the most influential to its selection behavior. Enhancing understanding of how the level of fragmentation on the landscape relates to agricultural use can serve to help focus conservation efforts. Continued accelerated agriculture expansion is increasing the rate of contact between elephants and humans and, thereby escalating negative human-elephant interactions, often resulting in human and elephant deaths. Gaining a deeper understanding of habitat selection behavior by elephants across the changing landscapes of Asia can help inform management decisions and conservation actions. © 2024 The Authors.

S.K. Chaudhary, A.C. Pandey & B.R. Parida

Geospatial analysis of elephant habitat suitability and movement for mapping the elephant corridor in Dalma Wildlife Sanctuary (India)

Environmental Monitoring and Assessment 196 (2024) e936

Abstract. No permission to print abstract.

S.E. Childs-Sanford, W.K. Kiso & D.L. Schmitt

Serum Vitamin D and selected biomarkers of calcium homeostasis in Asian elephants (*Elephas maximus*) managed at a low latitude

Journal of Zoo and Wildlife Medicine 55 (2024) 430-435

Abstract. An understanding of species-specific vitamin D metabolism and its role in calcium homeostasis is essential for correct diet formulation and development of husbandry protocols for managed nondomestic species. This study documented serum vitamin D metabolites and other analytes involved in calcium homeostasis in Asian elephants (Elephas maximus) managed at a latitude similar to their wild natural habitat. Serum values for 33 elephants managed at a low latitude were measured in the peak of summer, revealing low vitamin D-2 (25(OH)D-2 2.3 ± 6 0.6 ng/ ml and 24,25(OH)(2)D-2 2.17 ± 6 0.52 ng/ml) and nondetectable vitamin D-3. Serum minerals (calcium, phosphorus, magnesium), ionized calcium, and parathyroid hormone were within normal reported ranges. In comparison with previously reported values in elephants managed at a high latitude, 25(OH)D-2 ($P < 0.001$), 24,25(OH)(2)D-2 ($P = 0.001$), and magnesium ($P = 0.013$) were significantly lower, and parathyroid hormone was significantly higher ($P < 0.001$). The lack of D-3 production during ample sun exposure at a low latitude suggests that Asian elephants are incapable of cutaneous photobiosynthesis of vitamin D, and that low serum D-2 is normal for this species. © 2024 American Assoc. of Zoo Veterinarians.

J.L.S. Clinton, T.E. Hoornweg, J. Tan, R. Peng, W. Schaftenaar, V.P.M.G. Rutten, C.A.M. de Haan & P.D. Ling

The EEHV1A gH/gL complex elicits humoral and cell-mediated immune responses in mice

Vaccine 42 (2024) e126227

Abstract. No permission to print abstract.

J.A.H. Crawley, H. Nandar, H.T. Zaw, M. Lahdenpera, D.J.F. dos Santos, M.W. Seltmann,

J.L. Brown, R.M. Goodsell, Z.M. Oo, W. Htut, U.K. Nyein, H.H. Aung & V. Lummaa

Asian elephant calf physiology and mahout perspectives during taming in Myanmar

Royal Society Open Science 11 (2024) e 231172

Abstract. A quarter of Asian elephants are captive, with greater than 90% of these tamed and cared for by handlers (mahouts) in Asia. Although taming is a much-discussed welfare issue, no studies to our knowledge have empirically assessed its impact on calves, and dialogue surrounding taming often lacks perspectives of those involved. Here, we interviewed mahouts involved in taming and monitored five physiological measures (faecal glucocorticoid metabolites (FGMs), serum cortisol, glucose, creatine kinase (CK) and heterophil:lymphocyte (H:L)) over the first 10 days of taming and following six months in 41 calves undergoing taming and 16 control individuals. These measures assess the duration and intensity of stress during taming. Interviews suggested mahouts had major concerns for their safety when discussing changing taming practices, an important consideration for future management. Calf physiological measures were elevated by 50-70% (FGMs/cortisol/glucose), 135% (H:L) and greater than 500% (CK) over the first few days of taming, indicative of elevated stress, not seen to the same extent in control adults. Some measures stabilized sooner (glucose/cortisol/CK/FGM: 7-10 days) than others (H:L: one-two months), indicating mostly acute stress. Our findings inform the welfare of approximately 15 000 captive elephants around the world. Future studies should compare taming in different populations and consider calf and mahout welfare. © 2024 The Authors.

S.J.C. de Mel, S. Seneweera, A. Dangolla, D.K. Weerakoon, R. King, T. Maraseni & B.L. Allen (2024)

Attitudes towards causes of and solutions to conflict between humans and Asian elephants

Conserv. Science and Practice 6 (2024) e13238

Abstract. Many Asian elephant populations inhabit fragmented human-dominated landscapes. Human-elephant conflict (HEC) has intensified in such regions, resulting in the deaths of hundreds of people and elephants each year. Controversy between stakeholders then arises as people debate the merits of HEC mitigation approaches, stifling progress. We conducted a survey to evaluate the opinions of experts, farmers and others who have and have not experienced HEC (n = 611), on the causes of HEC, the importance of, conservation of and co-existence with elephants, and on the acceptability and effectiveness of potential HEC mitigation methods. Analysis of variance and the Potential for Conflict Index showed that all groups agreed with nine of the 10 causes of HEC assessed, on average. All respondent groups had mostly positive attitudes towards the importance and conservation of elephants. However, farmers exposed to HEC disagreed that people should coexist with elephants and supported the view that elephants should be removed from human habitats. All groups agreed on the acceptability and effectiveness of electric fencing, early warning systems with infrasonic call detectors, Global Positioning System collars and geophones. However, there was disparity in views between the experts and other stakeholder groups on the acceptability and effectiveness of restricting elephants to protected areas, and translocation of problem elephants to protected areas away from their capture site or to wild elephant holding grounds. While similar views between stakeholders on many subjects are encouraging for elephant conservation, the disparities identified should be given greater attention when planning HEC management programs to minimize conflict between stakeholders. © 2024 The Authors.

R. De, R. Sharma, S.K. Singh, R. Rasteiro, R. Bhaskar, I. Khan, R. Kanagaraj, K. Kakati, P. Nigam, A.C. Williams, P. Davidar, B. Habib & S.P. Goyal

Conservation implications of high gene flow and lack of pronounced spatial genetic structure in elephants supported by contiguous suitable habitat in north-western India

Conserv. Science and Practice 6 (2024) e13075

Abstract. The western Terai Arc Landscape (wTAL) in Uttarakhand, India, marks the range limit for the Asian elephant in north-western India. This region has been impacted by land-use changes and infrastructure expansion for the last seven decades. To evaluate the impact of habitat deterioration on the population structure of elephants in the region, we characterized

their genetic diversity and local genetic structure using mitochondrial (D loop) and nuclear DNA (microsatellites; n = 15) markers. We used tissue samples of 114 elephants from five different sub-populations, collected between 2005 and 2014. The genetic variation was moderate (H-O = 0.49-0.55) compared with other Indian elephant populations. Two mtDNA haplotypes were identified without strong spatial patterns across wTAL. Bayesian individual-based clustering algorithm identified two genetic clusters (K = 2) with high admixture (50% at Q < 0.7) and no spatial adherence. Though K = 1 was not supported by the Bayesian algorithm, multivariate analysis and sibship patterns did not indicate genetic differentiation. The lack of spatial genetic structuring suggests high levels of gene flow, indicating that this population is still panmictic. This suggests that the life history traits of elephants as well as the ecological features of this landscape influence genetic connectivity. However, ongoing land use changes necessitate regular genetic monitoring in wTAL to identify incipient structuring caused by anthropogenic barriers to movement.

S. Deb, R. Ravindran & S. K. Radhakrishnan
Design and field installation of automated electronic Asian elephant signage for human safety
J. of Threatened Taxa 16 (2024) 25482–25485
Abstract. Human-elephant interactions results in numerous deaths and injuries, often due to accidental encounters at elephant crossing points at night. Addressing this, the proposed electronic elephant signage, a solar-powered device, marks crossing points with a glowing elephant-shaped light. Successfully tested in the Sathyamangalam Tiger Reserve, it activates at dusk, blinking throughout the night, effectively reducing surprise encounters and promoting safer coexistence. © The Authors.

A. Devi, M. Sharma, R. Badola & S.A. Hussain
Unveiling the mysteries of Asian herbivores resource partitioning in tropical wet-grassland ecosystem
Global Ecology and Conservation 54 (2024) e03079
Abstract. Ecological niche partitioning is fundamental for the coexistence of sympatric species. However, the relationship between herbivore body size and forage availability on resource segregation and selection remains debatable. This study quantifies the niche differentiation and selectivity of forage species consumed by six Asian large herbivores (SLH), including mega-herbivores like greater one-horned rhino, Asian elephant and Asiatic wild buffalo, and meso-herbivores like swamp deer, hog deer and sambar in tropical wet-grasslands of the Brahmaputra floodplains. We hypothesized that body size influences dietary niche breadth and interspecific dietary similarities or dissimilarities, while forage availability influences forage selectivity among Asian herbivores. We used micro-histological technique, harvest method and Jacobs Index to quantify SLH foraging patterns, forage availability and preference, respectively. Results of the study revealed high niche breadth for elephant (0.56>B-s <= 0.74) among mega-herbivores and for sambar (0.49>B-s <= 0.64) among meso-herbivores. SLH showed a significant positive correlation between body size and niche breadth in wet season. High dietary overlap was recorded between buffalo and hog deer (0.79-0.86) and swamp deer and hog deer (0.75-0.86) among SLH, rhino and buffalo (0.80-0.83) among mega-herbivores, and swamp deer and hog deer (0.75-0.86) among meso-herbivores. High dietary dissimilarity was recorded between elephant and swamp deer (36-37 %), elephant and buffalo (27-33 %), and swamp deer and sambar (27-29 %). Compared to dry season (1354.54 ± 641.30 g m^{-2}, significantly higher biomass was recorded in wet season (3026.93 ± 1632.65 g m^{-2}; $p<0.05$). From dry to wet season, rhino, buffalo and hog deer shift their preferred forage from dicot to monocot. Dicot was the most preferred forage of elephant among mega-herbivores, and monocot of swamp deer and sambar among meso-herbivores. Mega- and meso-herbivores avoid invasives *Merremia umbellata* and *Mimosa* spp., while meso-herbivores avoid *Mikania micrantha*. Body size explains niche partitioning only for rhino, elephant and swamp deer. Forage availability contributed to niche breadth and forage preference. In conclusion, forage segregation, despite being challenging to interpret at taxonomic level, influences niche partitioning among mega- and meso-herbivores. © 2024 The Authors.

C. Dorji, R.K. Chhetri & T. Dorji

Impact of human-elephant conflict on the communities' livelihood: A study in Southern Bhutan

Geojournal 89 (2024) 184

Abstract. No permission to print abstract.

C. Doyle, H. Rally, L. O'Brien, M. Tennison, L. Marino & B. Jacobs

Continuing challenges of elephant captivity: the captive environment, health issues, and welfare implications

Peerj 12 (2024) e18161

Abstract. Although the well-being of elephants in captivity is of paramount importance, the confinement of these long-lived, highly intelligent, and socially complex animals continues to present significant challenges. Here, we provide an overview of the current state of elephant confinement (primarily in the West) by examining captive facilities, improvements, and continuing problems, and the clinical/behavioral/ neural issues that remain. Specifically, we examine quantitative and qualitative aspects of the enclosed space, sociocognitive factors, dietary differences, and health/ welfare concerns (e.g., stereotypies, physical health, nutrition, reproduction, life expectancy). The challenges of the captive environment become especially salient when juxtaposed next to the complex, multifaceted characteristics of the elephant's natural environment. Despite the best efforts of some facilities to improve the captive environment, serious welfare challenges remain. Such confinement issues thus raise important welfare and ethical concerns with regards to captive elephant well-being. © 2024 The Authors.

