# Recent Publications on Asian Elephants

Compiled by Jennifer Pastorini

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If you need additional information on any of the articles, please feel free to contact me. You can also let me know about new (2022) publications on Asian elephants.

**Abstract.** No permission to print abstract.

T. Angkawanish, H.J.C.M. Vernooij, A. Sirimalaisuwan, M. Nielen, P. Charernpan & V.P.M.G. Rutten

**Prevalence and demographic risk factors of *Mycobacterium tuberculosis* infections in captive Asian elephants (*Elephas maximus*) based on serological assays**

*Frontiers in Vet. Science 8 (2021) e713663*

**Abstract.** To address putative TB statuses of elephants and to identify and quantify potential demographic risk factors for TB, three ELISAs specific for different mycobacterial antigens (ESAT6, CFP10, MPB83) and the TB Stat-Pak assay were used as surrogate serological markers for TB infection in elephants. In view of the low number of animals of which the infected status could be confirmed (4 out of 708) Latent Class Analyses of TB serology test outcomes was used to predict the putative TB status of each of 708 elephants as positive (17.3%), inconclusive (48.7%), or negative (34%) when assessed on a population basis. Correlation between test performance of the individual assays was high between the ELISAs, but low with that of the TB Stat-Pak assay. Risk factors, assessed based on cut off values for each of the ELISAs determined by ROC analysis, included sex, BCS, age, working time, feed type, management system, camp size and region. Old age elephants were more likely to show a positive TB serology test outcome, than younger ones. Elephants working 7 h per day and the ones in good condition BCS (7–11) were less likely to be positive in TB serology testing. In addition, fewer animals in the large camp size (31–50 elephants) were found to be positive in ELISA tests, compared to elephants in the other camp sizes. In this study, the North region had the lowest percentages of elephants with positive TB test outcome, the West region and to a lesser extend the other regions showed clearly higher percentages of positive animals. Even though assays used in the present study have not been validated yet, results obtained showed promise as diagnostic or screening tests. For the diagnosis of animals suspected to be infected, the ELISA tests, once further optimized for the individual antigens, can be used in parallel. For screening of complete camps for presence or absence of infection, a single optimized ELISA test can be utilized. 

Ardiantiono, Sugiyo, P.J. Johnson, M.I. Lubis, F. Amama, Sukatmoko, W. Marthy & A. Zimmermann

**Towards coexistence: Can people's attitudes explain their willingness to live with Sumatran elephants in Indonesia?**

*Conservation Science & Practice 3 (2021) e520*

**Abstract.** Understanding coexistence between humans and threatened wildlife is a central focus in conservation. Way Kambas National Park in Sumatra Island, Indonesia, harbors one of the largest populations of the critically endangered Sumatran elephant (*Elephas maximus sumatranus*). The people who live alongside this population are affected by intensive crop foraging. Our study investigated the factors which influenced attitudes toward elephants. We then evaluated the implications of reported attitudes for future willingness to live with elephants. We surveyed 660 respondents in 22 villages around the park. People generally reported positive attitudes toward elephants (smartness 95%, usefulness 62%, importance 57%, and

pleasantness 53%), apart from where human safety was concerned (safety 11%). Each dimension of attitude was explained by different factors including age, gender, knowledge of elephants, and distance to crop foraging locations. Most respondents (62%) expressed no willingness to coexist with elephants. Such willingness was lower when elephants were perceived to be more dangerous, but higher if beliefs in the benefits of elephants were greater. Efforts to improve crop foraging mitigation practice and to increase people's awareness of elephant benefits may promote support for their conservation. Through this study, we advocate the integration of social science to promote human–wildlife coexistence strategies, an approach that is currently limited in Indonesia. 

L.P. Barrett & S. Benson-Amram

**Multiple assessments of personality and problem-solving performance in captive Asian elephants (*Elephas maximus*) and African savanna elephants (*Loxodonta africana*)**

*Journal of Comparative Psychology 135 (2021) 406-419*

**Abstract.** No permission to print abstract.

U. Bechert, S. Hixon & D. Schmitt

**Diurnal variation in serum concentrations of cortisol in captive African (*Loxodonta africana*) and Asian (*Elephas maximus*) elephants**

*Zoo Biology 40 (2021) 458-471*

**Abstract.** Cortisol is involved in a broad range of physiological processes and enables animals to adapt to new situations and challenges. Diurnal fluctuations in circulating cortisol concentrations in elephants have been demonstrated based on samples from urine and saliva. The aims of this study were to demonstrate diurnal cortisol fluctuations based on blood samples and compare concentrations between seasons, species, and changes in reproductive hormone concentrations. Nine African (*Loxodonta africana*) and three Asian (*Elephas maximus*) elephants at two facilities in the United States were included in this study. Blood samples were collected every 2–3 h at one location and every 1–6 h at another. Peak serum concentrations of cortisol averaged 28 ng/ml for both African and Asian elephants, and diurnal cycles included a fivefold decrease from morning peak to evening nadir concentrations. Diurnal cortisol profiles varied uniquely among individual elephants. During the winter, nadir concentrations of cortisol were slightly higher, and the timing of peak concentrations was less predictable. There was no correlation between diurnal serum concentrations of progesterone and cortisol; however, a significant correlation ($p = 0.02$) was identified between serum concentrations of testosterone and cortisol when a time lag of ~2–3 h was considered. The physiological significance of the positive correlations between diurnal serum concentrations of cortisol and testosterone in male elephants remains to be determined. If cortisol concentrations are being used to evaluate elephant health or welfare, samples should be obtained at the same time each day to minimize variation due to diurnal fluctuations, and ideally seasonal variations and individuality in diurnal profiles should also be considered. 