L. Galante, D.J.F. dos Santos, E. Mikkonen, J. Horak, Z. Stijepic, H. Demmelmair, A. Vielhauer, B. Koletzko, H.T. Zaw, W. Htut, V. Lummaa & M. Lahdenperae

Milk metabolite composition of a semi-captive population of Asian elephants

Royal Society Open Science 11(2024) e240930

Abstract. Lack of maternal milk commonly leads to Asian elephant calves' death in captivity. Currently, available supplements seem inefficient. Hence, we aimed at characterizing the composition of Asian elephant milk to provide information on calves' nutritional needs. Seventy milk samples from 22 Asian elephants living in semi-captivity in their natural environment in Myanmar were collected. Samples were analysed through various techniques including liquid chromatography tandem mass spectrometry, gas chromatography-flame ionization detector, and bicinchoninic acid assay to determine total protein content and various metabolites. Associations with lactation stage (months postpartum) were investigated through repeated measure mixed models. We identified 160 compounds: 22 amino acids, 12 organic acids of the tricarboxylic acid cycle, 27 fatty acids, 15 acyl-carnitines and 84 phospholipids. The milk contained substantial amounts of free glutamate (median: 1727.9, interquartile range (IQR): 1278.4 μmol l^{-1}) and free glycine (2541.7, IQR: 1704.1 μmol l^{-1}). The fatty acid profile was mostly constituted by saturated fatty acids, particularly capric acid (40.1, IQR: 67.3 g l^{-1}). Milk samples also contained high amounts of carnitines, phospholipids and organic acids. The wide array of metabolites identified and quantified, some of which present high concentrations in the milk from this species as opposed to other species, suggests underpinning physiological functions that might be crucial for the survival of Asian elephant calves. © 2024 The Authors.

R. Ghimire, J.L. Brown, C. Thitaram & P. Bansiddhi

Comparison of animal welfare assessment tools and methodologies: need for an effective approach for captive elephants in Asia

Frontiers in Vet. Science 11 (2024) e1370909

Abstract. Welfare is a fundamental aspect of animal management and conservation. In light of growing public awareness and welfare concerns about captive elephants, there is an urgent need for comprehensive, globally coordinated efforts for Asian elephants that participate in religious, logging, or tourist activities in range countries where the majority reside, and where welfare issues have been identified but not addressed. This review provides a comparative analysis of available animal assessment tools. Each offers distinct features for assessment that allow institutions to select criteria for specific needs and available resources. Most are applied to general animal welfare assessments, although some are tailored to particular species, including elephants. The tools span diverse formats,

from digital to primarily paper-based assessments. Assessments operate at individual and institutional levels and across multiple welfare domains. Methodologies rely on keeper ratings or expert evaluations, incorporate numerical scoring and Likert scales for welfare grading, and encompass inputs including behaviors, health, and physiological indicators. For tourist camp elephants, one challenge is that the tools were developed in zoos, which may or may not have application to non-zoological settings. Digital tools and assessment methodologies such as keeper ratings face logistical challenges when applied across tourist venues. As with any tool, reliability, validity, and repeatability are essential and must address the unique welfare challenges of diverse captive settings. We propose that a holistic, context-specific, evidence-based, and practical tool be developed to ensure elephant welfare standards in non-zoological facilities throughout Asia.

R. Ghimire, J.L. Brown, C. Thitaram, S.S. Glaeser, K. Na-Lampang, P. Kulnanan & P. Bansiddhi

Development of a welfare assessment tool for tourist camp elephants in Asia

Peerj 12 (2024) e18370

Abstract. Background: Approximately one-third of Asian elephants are managed under human care, participating in educational, cultural, religious, and tourist activities. Management conditions vary considerably among venues, raising questions about whether welfare needs are consistently being met, particularly for Asian tourist camp elephants. To evaluate the well-being of elephants engaged in tourist activities, an evidence-based tool is needed for routine assessments to identify potential welfare risks, aid in the development of better camp standards, and enable caretakers to address specific concerns. While many animal welfare tools exist, none have been designed to consider specific environments and management practices faced by elephants living and working in tourist camps. Methods: Using direct observations and interviews, the Elephant Welfare Assessment Tool (EWAT) was developed for tourist camp elephants using the Five Domains Model as a framework. Measures were selected based on peer-reviewed literature, existing standards and guidelines, and opinions from animal welfare experts working with zoo and tourist camp elephants. The EWAT differs from existing tools by including criteria on work activities and restraint methods (e.g., chaining and ankus use), factors common in Asia but not often encountered by western zoo elephants. Measures were scored using a 0-2 Likert Scale. The tool was tested in Thailand and determined by calculating a content validity index (CVI) and conducting inter-rater and test-retest reliability tests. Results: The initial tool included 18 animal-based and 21 resource-based measures across four domains: Nutrition (n = 5), Environment (n = 14), Health (n = 10), and Behavior and Mental State (n = 10). Index scores of content validity (CVI) (Item CVI (0.83), Scale CVI/Average (0.98), and Scale CVI/Universal (0.89)) were high. Measures scoring less than 0.83 were removed: the opportunity to mate, the mahout-elephant relationship, and mahout job satisfaction. The final tool consisted of 42 questions related to 36 measures, including 18 animal-based and 18 resource-based measures within the Nutrition (n = 5), Environment (n = 11), Health (n = 10), and Behavior and Mental State (n = 10) domains. Intraclass correlation coefficients (ICC) for inter-rater reliability (0.78-0.90, $p < 0.05$) and test-retest (0.77-0.91, $p < 0.05$) analyses conducted at two camps showed good agreement. Conclusions: This new assessment tool (EWAT) is a context-specific, holistic method designed to offer a practical means of conducting individual and institutional-level assessments of elephant welfare in tourist camps. It is based on the Five Domains Model using reliable and validated animal- and resource-based measures, data collection through direct observation and interviews, and a numerical scoring system. The tool includes several criteria applicable to tourist rather than zoo venues to make it more relevant to the challenges faced by working elephants in Asia.

S. Ghosh, M. Mandal, D. Das & S.K. Gayen

Modeling on the assessment of habitat suitability and conflicting nature nexus of human-elephant-environment at the Alipurduar district in India

Modeling Earth Systems and Environment 10 (2024) 7459-7478

Abstract. No permission to print abstract.

T. Giggin, K.D. Martin, S.K. Vebugopal, K.S. Anil, A.R. Sreeranjini & M.K. Narayanan

Comparative analysis of mathematical models and app-based measurement for estimating the cutaneous wound areas of captive Asian elephants

Cureus 16 (2024) e65533

Abstract. To evaluate the variation in the area estimation under different mathematical calculations against measurement by a smartphone application in estimating the cutaneous wound areas in captive Asian elephants. The study was conducted on captive Asian elephants (*Elephas maximus*) with cutaneous wounds reported to Veterinary Hospitals of Kerala Veterinary and Animal Sciences University and elephant camps within and outside Kerala state (mostly southern states of India, namely, Kerala and Tamil Nadu) over the period September 2019 to October 2022. Thirty-five clinical cases diagnosed with skin wounds of different aetiologies at various parts of the body were subjected to measurement, and 111 measurements were taken using a smartphone application, Imito Measure (Imito AG, Zurich, Switzerland). Based on the outer wound perimeters handmarked on the mobile screen over the image taken, Imito Measure calculated the length, width, perimeter, and area. The length and width measurements from this were applied to four mathematical models of wound measurements. Wound surface area calculations were further done by these models and were compared. The observed results indicated no significant difference between the five methods of area measurement in all the studied cases since the $P > 0.05$. The findings revealed no significant difference between the five techniques of wound area measurement. From the practical clinical utility point, the smartphone application has an edge over the mathematical methods in animals, especially captive Asian elephants, as it has the major advantage of being non-contact and thus addresses some major welfare concerns. © 2024 The Authors.

M. Guarnieri, G. Kumaishi, C. Brock, M. Chatterjee, E. Fabiano, R.K. Adefowora, A. Larsen, T.M. Lockmann & P.R. Roehrdanz

Effects of climate, land use, and human population change on human-elephant conflict risk in Africa and Asia

PNAS 121 (2024) e2312569121

Abstract. Human-wildlife conflict is an important factor in the modern biodiversity crisis and has negative effects on both humans and wildlife (such as property destruction, injury, or death) that can impede conservation efforts for threatened species. Effectively addressing conflict requires an understanding of where it is likely to occur, particularly as climate change shifts wildlife ranges and human activities globally. Here, we examine how projected shifts in cropland density, human population density, and climatic suitability-three key drivers of human-elephant conflict-will shift conflict pressures for endangered Asian and African elephants to inform conflict management in a changing climate. We find that conflict risk (cropland density and/or human population density moving into the 90th percentile based on current - day values) increases in 2050, with a larger increase under the high- emissions "regional rivalry" SSP3 - RCP 7.0 scenario than the low-emissions "sustainability" SSP1 - RCP 2.6 scenario. We also find a net decrease in climatic suitability for both species along their extended range boundaries, with decreasing suitability most often overlapping increasing conflict risk when both suitability and conflict risk are changing. Our findings suggest that as climate changes, the risk of conflict with Asian and African elephants may shift and increase and managers should proactively mitigate that conflict to preserve these charismatic animals. © 2024 The Authors.

T.D. Gunawansa, K. Perera, A. Apan & N.K. Hettiarachchi

Identifying human elephant conflict hotspots through satellite remote sensing and GIS to support conflict mitigation

Remote Sensing Applications-Society and Environment 35 (2024) e101261

Abstract. Human-elephant conflict (HEC) is a significant issue in Sri Lanka and many parts of the world where elephants and humans coexist. To address HEC, this study integrates remote sensing and GIS analysis, focusing on monitoring changes in greenery. The study prepared the latest land cover and land use (LCLU) maps with Sentinel-2 satellite data, correlating them with reported HEC incidents reported in 2021 and 2022 to identify HEC hotspots in two forest

-dominated regions of Southeast Sri Lanka. High-resolution Sentinel-2 satellite imagery were used to detect areas of human activities and elephant habitats in proximity to each other. Random Forest (RF) and Support Vector Machine (SVM) classification methods were used for LCLU classification. The overall accuracy of the classification was 97.31 and 94.62, and kappa was 0.95 and 0.90 for RF and SVM, respectively. Multi -temporal normalised difference vegetation index (NDVI) analysis provided insights into vegetation health and coverage, offering a clear picture of greenery changes. Monthly changes in vegetation cover readings were quantified using NDVI values derived from MODIS data, identifying suitable regions for elephants to forage frequently. Furthermore, Kernel density estimation identified high -density areas for reported incidents of human and elephant deaths. This process involved assigning weight to conflict incidents within a 5 km radius, considering the proximity to the forest, and evaluating greenery changes using NDVI values, revealing varying levels of HEC risk, ranging from very high to low. The LCLU map, created using the RF classifier, indicates that all potential HEC hotspots for very high and high HEC risks are closely aligned with forest boundaries. The findings support HEC mitigation strategies through community awareness, HEC hotspots mapping and restoration practices to ensure a sustainable human-elephant coexistence. This method will help policymakers in wildlife conservation to identify high risk HEC zones to support HEC mitigation. In conclusion, this study highlights the potential of integrating remote sensing and GIS techniques in demarcating HEC hotspots in Sri Lanka to support conflict mitigation efforts. © 2024 The Authors.

J. Haycock, T. Maehr, A. Dastjerdi & F. Steinbach

Immunostimulation of Asian elephant (*Elephas maximus*) blood cells by parapoxvirus ovis and CpG motif-containing bacterial plasmid DNA upregulates innate immune gene expression

Frontiers in Immunology 15 (2024) e1329820

Abstract. The immune system of Asian elephants (*Elephas maximus*) is poorly studied, compared to that of livestock, rodents or humans. The innate immune response has become a focus of interest in relation to Elephant endotheliotropic herpesviruses (EEHVs). EEHVs cause a fatal hemorrhagic disease (EEHV-HD) and are a significant threat to captive Asian elephant populations worldwide. Similar to other herpesvirus infections, nearly all animals become infected, but only some develop disease. As progression to EEHV-HD is often acute, a robust innate immune response is crucial to control EEHV infections. This is invariably true of the host in the first instance, but it can also potentially be modulated by intervention strategies. Here, two immunostimulant veterinary medicinal products, authorized for use in domestic species, were tested for their ability to induce innate anti-viral immune responses in Asian elephant blood cells. Sequence data were obtained for a range of previously unidentified Asian elephant immune genes, including C-X-C motif chemokine ligand 10 (CXCL10), interferon stimulated gene 15 (ISG15) and myxovirus GTPase 1 (Mx1), and were employed in the design of species-specific qPCR assays. These assays were subsequently used in analyses to determine fold changes in gene expression over a period of 24 hours. This study demonstrates that both immunostimulant medications are capable of inducing significant innate anti-viral immune responses which suggests that both could be beneficial in controlling EEHV infections in Asian elephants. © 2024 The Authors.

T.E.R.G. Huijsmans, A. Van Soom, K. Smits, J. Wauters, D. Hagan & T.B. Hildebrandt

Elephant gestation: Insights into idiopathic abortions and stillbirth

Zoo Biology 43 (2024) 575-579

Abstract. The declining African and Asian elephant populations emphasize the importance of a backup population. Successful reproduction in captivity plays a key role in maintaining such a genetically diverse ex situ population but is challenged by reproductive loss in the form of abortions and stillbirths. The elephants' biphasic prolactin pattern led us to predict a higher incidence of abortions during the time of reduced prolactin concentrations. Therefore, this study focuses on the identification of months during elephant gestation which are prone to loss of pregnancy. A metric was developed to identify

the fetal age of aborted calves based on the fetal mass using a regression model. Data on idiopathic abortions in captive and wild elephants collected from zoos, tourist camps, semi-captive, and free-ranging populations since 1974 were analyzed, revealing a significantly higher prevalence of abortions during the 15th and 17th month of gestation. Additionally, the prevalence of stillbirths in the 22nd month of gestation between 2000 and 2023 was assessed. Although stillbirths showed a declining trend over time, the average prevalence between 2019 and 2023 was still 2.8%. Consequently, the 15th, 17th, and 22nd month of gestation were identified as stages prone to pregnancy loss. These findings underscore the necessity of researching risk factors and preventative measures for pregnancy loss in these 3 months, especially exploring a possible link with prolactin during the 15th and 17th month of gestation. The identification of stages prone to fetal loss is a key step towards enhancing elephant reproductive success and welfare. Abortions in African and Asian elephants

M.Z. Islam & S. Wang

What triggered the human-wildlife conflicts in Bangladesh between forest proximity people and wildlife? A responsive study

Israel Journal of Ecology & Evolution 70 (2024) 159-171

Abstract. Reflecting upon the distressing situation of human-wildlife conflict (HWC), this study has identified numerous factors that exacerbate the HWC issue in Bangladesh, including a lack of awareness, a prevalent disregard for the law, inadequate punitive measures, institutional weaknesses, socio-economic challenges, a burgeoning population, a refugee crisis, rampant deforestation, encroachment upon natural habitats, migratory challenges faced by wildlife, and the influence of national and global politics. It is evident that these multifaceted elements significantly contribute to the escalation of HWC. The regions of Chittagong-Hill Tracts, the Sundarbans, and central-northern Bangladesh are facing a pressing HWC issue that demands our immediate attention. Tragically, over the past two decades, more than 118 elephants have lost their lives, while these creatures claimed 13 human lives in 2017-2018. Furthermore, tigers, an emblem of strength and beauty, have been responsible for the demise of approximately 50 individuals between 2009 and 2010. Astonishingly, the year 2022 has already witnessed a count of 375 HWCs. Therefore, this study delves deeper into the root causes of HWC in Bangladesh and proposes effective preventive measures to safeguard the endangered species, specifically the Asian elephants and Bengal tigers, who bear the brunt of these conflicts. © 2024 The Authors.

M.I.M. Jamaluddin, K.Z. Abidin, S.M. Nor, A. Shukor, A.I. Zainudddin, R. Illias & M.S. Mansor

Asian elephants involved in conflicts exhibit similar habitat use but travel farther than non-conflict individuals

Global Ecology and Conserv. 55 (2024) e03228

Abstract. Rapid development and deforestation in Peninsular Malaysia have degraded and fragmented the tropical forest, impacting the survival of many megafauna species. With reduced space to roam, Asian elephants may extend their range into the altered landscape, leading to human-elephant conflict (HEC). HEC is defined as any interactions between wild elephants and humans that result in negative effects on both humans and elephants. Although known as a keystone species in the region, spatial studies comparing conflict and non-conflict elephants have never been done before. In this study, we used GPS satellite collar data for five conflict and seven non-conflict elephants from 2012 to 2021. We mapped their home ranges, identified hotspots, and estimated the proportion of habitat use (area and time spent) across the Managed Elephant Ranges of Peninsular Malaysia. We found that nine of the 12 elephants spent >90 % of their time in their home range and >95 % of their time in hotspots in forested areas regardless of conflict status. redefining of conflict status as spending <53 % of the time in the home range and <41 % in hotspots in forested areas. However, conflict elephants moved significantly farther on the daily average than non-conflict elephants. Our findings highlight the importance of redefining the conflict status of elephants based on threat levels and habitat use to consider the rapidly degrading habitat that signals human-elephant coexistence. © 2024 The Authors.

J. Jue, Z.M. Thant & S. Shibata

GPS tracking reveals home range and habitat preference of semi-captive elephants in Myanmar

Landscape and Ecological Engineering 20 (2024) 213-221

Abstract. No permission to print abstract.

P. Kaswan & A. Roy

Unearthing calf burials among Asian elephants *Elephas maximus* Linnaeus, 1758 (Mammalia: Proboscidea: Elephantidae) in northern Bengal, India

J. of Threatened Taxa 16 (2024) 24615-24818

Abstract. Rampant environmental changes and forest destruction push elephants, both Asian and African, to explore human spaces to fulfil their dietary and ecological requirements and, consequently in shared spaces many 'novel' elephant behaviors come into the limelight. Elephant calf burial is reported in African literature but remains absent from the Asian context. We report calf burials by Asian elephants in the eastern Himalayan floodplains of the northern Bengal landscape. The study area consists of fragmented forests, tea estates, agricultural lands, and military establishments. Tea estates form the majority of elephant corridors, and we explain the burial strategy of elephants in the irrigation drains of tea estates. We present five case reports of calf burials by elephants. We aimed to understand the perimortem strategy and postmortem behavior of the Asian elephants. The major findings reflect that the carcasses were carried by trunks and legs for a distance before being buried in a 'legs-upright-position'. We further investigated the underlying reason for calf deaths through postmortem examinations. Direct human intervention was not recorded in any of the five deaths. Through opportunistic observation, digital photography, fieldnotes, and postmortem examination reports, we suggest that the carcasses were buried in an abnormal recumbent style irrespective of the reason for the calf's death. Through long-term observation, we further report that the elephants in this region clearly avoid the paths where carcasses were buried. We discuss and connect the literature of two distinct elephant species and also compare thanatological studies of other sentient nonhuman species. © 2024 The Authors.

A. Khan, M. Sil, T. Thekaekara, K.M. Garg, I. Sinha, R. Khurana, R. Sukumar & U. Ramakrishnan

Divergence and serial colonization shape genetic variation and define conservation units in Asian elephants

Current Biology 34 (2024) 4692-4703

Abstract. Asian elephants are the largest extant terrestrial megaherbivores native to Asia, with 60% of their wild population found in India. Despite ecological and cultural importance, their population genetic structure and diversity, demographic history, and ensuing implications for management/conservation remain understudied. We analyzed 34 whole genomes from most known elephant landscapes in India and identified five management/conservation units corresponding to elephants in Northern, Central, and three in Southern India. Our data reveal signatures of divergence and serial colonization and a potential dilution of genetic diversity from north to south of India. The northern populations diverged from others more than 70,000 years ago, have higher genetic diversity, and have low inbreeding (pi = 0.0016±0.0001; $F_{ROH>1\ MB}$= 0.09±0.03). Two of three populations in Southern India have low diversity and are inbred, with very low effective population sizes compared with census sizes (pi= 0.0014± 0.00009 and 0.0015± 0.0001; $F_{ROH>1\ MB}$= 0.25± 0.09 and 0.17± 0.02). Analyses of genetic load reveal the purging of potentially high-effect insertion/deletion (indel) deleterious alleles in the southern populations and a decreasing number of deleterious alleles from north to south. However, despite dilution and purging for the damaging mutation load in Southern India, the load that remains is homozygous. High homozygosity of deleterious alleles, coupled with low neutral genetic diversity, make southernmost populations high priority for conservation attention. Most surprisingly, our study suggests that patterns of genetic diversity and genetic load can correspond to genomic signatures of serial founding events, even in large, highly mobile, endangered mammals. © 2024 The Authors.

N. Kittisirikul, N. Bangkaew, W. Phimpraphai & S. Sripiboon

Unlocking insights: Mahout's perceptions and practices in managing elephant endotheliotropic herpesvirus (EEHV) infection

among captive Asian elephants in Surin province, Thailand

PLoS One 19 (2024) e0295869

Abstract. Surin, situated in the northeastern region of Thailand, has earned the reputation of being an "elephant village" due to its high captive elephant population and unique tradition of elephant rearing. However, the continuous occurrence of elephant endotheliotropic herpesvirus (EEHV) infection poses a significant threat to elephants, particularly the young ones. This study investigated various aspects of EEHV-related elephant care among ninety-two mahouts at the Surin Elephant Kingdom Project. This study used semi-structured interviews and observations to assess the mahouts' knowledge, attitude, and practice (KAP scores) toward EEHV transmission, prevention, and management. The result revealed knowledge and practice scores below expectations, indicating an insufficient understanding the nature of disease and preventive measures. However, the mahouts exhibited awareness of the severity of the disease and factors contributing to transmission risk. Regarding the relationship among KAP scores, a positive correlation was observed at a low level ($p < 0.05$) between the knowledge and practice scores. Interestingly, approximately 55% of the survey respondents were confident that their elephants would not receive EEHV, leading to inadequate prevention measures. From the result, it is crucial to provide comprehensive knowledge about the nature of the disease and preventive measures to all mahouts. This education should emphasize the importance of early monitoring signs, appropriate weaning age, and preventing viral transmission practices. The KAP survey offers valuable insights that can identify areas requiring improvement and guide the development of effective and targeted disease prevention programs within the specific population. Therefore, it is recommended that the KAP survey should be employed in other parts of the country where the elephant management system differs. © 2024 The Authors.

P. Kochprapa, C. Savini, D. Ngoprasert, T. Savini & G.A. Gale

Mitigating human-elephant conflict in Southeast Asia

Tropical Natural History 24 (2024) 70-83

Abstract. Human-elephant conflict (HEC) poses serious threats to humans and to elephants, and while HEC in Southeast Asia is increasing, mitigation effectiveness data are lacking. Previous assessments of available mitigation options have not compared relative benefits and impacts of each on a practical level to identify which factors should be considered by local agricultural communities and/or other stakeholders when choosing among mitigation options. Understanding which mitigation approach to apply in a given context is crucial for effective mitigation planning and can aid in the development of more holistic methods. We reviewed the literature regarding the strengths and weaknesses of 14 currently applied HEC mitigation methods in Southeast Asia, considering five key factors for each mitigation option: 1) effectiveness at reducing crop damage, 2) initial start-up costs, 3) maintenance/long-term costs, 4) potential impacts on humans and 5) potential impacts on elephants. Our results suggest there are considerable tradeoffs among these five factors for any given mitigation option and that none of the available mitigation methods are simultaneously highly effective in preventing crop damage and low cost while presenting minimal impact to people and elephants. Although our metric of comparison is not comprehensive, it may offer an initial set of guidelines for decision making. ©2024 Chulalongkorn University.

S. Köpke, S.S. Withanachchi, E.N. Chinthaka Perera, C.R. Withanachchi, D.U. Gamage, T.S. Nissanka, C.C. Warapitiya, B.M. Nissanka, N.N. Ranasinghe, C.D. Senarathna, H.R. Dissanayake, R. Pathiranage, C. Schleyer & A. Thiel

Factors driving human-elephant conflict: Statistical assessment of vulnerability and implications for wildlife conflict management in Sri Lanka

Tropical Natural History 33 (2024) 3075-3101

Abstract. Human-elephant conflict (HEC) is a serious social-ecological problem in Sri Lanka's elephant range regions, as between 200 and 400 elephants have been killed annually over the last years, and more than 1200 people have died from the consequences of elephant encounters within a decade. Crop foraging causes economic damage to farming households. The

study aims to understand factors driving vulnerability to HEC among the population. Employing a cross-communal multi-item large-N field survey (N = 651), authors were able to describe living conditions and perceptions of Sri Lankan villagers affected by HEC. By running a multiple regression analysis with correlated variables, the study is able to correlate independent variables to vulnerability, namely socio-economic conditions, environmental change and land-use, and awareness. Furthermore, a vulnerability map has been created, identifying Puttalam, Anuradhapura, Kurunegala, Matale, and Polonnaruwa districts as conflict hotspots. Private electric fences as a widespread protection measure were found to have unintended negative side-effects to non-protected households. The findings suggest the urgent need to upscale public policies mitigating the consequences of HEC on affected populations by reducing overall vulnerability to environmental hazards, including human-wildlife conflict. © 2024 The Authors.

H. Kopnina & L. Baker

Conservation, animal wellbeing, and indigenous participation at an elephant sanctuary in Mondulkiri, Cambodia

Society & Animals 32 (2024) 560-581

Abstract. This article focuses on the intersection of indigenous peoples, conservation, and elephant wellbeing in Cambodia. While social justice advocates emphasize the human cost of conservation in human-animal conflicts, those concerned with animal protection and rights have problematized the treatment of elephants. This critique stems from evidence that the human relationship to elephants, captive and wild, remains largely utilitarian or exploitive. In Cambodia, there is a record of wild Asian elephants coexisting with local communities, but more so a long history of elephants used for labor. This article discusses the possible areas of reconciliation between human and Asian elephant interests at a Mondulkiri elephant sanctuary in Cambodia, suggesting potential paths toward win-win scenarios for the local and indigenous people, as well as for the elephants and their habitats. © 2024 The Authors.

J. Kottwitz, U. Bechert, C. Cruz-Espindola, J.M. Christensen & D. Boothe

Single-dose, multiple-dose, and therapeutic drug monitoring pharmacokinetics of firocoxib in Asian elephants (*Elephas maximus*)

Journal of Zoo and Wildlife Medicine 55 (2024) 73-85

Abstract. Firocoxib is a COSyX-2-selective nonsteroidal anti-inflammatory drug (NSAID) with limited effects on COX-1, which means it likely has fewer side effects than typically associated with other NSAIDs. This study determined possible doses of firocoxib based on single- and multidose pharmacokinetic trials conducted in 10 Asian elephants (*Elephas maximus*). Initially, two single oral dose trials (0.01 and 0.1 mg/kg) of a commercially available tablet (n = 6) and paste (n = 4) formulation were used to determine a preferred dose. The 0.1 mg/kg dose was further evaluated via IV single dose (n = 3) and oral multidose trials (tablets n = 6; paste n = 4). Serum peak and trough firocoxib concentrations were also evaluated in Asian elephants (n = 4) that had been being treated for a minimum of 90 consecutive days. Key pharmacokinetic parameters for the 0.1 mg/kg single-dose trials included mean peak serum concentrations of 49 ± 3.3 ng/ml for tablets and 62 ± 14.8 ng/ml for paste, area under the curve (AUC) of 1,332 ± 878 h*mg/ml for tablets and 1,455 ± 634 h*mg/ml for paste, and half-life (T-1/2) of 34.3 ± 30.3 h for tablets and 19.9 ± 12.8 h for paste. After 8 d of dosing at 0.1 mg/kg every 24 h, pharmacokinetic parameters stabilized to an AUC of 6,341 ± 3,003 h*mg/ml for tablets and 5,613 ± 2,262 for paste, and T-1/2 of 84.4 ± 32.2 h for tablets and 62.9 ± 2.3 h for paste. Serum COX inhibition was evaluated in vitro and ex vivo in untreated elephant plasma, where firocoxib demonstrated preferential inhibition of COX-2. No adverse effects from firocoxib administration were identified in this study. Results suggest administering firocoxib to Asian elephants at a dose of 0.1 mg/kg orally, using either tablet or paste formulations, every 24 h. © 2024 American Assoc. of Zoo Veterinarians.

C.A. LaDue, J.L. Brown, M. Davis, G. Kibe &W.K. Kiso

Relationship between testosterone and sperm motility in Asian elephants (*Elephas maximus*): Potential implications during the sexual state of musth

Theriogenology Wild 4 (2024) e100072

Abstract. Male elephants regularly undergo a unique sexual period of musth that is characterized by elevated testosterone, analogous to the heightened reproductive seasonality of other mammals but distinct because it is nonseasonal and asynchronous among males. Our knowledge of male reproductive biology in elephants is limited compared to females, restricting our ability to effectively manage breeding and ensure optimal welfare, especially during musth. In this study, we analyzed the relationship between serum testosterone concentrations and sperm motility, a measure of semen quality. Semen (n = 152 samples) was collected from four male Asian elephants aged 8 to 47 years housed at the Denver Zoo between 2018 and 2022. For approximately half of the samples (n = 72), serum was also collected within a week of semen collection. Using paired semen and serum samples, we identified significant positive relationships between testosterone concentration and sperm motility in three elephants; the relationship in a fourth elephant trended towards significance. Three elephants exhibited musth during the study; in one elephant, sperm motility was significantly higher during musth, while in the other two, although samples were too limited for statistical analysis, patterns trended the same. Furthermore, two males exhibited increasing motility approaching the start of musth or as musth progressed. Together, these results provide the first evidence of a relationship between testosterone (and perhaps by extension, musth status) and a measure of semen quality in elephants. While further systematic research is warranted, this study has implications for understanding male reproductive activity in a non-seasonally breeding species and motivates innovation in semen collection techniques among Asian elephants to obtain high quality samples even during musth.

C.A. LaDue, M. Davis, R. Emory & R.J. Snyder

Male elephant management in AZA institutions: Current status and priorities for the future

Zoo Biology 43 (2024) 325-339

Abstract. Asian elephant and African savanna elephant populations collectively managed by ex-situ facilities accredited by the Association of Zoos and Aquariums (AZA) face sustainability challenges. Among the priorities to strengthen animal wellbeing and population sustainability is male elephant management. We conducted a survey of AZA facilities currently housing male elephants to assess the status, challenges, and priorities in three areas of male elephant management: musth, socialization, and semen collection. Surveys were administered to elephant care teams at AZA-accredited institutions between November 2022 and February 2023, and we received responses from 34 institutions (91.9% of AZA-accredited facilities holding adult male elephants), housing 32 adult male Asians and 26 adult male Africans. Most facilities prioritized breeding and male socialization over musth management and semen collection (although most facilities acknowledged that all these efforts are important), citing leadership support and staffing as most important to achieve male management goals. Behaviors most commonly accompanying musth included reduced appetite, difficulty training or shifting, human-directed aggression, and interest in females. Musth timing was variable between males and facilities. Most males were well-socialized with females and/or other males, though elephant compatibility and facility design were limiting factors in managing socialization. Although 60.6% of facilities collected semen or were training for semen collection, very few male elephants could reliably provide viable semen samples, challenging assisted reproductive efforts that could bolster population sustainability in both species. Together, our results provide a better understanding of the state of male elephant management, offering specific areas deserving of research and development to enhance wellbeing and sustainability. Our survey of male elephant management across AZA-accredited facilities revealed variation in practices related to musth, socialization, and semen collection, indicating areas for further capacity building. image We surveyed 34 AZA institutions to measure status, priorities, and challenges of major components of male elephant management (musth, socialization, semen collection). Musth management and socialization practices widely varied between institutions, and additional research is needed to characterize implications of this variation for wellbeing and sustainability. Further capacity building is needed to enhance semen collection efforts at the population level.

S. Lee, S. Hong, J. Kim & Z.M. Meng

Exploring the role of ethical experiences and psychological well-being in travel satisfaction: An animal welfare perspective in elephant-based tourism

Tourism Management Perspectives 51 (2024) e101248

Abstract. No permission to print abstract.

W. Li, P. Liu, N. Yang, S. Chen, X. Guo, B. Wang & Li Zhang

Improving landscape connectivity through habitat restoration: Application for Asian elephant conservation in Xishuangbanna Prefecture, China

Integrative Zoology 19 (2024) 319-335

Abstract. Habitat restoration is an effective method for improving landscape connectivity, which can reduce habitat fragmentation. Maintaining landscape connectivity could promote connections between habitat, which is extremely essential to preserve gene flow and population viability. This study proposes a methodological framework to analyze landscape connectivity for Asian elephant habitat conservation, aiming to provide practical options for reducing habitat fragmentation and improving habitat connectivity. Our approach involved combining a species distribution model using MaxEnt and landscape functional connectivity models using graph theory to assess the impact on connectivity improvement via farmland/plantation restoration as habitat. The results showed that: (1) there were 119 suitable habitat patches of Asian elephant covering a total area of 1952.41 km^2. (2) The connectivity between habitats improved significantly after vegetation restoration and the gain first decreased and then increased with the increase of dispersal distance. (3) The first few new habitat patches that were identified played an important role in improving connectivity, and the variation rate of connectivity gradually leveled off as the number of new habitats increased. (4) Prioritization of the 25 best new habitat patches increased connectivity from 0.54% to 5.59% as the dispersal distance increased and mainly was located between two Asian elephant distribution regions and two components. Establishment of new habitat patches was effective for improving or restoring connectivity. Our findings can be used as guidance for improving the studied fragmented Asian elephant habitats, and they can also be used as a reference for the habitat restoration of other endangered species heavily affected by habitat fragmentation. © 2023 John Wiley & Sons Australia, Ltd.

G. Maurer, M. Chandelier, B. Mulot & O. Gimenez

Polarized media coverage of conflicting, yet emblematic species: The ambivalent portrayal of the Asian elephant

Biological Conservation 289 (2024) e110391

Abstract. Species involved in human-wildlife conflicts are likely to generate polarized framings in the media. Because media contribute to shaping public opinion, an analysis of wild species in the media helps documenting perceptions and attitudes towards wildlife. The case of the Asian elephant is illustrative because of its ambivalent perception, holding strong cultural and symbolic dimensions, but also feared due to increasing damages and casualties. Through this case, we investigate how media portray an endangered species, both feared and revered. We used text mining, social network and lexical analysis to analyze 11,000 news articles dealing with Asian elephants over 13 years. We found a multifaceted image of the species with various framings. Most prevalent topics were local events recounting damages on crops, villagers' and elephants' deaths. Media also covered various topics from international traffic to conflict mitigation and conservation programs. Thematic articles depicted an institutional representation of human-elephant interactions focusing on global trends and management schemes, using a technical and sanitized lexicon. Conversely, event-driven reports were anchored in spatial and temporal lexicon, recounting elephant encounters and their specific behaviors, while quoting inhabitants with a highly emotional narrative. Our study suggests that event-driven articles highlighted the emotional response to damages caused by individual elephants rather than the demonization of the species. We suggest that, in the context of human-wildlife conflicts, fear and trauma should be better acknowledged to help reducing discrepancies found in media narratives before it fosters other sentiments such as anger and frustration that may impede conservation efforts. © 2023 The Authors.

G. Maurer, M.-P. Dubois, Z.M. Oo, V. Chanthavong, B. Mulot, O. Gimenez & F. Kjellberg

Genetic structure and diversity of semi-captive populations: The anomalous case of the Asian elephant

Conservation Genetics 25 (2024) 973-984

Abstract. Wild species living in captivity are subject to loss of genetic diversity, inbreeding depression, and differentiation among populations. Only very few species have been under human care for centuries but have not been selectively bred, have free-ranging movements most of the time, and retain porous barriers to gene flow between wild and captive populations. Such captive populations are expected to retain high levels of genetic diversity and anthropogenic factors should result in a limited genetic differentiation from wild populations. Asian elephants have been trained and used by humans for at least 4000 years as war animals, mounts of kings and draught animals. In Myanmar and Laos, elephants are still being used for hauling timber in the forest while retaining traditional management practices including seasonal release, free mating and movement. However, habitat fragmentation, isolation and reduced gene flows are threatening both semi-captive and wild pools. We genotyped 167 semi-captive elephants from Laos and Myanmar using a panel of 11 microsatellite loci to estimate the genetic diversity and population structure. We found that elephants of both countries presented high levels of genetic diversity and a low degree of inbreeding, if any. This agrees with the expected high level of genetic diversity in semi-captive populations. We found a weak differentiation along a geographical gradient from southern Laos to northern Myanmar but no differentiation between wild-caught and captive-born pools. The potential value for conservation of a large population of semi-captive elephants has been recognized but the conservation community has yet to fully explore the potential role semi-captive elephants could play in maintaining gene flows.

A. McGuire, M. Kienlen, R. Emory & C.A. LaDue

Overnight monitoring reveals the behavioral rhythms of a geriatric male elephant: An animal-centered case study of rest and stereotypy

Frontiers in Conservation Science 5 (2024) e1362313

Abstract. Monitoring overnight behavior is important in assessing the overall wellbeing of ex-situ elephant populations, with recumbent rest and stereotypy as key indicators of welfare. However, there have been few studies that address the overnight behavior of singly housed male elephants with a history of stereotypy. We conducted an opportunistic case study of the overnight behavior (i.e., rest and stereotypy) of a singly housed geriatric male Asian elephant at the Oklahoma City Zoo to identify his overnight behavioral rhythms in response to physiological (musth) and environmental changes (habitat access, automatic timed feeders) and guide management strategies. Infrared cameras were utilized to conduct continuous focal-animal sampling of the elephant's behavior between 20:00 and 08:00 in indoor and outdoor habitats. Sampling occurred from January 2023 to October 2023, with a total of 179 overnight observations. The elephant exhibited recumbent rest for 175.66 +/- 6.80 (mean +/- SE) minutes per night and was engaged in stereotypy for 175.88 +/- 9.68 minutes per night. While there was no significant relationship between stereotypy and the sexual state of musth, musth was associated with reduced durations of recumbent rest. Access to both indoor and outdoor habitats was significantly related to decreased stereotypy compared to indoor-only treatments. Recumbent rest occurred most frequently between 02:00 and 05:00, and stereotypic behavior was most common between 06:00 and 08:00. Contrary to our expectations, automatic feeders did not significantly reduce stereotypy. The results of this study provide insight into the behavioral patterns of a geriatric male Asian elephant, demonstrating the importance of implementing an animal-centered approach to enhance animal wellbeing. As the zoo-housed Asian elephant population grows and continues to age, this case study emphasizes the importance of developing comprehensive welfare strategies for the elephants in our care.

P. Mohandas, J.S. Anni, T. Choudhury & R. Thanasekaran

Elephant movement mapping in Hosur forest border areas to detect the elephant intrusion pattern and mitigation measures to resolve

human-elephant conflict
GeoJournal 88 (2023) S3-S14
Abstract. No permission to print abstract.

H. Moullec, V. Berger, D.J. Santos, S. Ukonaho, L. Yon, M. Briga, U.K. Nyein, V. Lummaa & S. Reichert
Testosterone variation in a semi-captive population of Asian elephants in Myanmar
Conservation Physiology 12 (2024) coae076
Abstract. Hormones are known to be involved in life-history trade-offs as systemic signals that establish functional links among traits and regulate key behavioural and physiological transitions between states in organisms. Although major functions of many steroid hormones such as testosterone are conserved among vertebrates, circulating concentrations vary widely both within and across species, and the degree to which observed hormone concentrations mediate life-history responses to environmental variation is less understood. In this study, we investigated how faecal testosterone metabolite (FTM) concentrations varied with extrinsic and intrinsic factors. To do so, we took advantage of a 6-year period of longitudinal sampling of FTM, indicators of stress and oxidative status in a semi-captive population of Asian elephants (n = 3163 samples from 173 individuals) in Myanmar. We determined how the variation in FTM is associated with age, sex, origin (captive-born or wild-caught), seasonality of the environment, individual stress level [measured by faecal glucocorticoid metabolite (FGM) and heterophil to lymphocyte ratio (H/L)] and oxidative status (reactive oxygen metabolite concentrations and superoxide dismutase activity). We reported that FTM increased with age from juvenile to adulthood for both sexes, with higher FTM concentrations in males than females. Moreover, elephants showed significantly higher FTM concentrations during the hot season and monsoon than in the cold season. However, for the physiological indicators, we found contrasting results. While FTM concentrations were strongly positively correlated with FGM concentrations, FTM concentrations were not related to H/L ratios. Finally, we found no relationship between FTM and the oxidative status of individuals. Our study provides new insights on the factors associated with variation in testosterone concentrations-a key hormone for reproduction and fitness of individuals-in Asian elephants living in their natural environment, which has relevance for effective conservation measures of this endangered species. © 2024 The Authors.

L. Natarajan, P. Nigam & B. Pandav
Impacts of passive elephant rewilding: Assessment of human fatalities in India
Environmental Conserv. 50 (2023) 186-191
Abstract. No permission to print abstract.

C. Negus, A. Pinyopummin, S. Mahasawangkul, R. Hobbs & R. Bathgate
Asian elephant (*Elephas maximus*) seminal plasma: Establishing the proteome and effect on spermatozoa when added to cryomedium
Reproduction Fertility and Development 36 (2024) QC12106
Abstract. The removal or supplementation of ejaculates with seminal plasma (SP) can affect cryotolerance and post-thaw survival of spermatozoa in many species. In the Asian elephant, elucidation of the SP proteome and investigation of how it affects spermatozoa may enable improvement of cryopreservation protocols. Herein, we characterise the Asian elephant SP proteome and investigate the impacts of SP on sperm cryotolerance in the presence of conspecific or heterospecific SP. Proteomic analysis of Asian elephant SP was performed using mass spectrometry on nine samples from three individuals. In a separate study, SP was removed from six ejaculates and spermatozoa were resuspended in Tris extender supplemented with: no seminal plasma (NOSP), conspecific SP from ejaculates exhibiting 'good' (GSP, >60%) or mixed sperm total motility (MSP), or horse SP (HSP). Samples underwent cryopreservation, and sperm parameters were compared prior to cryopreservation and after thawing (0 and 2 h). Mass spectrometry identified 155 proteins from an array of families. Significant differences were observed in post-thaw sperm quality between SP treatments: high concentrations of MSP (25%, v/v) displayed greater average path and straight-line velocity immediately after thawing ($P < 0.05$) and greater sperm motility index and beat cross frequency than NOSP after 2 h post-thaw incubation ($P < 0.05$). The addition of HSP improved sperm kinematic parameters compared to NOSP and GSP treat-

ments ($P < 0.05$). These preliminary findings suggest the potential of SP to enhance the cryosurvival of Asian elephant spermatozoa, with HSP showing particularly promising results compared to conspecific SP (GSP). Further research into the specific effects of Asian elephant SP proteins is warranted. © 2024 The Authors.

R. Noda, M.F. Mechenich, J. Saarinen, A. Vehtari & I. Zliobaite

Predicting habitat suitability for Asian elephants in non-analog ecosystems with Bayesian models

Ecological Informatics 82 (2024) e102658

Abstract. Rewilding is an ambitious approach to conservation aiming at restoring and protecting natural processes. As the world is rapidly transitioning into conditions that have not been observed before, we need to be able to extrapolate and predict how natural processes would act under new conditions. Species distribution models have a good potential to inform rewilding decisions by the predictive modelling of potential species presence under various habitat conditions. A critical requirement when utilizing these models is to be able to express the uncertainty in the environment or its predictions. This study demonstrates the use of Bayesian statistical models to address this challenge. As a case study, we explore Bayesian logistic regression and Bayesian generalized additive models in order to predict suitable habitats for Asian elephants until the year 2070 under the worst case working scenario of climate change. In this comparative study predictions of habitat suitability are solely based on climatic conditions. The results of the two Bayesian models are compared to two benchmark models, maximum-likelihood estimated logistic regression and random forest. We analyze and discuss trade-offs, relative advantages, and limitations of these modelling choices. The results of our analysis suggest that one configuration of Bayesian logistic regression gives the most robust predictions in this setting, which tend to correspond with the distribution of woodland biomes broadly similar to those in the species ' historical range. © 2024 The Authors.

C. E. O'Connell-Rodwell, J.L. Berezin, A. Dharmarajan, M.E. Ravicz, Y. Hu, X. Guan, K.N. O'Connor & S. Puria

The impact of size on middle-ear sound transmission in elephants, the largest terrestrial mammal

PLoS One 19 (2024) e0298535

Abstract. Elephants have a unique auditory system that is larger than any other terrestrial mammal. To quantify the impact of larger middle ear (ME) structures, we measured 3D ossicular motion and ME sound transmission in cadaveric temporal bones from both African and Asian elephants in response to air-conducted (AC) tonal pressure stimuli presented in the ear canal (PEC). Results were compared to similar measurements in humans. Velocities of the umbo (VU) and stapes (VST) were measured using a 3D laser Doppler vibrometer in the 7-13,000 Hz frequency range, stapes velocity serving as a measure of energy entering the cochlea-a proxy for hearing sensitivity. Below the elephant ME resonance frequency of about 300 Hz, the magnitude of VU/PEC was an order of magnitude greater than in human, and the magnitude of VST/PEC was 5x greater. Phase of VST/PEC above ME resonance indicated that the group delay in elephant was approximately double that of human, which may be related to the unexpectedly high magnitudes at high frequencies. A boost in sound transmission across the incus long process and stapes near 9 kHz was also observed. We discuss factors that contribute to differences in sound transmission between these two large mammals. © 2024 The Authors.

S. Pahari, R. Joshi & U. Paudel

Navigating coexistence: Addressing human-elephant encounters in the buffer zone of Bardiya National Park, Nepal

Journal of Resources and Ecology 15 (2024) 412-421

Abstract. The Asian elephant is one of the important megafaunas in protected areas of the Terai (lowland) region of Nepal. They often encounter humans and their livelihood-supporting activities in the proximity of forest boundary within the protected area. The human-elephant conflict (HEC) has been one of the major issues in the human settlement close to the protected area, which has caused economic losses and poised a threat to human lives every year. The issue has obstructed sustainable management initiatives within the protected areas. The ob-

jective of the study is to analyze the cause of the HEC in the Buffer Zone of Bardiya National Park and to assess people's perception of this megafauna. The structured questionnaire survey was done in three municipalities within the Buffer Zone of Bardiya National Park. Besides, key informants' interview was done to supplement the questionnaire survey. The result shows that 93% of the respondents have been a victim of elephant attacks in the past three years. Last year, on average, each household lost approximately NRs 9690 (USD 1 = NRs 132.72) worth of stored harvest due to the elephant attack. Most of the attack occurs during the season between July to September, followed by the season between October to December. It also indicates that the preference of elephants for crops is the primary cause of elephant attacks/raids in the study area. The second important cause of the elephant attack is insufficient food base which is followed by the expansion of agricultural fields towards the forest. Ninety percent of respondents react to the elephant attack by chasing them (using fire or noise). Fifty-one percent of respondents accept the human-elephant coexistence because of their biological and economic values. However, 40% of them reject the coexistence because of the threat posed by the elephant upon the local people and their livelihood. HEC hinders the management campaign and therefore has to be resolved through collaboration of the protected area, the local people and the administrative stakeholders. It is suggested that more study has to be made to acknowledge the pattern of residing as well as migrating elephants around forest boundaries and adjacent settlements.

H.S. Palei, A.K. Jangid, D.D. Hanumant, N.C. Palei & A.K. Mishra

On the elephant trails: Habitat suitability and connectivity for Asian elephants in eastern Indian landscape

Peerj 12 (2024) e16746

Abstract. Identifying suitable habitats and conserving corridors are crucial to the long-term conservation of large and conflict-prone animals. Being a flagship species, survival of Asian elephants is threatened by human-induced mortality and habitat modification. We aimed to assess the habitat suitability and connectivity of the Asian elephant habitat in the state of Odisha in eastern India. We followed the ensemble of spatial prediction models using species presence data and five environmental variables. We used least-cost path and circuit theory approaches to identify the spatial connectivity between core habitats for Asian elephants. The results revealed that normalized difference vegetation index (NDVI; variable importance 42%) and terrain ruggedness (19%) are the most influential variables for predicting habitat suitability of species within the study area. Our habitat suitability map estimated 14.6% of Odisha's geographical area (c. 22,442 km^2) as highly suitable and 13.3% (c. 20,464 km^2) as moderate highly suitable. We identified 58 potential linkages to maintain the habitat connectivity across study area. Furthermore, we identified pinch points, bottlenecks, and high centrality links between core habitats. Our study offers management implications for long-term landscape conservation for Asian elephants in Odisha and highlights priority zones that can help maintain spatial links between elephant habitats.

A. Pandit, J. Thapa, A. Sadaula, Y. Suzuki, C. Nakajima, S.K. Mikota, N. Subedi, B.K. Shrestha, M. Shimozuru, B. Shrestha, B. Raya, S. Chaudhary, S. Paudel & T. Tsubota

Epidemiology and molecular characterization of *Mycobacterium tuberculosis* including a drug-resistant strain associated with mortality of Asian elephants in Nepal 2019–2022

Tuberculosis 148 (2024) e102550

Abstract. No permission to print abstract.

U. Paudel, K.C. Rabin Bahadur, R. Kadariya, A. Karki, B. P. Shrestha, S. K. Shah, N. Subedi & S.K. Thapa

Human-wildlife conflict in Bardia-Banke Complex: Patterns of human fatalities and injuries caused by large mammals

Ecology and Evolution 14 (2024) e70395

Abstract. Human fatalities and injury from wildlife attacks often result in a negative attitude toward conservation. This research was undertaken to investigate the patterns and conflict-causing factors of human killing and injury by large mammals, especially by Asian elephant, common leopard, and Bengal tiger in the Bardia-Banke Complex of western Nepal. We collected human death and injury records

caused by wildlife in the Bardia-Banke Complex between 2019 and 2023, based on relief applications submitted by the victim's family. Additionally, camera trap monitoring was conducted following incidents of human-tiger and human-leopard conflicts. A total of 76 incidents involving human casualties and injuries were considered for analysis. Incidents of livestock depredation, crop raiding, and property damage were excluded from the analysis. Most of the attacks on humans were caused by tigers (75%), followed by elephants (16%) and leopards (9%). Almost all incidents occurred in daytime (97%). The highest number of conflicts were recorded in 2021, with 20 incidents. Most of the cases (84%) occurred within 1 km of forest edge. Khata corridor and the western side of the Bardia National Park, i.e., Karnali River corridor, were identified as high-conflict areas. The primary causes of the conflict manifested in cattle grazing (28%), grass cutting (28%), firewood collection (11%), fishing (8%) and vegetable collection (5%). To promote human-wildlife coexistence, community-based patrols (33%), habitat restoration (26%), electric fencing (26%), and insurance (7%) were identified as the preferred strategies. Therefore, we recommend that stakeholders and concerned bodies increase awareness among local community about the use of forest resources, wildlife behavior, and human-wildlife conflict mitigation strategies.

A. Purathekandy, M.A. Oommen, M. Wikelski & D.N. Subramani

An agent-based model of elephant crop raid dynamics in the Periyar-Agasthyamalai complex, India

Ecological Modelling 496 (2024) e110843

Abstract. No permission to print abstract.

A.K. Ram, B.R. Lamichhane, N. Subedi, N.K. Yadav, A. Karki, B. Pandav, C. Brown, T.B. Khatri & C.B. Yackulic

Dynamic occupancy modelling of Asian elephants (*Elephas maximus*) reveals increasing landscape use in Nepal

Scientific Reports 14 (2024) e20023

Abstract. Large mammals with general habitat needs can persist throughout mixed used landscapes, however, human-wildlife conflict frequently leads to their restriction to protected areas. Conservation efforts, especially for reducing conflicts with humans, can enhance tolerance of humans towards species like Asian elephants in human-dominated landscapes. Here, we examine how elephant use in the Chure Terai Madhesh Landscape (CTML) covering the entire elephant range of Nepal changed between 2012 and 2020 in relationship to protection status and environmental conditions. We systematically surveyed similar to 42,000 km^2 of potential habitat, by dividing the study area into 159 grid cells of 15 x 15 km^2 and recorded elephant signs during the cool, dry season in three years (2012, 2018 and 2020). We analyzed the survey data in a single-species, multi-season (dynamic) occupancy modeling framework to test hypotheses regarding the influence of environmental conditions and protected area status on landscape use by elephants over time. The best-supported model included protected area effects on initial use, colonization, and detection probability as well as temporal variation in colonization and detection probability. Initial use and colonization rates were higher in protected areas, however elephants increasingly used cells located both inside and outside the protected areas, and the difference in use between protected areas and outside declined as elephants use became prevalent across most of the landscape. While elephant use was patchily distributed in the first year of surveys consistent with past descriptions of four sub-populations, elephant use consolidated into a western and eastern region in subsequent years with a gap in their distribution occurring between Chitwan and Bardiya National Parks. Our manuscript highlights the increasing landscape use by elephants in both protected areas and areas outside protected areas and suggests that management interventions that focus on reducing conflicts can promote greater use of both protected areas and areas outside of protected areas.

G. Rich, R. Stennett, M. Galloway, M. McClure, R. Riley, E.W. Freeman & K.E. Hunt

Nailing it: Investigation of elephant toenails for retrospective analysis of adrenal and reproductive hormones

Conservation Physiology 12 (2024) coae048

Abstract. Hormone monitoring of at-risk species can be valuable for evaluation of individual

physiological status. Traditional non-invasive endocrine monitoring from urine and faeces typically captures only a short window in time, poorly reflecting long-term hormone fluctuations. We examined toenail trimmings collected from African and Asian elephants during routine foot care, to determine if long-term hormone patterns are preserved in these slow-growing keratinized tissues. We first measured the growth rate of elephant toenails biweekly for one year, to establish the temporal delay between deposition of hormones into nail tissue (at the proximal nail bed) and collection of toenail trimmings months later (at the distal tip of the nail). In African elephants, toenails grew similar to 0.18 ± 0.015 mm/day (mean ± SEM) and in Asian elephants, toenails grew similar to 0.24 ± 0.034 mm/day. This slow growth rate, combined with the large toenail size of elephants, may mean that toenails could contain a 'hormone timeline' of over a year between the nail bed and nail tip. Progesterone, testosterone and cortisol were readily detectable using commercial enzyme immunoassays, and all assays passed validations, indicating that these hormones can be accurately quantified in elephant toenail extract. In most cases, variations in hormone concentrations reflected expected physiological patterns for adult females and males (e.g. ovarian cycling and musth) and matched individual health records from participating zoos. Progesterone patterns aligned with our calculations of temporal delay, aligning with female ovarian cycling from over six months prior. Unexpectedly, male testosterone patterns aligned with current musth status at the time of sample collection (i.e. rather than prior musth status). Though this sample type will require further study, these results indicate that preserved hormone patterns in elephant toenails could give conservationists a new tool to aid management of elephant populations.

M. Salas, O. Tallo-Parra & X. Manteca
Evidence-based zoo animal welfare assessment: Putting science into practice
Journal of Zoo and Aquarium Research 12 (2024) 205-211
Abstract. This comprehensive review explores evidence-based strategies for assessing and enhancing animal welfare in modern zoos and aquariums. The two primary objectives are to explore the ways in which understanding behavioural biology and natural history of a given species can enhance zoo animal welfare assessments and discuss how current knowledge of fundamental principles regarding animal behaviour and physiology can help identify and validate welfare indicators. Species-specific protocols, generic protocols and risk assessment methods are examined and the complexities of using natural behaviour as a welfare indicator are explored, acknowledging the inherent challenges of comparing captive and wild behaviours. Behavioural indicators as predominant tools in welfare assessment are analysed for their selection, development and validation. Challenges such as observer bias and external influences are discussed, highlighting the importance of ongoing research and collaboration for refining behavioural indicators. The review extends to physiological indicators, focusing on their diversity and complementarity with behavioural assessments. The selection process involves consideration of species-specific characteristics, biological matrices and sampling methodology. Challenges in the validation of physiological indicators are discussed, underlining the need for comprehensive studies. In conclusion, this review advocates for an integrated, evidence-based approach that combines behavioural and physiological indicators, acknowledging the challenges and offering practical insights for advancing animal welfare in zoo settings.

C. Schiffmann, L. Schiffmann, P. Prager, J. Pastorini, M. Clauss & D. Codron
Face to face: Human recognition of Asian elephant facial features
Mammalian Biology 104 (2024) 389-394
Abstract. No permission to print abstract.

Schulz, A. K., L. V. Kaufmann, N. Reveyaz, C. Ritter, T. Hildebrandt and M. Brecht (2024)
Elephants develop wrinkles through both form and function
Royal Society Open Science 11(10).
Abstract. The trunks of elephants have prominent wrinkles from their base to the very tip. But neither the obvious differences in wrinkles between elephant species nor their development have been studied before. In this work, we char-

acterize the lifelong development of trunk wrinkles in Asian and African elephants. Asian elephants have more dorsal major, meaning deep and wide, trunk wrinkles (approx. 126 +/- 25 s.d.) than African elephants (approx. 83 +/- 13 s.d.). Both species have more dorsal than ventral major trunk wrinkles and a closer wrinkle spacing distally than proximally. In Asian elephants, wrinkle density is high in the 'trunk wrapping zone'. Wrinkle numbers on the left and right sides of the distal trunk differed as a function of trunk lateralization, with frequent bending in one direction causing wrinkle formation. Micro-computed tomography (microCT) imaging and microscopy of newborn elephants' trunks revealed a constant thickness of the putative epidermis, whereas the putative dermis shrinks in the wrinkle troughs. During fetal development, wrinkle numbers double every 20 days in an early exponential phase. Later wrinkles are added slowly, but at a faster rate in Asian than African elephants. We discuss the relationship of species differences in trunk wrinkle distribution and number with behavioural, environmental and biomechanical factors. © 2024 The Authors.

T.T. Shameer, P. Routray, A. Udhayan, N. Ranjan, M. G. Ganesan, A. Manimozhi & D. Vasanthakumari

Understanding the patterns and predictors of human-elephant conflict in Tamil Nadu, India

European Journal of Wildlife Research 70 (2024) e95

Abstract. No permission to print abstract.

K. Sharma, K. Mathesh, P. Janmeda, S. Nautiyal, P.S. Lakshmi, A. Subash, S. Mahajan, R. Agrawal, A.M. Pawde & G.K. Sharma

Production and characterization of biologicals for disease diagnosis and pathological evaluation of elephant endotheliotropic herpesvirus (EEHV)

J. of Virological Methods 329 (2024) e114970

Abstract. No permission to print abstract.

R. Sharma, R. De, J.-P. Puyravaud, J. Parida, A. Sedhupathy, T. Kalam, A. Rahim, K.M. Selvan, N. Arumugam, S. P. Goyal & P. Davidar

Patterns of genetic diversity, gene flow and genetic structure of three Peninsular Indian elephant populations indicate population connectivity

Conservation Genetics 25 (2024) 1175-1193

Abstract. No permission to print abstract.

M. Shi, F. Chen, S.K. Sahu, Q. Wang, S. Yang, Z. Wang, J. Chen, H. Liu, Z. Hou, S.-G. Fang & T. Lan

Haplotype-resolved chromosome-scale genomes of the Asian and African savannah elephants

Scientific Data 11 (2024) e63

Abstract. The Proboscidea, which includes modern elephants, were once the largest terrestrial animals among extant species. They suffered mass extinction during the Ice Age. As a unique branch on the evolutionary tree, the Proboscidea are of great significance for the study of living animals. In this study, we generate chromosome-scale and haplotype-resolved genome assemblies for two extant Proboscidea species (Asian Elephant, Elephas maximus and African Savannah Elephant, Loxodonta africana) using Pacbio, Hi-C, and DNBSEQ technologies. The assembled genome sizes of the Asian and African Savannah Elephant are 3.38 Gb and 3.31 Gb, with scaffold N50 values of 130 Mb and 122 Mb, respectively. Using Hi-C technology similar to 97% of the scaffolds are anchored to 29 pseudochromosomes. Additionally, we identify similar to 9 Mb Y-linked sequences for each species. The high-quality genome assemblies in this study provide a valuable resource for future research on ecology, evolution, biology and conservation of Proboscidea species. © 2024 The Authors.

R. Singh, R. Negi, A.I. Gonji, N. Sharma & R.K. Sharma

Past shadows and gender roles: Human-elephant relations and conservation in Southern India

Journal of Political Ecology 31 (2024) 604-623

Abstract. Some conceptual thinking about human-wildlife relations has lacked translations into empirical studies with an in-depth enquiry into social, cultural, economic and ecological aspects. This study explores human-elephant relations in a cohabited landscape in the Western Ghats of India, with a focus on 'more than conflict' relations. The Valparai plateau, in the Indian Western Ghats, is a landscape dominated

by tea estates and remnants of rainforest fragments where human communities cohabit and closely interact with wildlife. We offer an empirical contribution on the variegated and paradoxical relation between care and fear, between empathy and hate and between the residents and elephants of Valparai. Where conflicts occur between elephants and humans, they have multiple meanings. Gender and unpleasant memories serve as drivers of negative attitudes towards wildlife. A conservation intervention based on engagement and collaboration with local people was perceived as highly effective. Preventive and mitigative, rather than reactive conflict mitigation strategies may have a significant role to play in maintaining the social carrying capacity of local communities towards elephants. We explore the many facets of human-elephant relations, and the numerous entanglements between them, thereby adding multiple layers to the extant knowledge of human-animal relations in the Western Ghats.

J. Supanta, J.L. Brown, P. Bansiddhi, C. Thitaram, V. Punyapornwithaya, K. Punturee, P. Towiboon, N. Somboon & J. Khonmee
Physiological changes in captive elephants in northern Thailand as a result of the COVID-19 tourism ban-stress biomarkers
Frontiers in Vet. Science 10 (2023) e1303537
Abstract. The international travel ban instituted by the Thai government in March 2020 in response to the COVID-19 pandemic greatly affected how tourist camp elephants were managed, with reductions in exercise opportunities, longer chaining hours, and diminished food provisioning. This study was conducted to determine how those changes affected health and welfare biomarkers in individual elephants over the 2 years of the countrywide lockdown (April 2020-April 2022). Blood and fecal samples were collected from 58 elephants at six camps (monthly in Year 1, quarterly in Year 2) and analyzed for stress biomarkers - fecal glucocorticoid metabolites (fGCM), serum oxidative stress [malondialdehyde (MDA) and 8-hydroxy-2 '-deoxyguanosine (8-OHdG)], and stress leukograms. Overall, fGCM concentrations increased within the first few months and remained higher than pre-COVID levels, as did the H/L ratio, a measure affected by cortisol. Serum 8-OHdG, an indicator of DNA oxidative damage, also increased over time, while monocytosis and lymphopenia further suggested alterations in immune function as a result of stress. By contrast, another marker of oxidative stress, serum MDA, declined, possibly in response to reduced roughage and supplement intake. A notable finding was a seasonal pattern of fGCM that was significantly different from previous studies. Whereas higher fGCM during the rainy season were observed in this study, previously, concentrations were highest during the winter, high tourist season. Thus, ironically, both the presence and absence of tourists have been associated with increased fGCM concentrations, albeit for different reasons. Camp management factors negatively affecting stress outcomes included shorter chain lengths, longer chain hours, lack of exercise, and reduced roughage and supplements. Overall, it was clear that camps struggled to maintain adequate care for elephants during the COVID-19 pandemic, highlighting the importance of tourist income and need for contingency plans to cope with potential future disruptions to tourism. © 2023 The Authors.

K. Suresh, C. Wilson, A. Quayle, S. Managi & U. Khanal
Are farmers willing to accept compensation from tourism revenue for elephant crop damage and coexistence support? Evidence from Sri Lanka
Ecological Economics 224 (2024) e108300
Abstract. No permission to print abstract.

N. Sutthiboriban, A. Simcharoen, G.A. Gale, D. Ngoprasert, W. Chutipong & N. Tantipisanuh
Factors affecting crop damage by elephants in the buffer zone of Huai Kha Khaeng, a world heritage site
Pacific Conserv. Biology 30 (2024) PC23061
Abstract. Human-elephant conflict is a growing global problem. To mitigate such conflict, understanding factors affecting elephant intrusions into human-dominated areas is crucial. These factors are, however, complex because they are site specific and context dependent. This study aimed to identify factors associated with crop damage incidents from elephants in a buffer zone of a protected area in western Thailand. Interviews were conducted with local people to quantify crop damage by elephants

between November 2020 to April 2021. We used compositional analysis to determine whether different crop types received different damage from elephants, and logistic regression analysis to examine environmental factors associated with crop damage incidents. Although it was previously thought that elephants focus on dominant palatable crops, we found that small patches of highly preferred crops can influence where elephants choose to feed. Distance from village was also a significant factor in crop foraging. Crop damage was not different between dry and wet seasons, probably because key crops were available year-round. Crop damage occurred across multiple crop types but mainly those with higher sugar content. The damage mostly occurred in fields farther from villages, suggesting that presence of humans may alter elephant crop foraging. No specific seasonal period of crop damage was observed. Changing crop types from species preferred by elephants to less preferred species and growing mixed species (multi-crop systems) instead of single species (mono-crops) may reduce elephant incursions. However, this needs field testing, including market-based assessments to evaluate the economic viability for farmers. Human-elephant conflicts occur frequently across countries within the elephant species range, but solutions remain elusive and are probably site-specific. In our study in western Thailand, pineapple received the most damage. Plantations further away from villages and those with larger areas of corn (an elephant-preferred crop) were associated with more crop damage. Based on local experience, planting multiple crops less preferred by elephants may reduce conflicts.

H. Sylvester, J. Raines, A. Burgdorf-Moisuk, M. Connolly, S. Wilson, L. Ripple, S. Rivera, S. McCain & E. Latimer

Selected instances of elephant endotheliotropic herpesvirus shedding in trunk secretions by African elephants (*Loxodonta africana*) in comparison to shedding by Asian elephants (*Elephas maximus*)

Journal of Zoo and Wildlife Medicine 55 (2024) 182-194

Abstract. This study examined the viral shedding kinetics of elephant endotheliotropic herpesvirus (EEHV) in African elephants compared to viral shedding behavior in Asian elephants. Little is known about the transmission dynamics and epidemiology of this disease in African elephants. In light of recent clinical cases and mortalities, this paper aims to identify trends in viral biology. Trunk wash samples were collected from 22 African elephants from four North American zoological institutions that had recently experienced herd viremias or translocations. Processing of these samples included DNA extraction followed by qPCR to quantitate viral DNA load. The results were then compared with available literature that chronicled similar cases in Asian and African elephants. Minimal EEHV shedding was detected in response to varied herd translocations. Increased shedding was recorded in herds in which an elephant experienced an EEHV viremia when compared to baseline shedding. These index infections were followed by subsequent viremias in other elephants, although it is not known if these were recrudescence, transient controlled viremias, and/or primary infections via transmission to other elephants. When compared to historically published data, it was observed that EEHV3 cases in African elephants and EEHV1A cases in Asian elephants had consistently higher levels of viral DNA in the blood than were shed in trunk secretions, a fact that is seemingly inconsistent with such severe cases of disease and the high mortality rates associated with those respective types. The findings produced in this study highlight the need for more routine monitoring of viral shedding in African elephant herds to elucidate possible EEHV transmission and recrudescence factors for ex situ population management. © 2024 American Association of Zoo Veterinarians.

K. Takehana, T.E. Hoornweg, W. Schaftenaar, V.P. Rutten, C.A. De Haan & K. Matsuno

Elephant endotheliotropic herpesvirus gB-specific antibody levels in sera of Asian elephants (*Elephas maximus*) in Japanese zoos

Journal of Veterinary Medical Science 86 (2024) 1279-1283

Abstract. Prevalence of elephant endotheliotropic herpesvirus (EEHV) infections in Asian elephants in Japan was assessed by determination of EEHV gB specific antibody levels. Among 28 healthy Asian (sub) adult elephants from 11 zoos, 27 animals exhibited intermediate

to high antibody levels. Like elsewhere worldwide, this suggested exposure of Asian elephants in Japan to at least one EEHV (sub) species. Longitudinal observations of two elephants monitored from birth to 30-month of age showed consistent high antibody levels. Another juvenile showed antibody levels that decreased to undetectable levels prior to death at 13 months of age. This fatal case supports earlier reports that low antibody levels are a risk factor for development of EEHV hemorrhagic disease.

N.R. Talukdar, P. Choudhury & F. Ahmad
Human-elephant conflict hotspots in Assam: A rapid appraisal method
Biodiversity and Conserv. 33 (2024) 2231-2245
Abstract. No permission to print abstract.

H.B. Tilley, D. Murphy, K. Wierucka, T.C. Wong, A. Surreault-Chable & H.S. Mumby
Physical activity and temperature changes of Asian elephants (*Elephas maximus*) participating in eco-tourism activities and elephant polo
PLoS One 19 (2024) e0300373
Abstract. Captive and domestic animals are often required to engage in physical activity initiated or organised by humans, which may impact their body temperature, with consequences for their health and welfare. This is a particular concern for animals such as elephants that face thermoregulatory challenges because of their body size and physiology. Using infrared thermography, we measured changes in skin temperature associated with two types of physical activity in ten female Asian elephants at an ecotourism lodge in Nepal. Six elephants took part in an activity relatively unfamiliar to the elephants-a polo tournament-and four participated in more familiar ecotourism activities. We recorded skin temperatures for four body regions affected by the activities, as well as an average skin temperature. Temperature change was used as the response variable in the analysis and calculated as the difference in elephant temperature before and after activity. We found no significant differences in temperature change between the elephants in the polo-playing group and those from the non-polo playing group. However, for both groups, when comparing the average skin body temperature and several different body regions, we found significant differences in skin temperature change before and after activity. The ear pinna was the most impacted region and was significantly different to all other body regions. This result highlights the importance of this region in thermoregulation for elephants during physical activity. However, as we found no differences between the average body temperatures of the polo and non-polo playing groups, we suggest that thermoregulatory mechanisms can counteract the effects of both physical activities the elephants engaged in.

L. Urban, R. Becker, A. Ochs, F. Sicks, M. Brecht & L.V. Kaufmann
Water-hose tool use and showering behavior by Asian elephants
Current Biology 34 (2024) 5602-5606
Abstract. Since Jane Goodall's famous observations of stick tool use by chimpanzees,1 animal tool use has been observed in numerous species, including many primates, dolphins, and birds. Some animals, such as New Caledonian crows, even craft tools. Elephants frequently use tools and also modify them. We studied water-hose tool use in Asian zoo elephants. Flexibility, extension, and water flow make hoses exceptionally complex tools. Individual elephants differed markedly in their water-hose handling. Female elephant Mary displayed sophisticated hose-showering behaviors. She showed lateralized hose handling, systematically showered her body, and coordinated the trunk-held water hose with limb behaviors. Mary usually grasped the hose behind the tip, using it as a stiff shower head. To reach her back, however, she grasped the hose further from the tip and swung it on her back, using hose flexibility and ballistics. Aggressive interactions between Mary and the younger female elephant, Anchali, ensued around Mary's showering time. At some point, Anchali started pulling the water hose toward herself, lifting and kinking it, then re- grasping and compressing the kink. This kink-and-clamp behavior disrupted water flow and was repeated in several sessions as a strict sequence of maneuvers. The efficacy of water flow disruption increased over time. In control experiments with multiple hoses, it was not clear whether Anchali specifically targeted Mary's showering hose.

We also observed Anchali pressing down on the water hose, performing an on- hose trunk stand, which also disrupted water flow. We conclude that elephants show sophisticated hose tool use and manipulation. © 2024 The Authors.

P. Vineetha, S. Sarun, S. Selvakumar & R. Rajesh

Geospatial based AHP analysis for habitat suitability of elephants and the effects of human elephant conflict in a tropical forest of Western Ghats in India

European Journal of Wildlife Research 70 (2024) e82

Abstract. No permission to print abstract.

Y. Wang, Y. Wang, J. Zhou, M. Bao, T. Shah, S. Yang, J. Zheng, Q. Li, Y. Hou, B. Wang & R. Yuan

Exploring the gut microbiota of healthy captive Asian elephants from various locations in Yunnan, China

Frontiers in Microbiology 15 (2024) e1403930

Abstract. The Asian elephant is a giant herbivore classified as an endangered wildlife species by the International Union for Conservation of Threatened Species. This study aims to investigate and compare the core gut microbiota of captive Asian elephants from three different locations in Yunnan Province, China, to explore the impact of environmental and husbandry factors on microbial diversity. We collected fecal samples from 29 captive Asian elephants from three locations and performed full-length 16S rRNA gene sequencing. Microbial diversity was assessed using alpha diversity (Chao1 and Shannon indexes) and beta diversity (Bray-Curtis and Euclidean distance metrics). Principal coordinate analysis (PCoA) was used to visualize microbial variation among groups. Alpha diversity analysis showed that the microbial diversity in the Yexianggu group was higher than that in the other groups. Bray-Curtis and Euclidean metrics revealed significant differences among the microbial communities. Bacteroidetes and Firmicutes, which are key cellulose-degrading bacteria, were the dominant phyla in all groups. Synergistaceae was the most abundant family in the Menghai group, while Lachnospiraceae and Pirellulaceae were more abundant in the Yexianggu and Yuantongshan groups, respectively. Genus p-1008-a5-gut-group was more abundant in Yexianggu, and Prevotella was predominant in Menghai. These results indicate that habitat and husbandry practices significantly influence the gut microbiota of captive Asian elephants. The identification of bacterial species highlights the potential role of specific microbes in maintaining host-microbial interactions. Promoting microbial diversity through improved captive conditions could enhance the health of these endangered animals. © 2024 The Authors.

H. Xu, L. Jiang & Y. Liu

Mapping the potential distribution of Asian elephants: Implications for conservation and human-elephant conflict mitigation in South and Southeast Asia

Ecological Informatics 80 (2024) e102518

Abstract. Asian elephants play a pivotal role in their ecosystem. Understanding the potential distribution area of this species is vital for effective conservation efforts and mitigation of human-elephant conflicts. In this study, we used the maximum entropy to simulate the potential distribution area of Asian elephants across South and Southeast Asia, leveraging Maximum Entropy (MaxEnt) and presence data sourced from the Global Biodiversity Information Facility (GBIF). The analysis revealed that the potential distribution area of Asian elephants spans 530,418 km^2 (10.59% of the study area), with significant potential distribution areas observed in Indonesia (136,890 km^2) and Malaysia (119,497 km^2). Vegetation type emerged as the dominant environmental factor influencing model outcomes, encompassing aspects such as broadleaved evergreen tree coverage, broadleaved deciduous closed tree coverage and EVI. The potential distribution area of Asian elephants overlaps with regions inhabited by 55.25 million people, with 6.07 million people residing in highly suitable habitats. India and Malaysia have high potential for human-elephant conflict due to the high number of people living in potential and highly suitable habitats for elephants. Bangladesh and Nepal, on the other hand, have fewer people living in these habitats suitable for elephants, but they face relatively high human population density in these areas. © 2024 The Authors.

H. Yildiz, O. Heise, B. Gerhardt, G. Fritsch, R. Becker, A. Ochs, F. Sicks, P. Buss, L.-M. de Klerk-Lorist, T. Hildebrandt & M. Brecht

Macrovibrissae and microvibrissae inversion and lateralization in elephants

Annals of the New York Academy of Sciences 1538 (2024) 85-97

Abstract. Elephants are known for strongly lateralized trunk behaviors, but the mechanisms driving elephant lateralization are poorly understood. Here, we investigate features of elephant mouth organization that presumably promote lateralization. We find the lower jaw of elephants is of narrow width, but is rostrally strongly elongated even beyond the jaw bone. Elephant lip vibrissae become progressively longer rostrally. Thus, elephants have two lateral dense, short microvibrissae arrays and central, less dense long macrovibrissae. This is an inversion of the ancestral mammalian facial vibrissae pattern, where central, dense short microvibrissae are flanked by two lateral macrovibrissae arrays. Elephant microvibrissae have smaller follicles than macrovibrissae. Similar to trunk-tip vibrissae, elephant lip microvibrissae show laterally asymmetric abrasion. Observations on Asian zoo elephants indicate lateralized abrasion results from lateralized feeding. It appears that the ancestral mammalian mouth (upper and lower lips, incisors, frontal microvibrissae) is shaped by oral food apprehension. The elephant mouth organization radically changed, however, because trunk-mediated feeding replaced oral apprehension. Such elephant mouth changes include the upper lip-nose fusion to the trunk, the super-flexible elongated lower jaw, the loss of incisors, and lateral rather than frontal microvibrissae. Elephants' specialization for lateral food insertion is reflected by the reduction in the centering effects of oral food apprehension and lip vibrissae patterns. This study explores the macro- and microvibrissae found on the elephant jaw. Compared to ancestral mammals, the elephant jaw has an inversion of oral macro- and microvibrissae with macrovibrissae located anteriorly and microvibrissae located posteriorly. Abrasions of microvibrissae were asymmetrical and appeared to be related with trunk laterality during feeding. The unique location and pattern of elephant vibrissae may reflect its evolution of their specialized method of food acquisition.

S.H. Youn, E. Jung, K.Y. Shin & K.-T. Kim

Musth cases in two captive male Asian elephants (*Elephas maximus*) Korea

Journal of Veterinary Science 25 (2024) e76

Abstract. When male elephants reach sexual maturity, they exhibit excessive sexual behaviors called musths. The musth period is important in the management of elephant herds. However, the timing of the musth and the effect of musth elephants on non-musth elephants in Korea have not been clearly analyzed. In our observations, one male elephant (Koshik), who had been alone with a female, was observed to be on musth from age 15, while another young male elephant (Udara), who joined the group later, was not observed to be on musth at age 15, moreover the male elephants that were found to be on musth earlier had a longer duration of musth after the introduction of the other male. Furthermore, we also found that Koshik's testosterone levels increased approximately 200-fold during musth (the lowest level was 0.93 ng/mL) compared to before musth (the highest level was 214 ng/mL). We found that the duration and behavior of musth in captive male elephants were affected by the introduction of other growing male elephants.

N. Zakaria, H. Juahir, S.M.M. Nor, N.H.M. Hanapi, H.H.W. Jusoh, N.Z.M. Afandi & M.T. Abdullah

Elephant research challenges and opportunities: A global bibliometric analysis

Ecological Informatics 82 (2024) e102662

Abstract. The Asian elephant, also known as Asiatic elephant is facing a significant decline in its wild populations due to habitat loss, fragmentation and degradation, leading to increased conflicts between humans and elephants. Preserving this iconic species is crucial, prompting researchers to explore various aspects of its biology, behavior, ecology and conservation efforts. In light of the profound importance of this subject, this study utilizes a descriptive systematic literature review (SLR) to examine global research trends on Asian elephants. Analyzing a dataset of 1780 articles spanning from 1914 to 2022, the study reveals a notable increase in publications, particularly since 2000, with 142 articles published in 2022 alone. This research provides a comprehensive overview of ad-

vancements in Asian elephant studies, promoting international collaboration and knowledge exchange among researchers. While research from leading scientific countries can aid in conservation efforts, there is a call for more inclusive, participatory and fair approaches. The study demonstrates a commitment to Equity, Inclusion and Diversity (EID) by adopting a multifaceted approach that considers the needs, perspectives and contributions of diverse stakeholders. By addressing disparities and advocating for social justice within elephant conservation, the study emphasizes the urgent need for collective action in conservation, welfare improvement, conflict resolution, ecosystem balance and overall enhancement of understanding about Asian elephants. Serving as a valuable resource for policymakers, conservation organizations and researchers, the study not only synthesizes existing literature but also identifies research gaps, highlights areas requiring immediate attention, and offers collaborative opportunities for global scientists to contribute to the well-being and preservation of this majestic species.

F. Zeng, M. Huang, K. Huang, J. Sa, S. Zhang & X. Chen

Potential contribution of alpha-fetoprotein level to biomarker of pregnancy outcome in Asian elephants

Vet. Medicine and Science 10 (2024) e1583

Abstract. Alpha-fetoprotein (AFP) is a structural serum glycoprotein that plays vital roles in reproduction and mammalian development. Analysis of serum prolactin (PRL) is considered one of the useful methods for diagnosing pregnancy in Asian elephants. However, the expression profiles of AFP in pregnant and nonpregnant Asian elephants remain unclear, nor is the relationship with PRL. In this study, serum seven gonadal hormones and AFP in three pregnant and seven nonpregnant Asian elephants were analysed by via radioimmunoassay (RIA) and enzyme-linked immunosorbent (ELISA) assay. We found that the mean (± SD) concentration of prolactin (PRL) in pregnant (136.782 ± 30.987 ng/mL) elephants was significantly higher than that in nonpregnant elephants (52.803 ± 21.070 ng/mL; $p \leq 0.0005$). The mean (± SD) concentration of AFP in pregnant elephants (11.598 ± 0.824 ng/mL) was significantly higher than that in nonpregnant elephants (7.200 ± 2.283 ng/mL; $p \leq 0.05$). Furthermore, the AFP concentration was positively correlated with the PRL concentration in the 10 Asian elephants studied. In conclusion, our findings suggest that serum AFP concentration is a potential biomarker of pregnancy outcomes in Asian elephants. Alpha-fetoprotein (AFP) is a structural serum glycoprotein that plays vital roles in reproduction and mammalian development. Analysis of serum prolactin (PRL) is considered one of the useful methods for diagnosing pregnancy in Asian elephants. We found the AFP concentration was positively correlated with the PRL concentration in the 10 Asian elephants studied. Therefore, we suggest that the serum AFP concentration is a potential biomarker of pregnancy outcomes in Asian elephants. © The Authors.

F. Zhou, M. Bao, X. Guo, Q. Shen, J. Chen, D. Li, H. Bao & L. Zhang

Heart rate patterns of captive Asian elephant (*Elephas maximus*) in their natural habitat at Wild Elephant Valley, Xishuangbanna of China

Heliyon 10 (2024) e25720

Abstract. There are few studies on the changes of heart rate of the Asian elephant, one of the largest tropical terrestrial mammals, with its self-factors and external environment. By measuring the heart rate (HR) of 35 Asian elephants, ranging in age from 4 months to 52 years, using a non-invasive electrocardiogram sensor in their natural habitat at Wild Elephant Valley, Xishuangbanna of China, we found factors that significantly influenced the HR were season, phase of the day, age, body weight, and the interaction between some of the above factors. We also observed that Asian elephants had lower resting heart rate in the morning of hot season than the cold and mild season, and the differences were significant, but the heart rate increased to similar levels in the afternoon regardless of the season. HR also decreased with age in all seasons and phases of the day. However, there was no significant effect of sex. This study reveals the adaptability of Asian elephant to tropical environment, and provides a basic reference for heart rate of Asian elephant under various natural conditions. © 2024 The Authors.