V. Berger, S. Reichert, M. Lahdenperä, J. Jackson, W. Htut & V. Lummaa

**The elephant in the family: Costs and benefits of elder siblings on younger offspring life-history trajectory in a matrilineal mammal**

*Journal of Animal Ecology 90 (2021) 2663-2677*

**Abstract.** Many mammals grow up with siblings, and interactions between them can influence offspring phenotype and fitness. Among these interactions, sibling competition between different-age offspring should lead to reproductive and survival costs on the younger sibling, while sibling cooperation should improve younger sibling's reproductive potential and survival. However, little is known about the consequences of sibling effects on younger offspring life-history trajectory, especially in long-lived mammals. We take advantage of a large, multigenerational demographic dataset from semi-captive Asian elephants to investigate how the presence and sex of elder siblings influence the sex, survival until 5 years old, body condition, reproductive success (i.e. age at first reproduction and lifetime reproductive success) and long-term survival of subsequent offspring. We find that elder siblings have heterogeneous effects on subsequent offspring life-history traits depending on their presence, their sex and the

sex of the subsequent offspring (named focal calf). Overall, the presence of an elder sibling (either sex) strongly increased focal calf long-term survival (either sex) compared to sibling absence. However, elder sisters had higher impact on the focal sibling than elder brothers. Focal females born after a female display higher long-term survival, and decreased age at first reproduction when raised together with an elder sister rather than a brother. Focal males born after a female rather than a male showed lower survival but higher body weight when both were raised together. We did not detect any sibling effects on the sex of the focal calf sex, survival until 5 years old and lifetime reproductive success. Our results highlight the general complexity of sibling effects, but broadly that elder siblings can influence the life-history trajectory of subsequent offspring. We also stress the importance of considering all life stages when evaluating sibling effects on life trajectories. © 2021 The Authors.

K. Budd, C. Sampson, P. Leimgruber, D. Tonkyn, K. Storey, M. Garrett & L.S. Eggert
**Population structure and demography of Myanmar's conflict elephants**
*Global Ecology and Conserv. 31 (2021) e01828*
**Abstract.** Despite containing the largest extent of unfragmented landscape in the Asian elephant (*Elephas maximus*) range, Myanmar has high levels of human-elephant conflict. The Bago Yoma mountain region of central Myanmar has previously been identified as an elephant conflict hotspot, characterized by high levels of crop-raiding and illegal killing of elephants for the ivory and skin trades. We used non-invasive fecal sampling to evaluate the population structure and demography of wild and captive elephants in the Bago Yoma using microsatellite loci and mitochondrial DNA in combination with crop-raiding status, age, and sex. We were able to collect 252 samples from wild elephants – 119 directly following conflict events – and 25 from captive elephants from which we identified 127 unique wild and 21 captive individuals. The population was biased toward subadults, which could be an important contributor to the high rates of conflict, as these individuals may lack the experience to avoid dangerous behaviors. Conflict elephants were primarily male, although both sexes and all ages engaged in crop-raiding, including females with juveniles. We found that elephants that commit solo raids were all male, while larger raiding parties often included both related and unrelated individuals of both sexes. Repeat offenders were common. These wild elephants contained high levels of genetic diversity, differentiated from local captive populations, and valuable for the species' conservation. Overall, the elephants of Bago Yoma, Myanmar have been heavily affected by conflict, and managers could utilize the knowledge presented to aid in the preservation of this population. © 2021 The Authors.

A. Campos-Arceiz, J.A. de la Torre, K. Wei, X.O. Wu, Y. Zhu, M. Zhao, S. Chen, Y. Bai, R.T. Corlett & F. Chen
**The return of the elephants: How two groups of dispersing elephants attracted the attention of billions and what can we learn from their behavior**
*Conservation Letters 14 (2021) e12836*
**Abstract.** none.

A. Chaitae, R. Rittiron, I.J. Gordon, H. Marsh, J. Addison, S. Pochanagone & N. Suttanon
**Shining NIR light on ivory: A practical enforcement tool for elephant ivory identification**
*Conservation Science & Practice 3 (2021) e486*
**Abstract.** The elephant ivory trade remains controversial because of concerns about the extinction risk of elephants and the different needs of CITES member states. Thailand's situation is particularly contentious because of the different legal status among types of elephant ivory. Thai law allows the local sale of ivory from domesticated Asian elephants, which creates challenges for Thai enforcement officers in identification of ivory provenance. We investigated the capacity of non-destructive Near Infrared (NIR) spectroscopy (600–1700 nm), combined with Partial Least Squares Discriminant Analysis (PLS-DA), to discriminate between ivory from African, wild Asian and domesticated Asian elephants. Ivory spectra of 64 elephants were divided randomly into calibration and validation datasets. We were able to determine elephant ivory provenance at both the interspecies (African and Asian elephant ivory), and within species (wild and domesticated Asian elephant ivory) classifications with 100% accuracy.

These results showed the potential use of handheld NIR spectrometers for rapid assessments of ivory provenance, as well as a forensic tool for wider enforcement. © 2021 The Authors.

Russell Clemens

**Asian elephant futures: A causal layered analysis with Gregory Bateson in mind**

*World Futures Review 12 (2020) 55-80*

**Abstract.** Human population growth and dwindling fragmented natural habitats for elephants in Asia are leading to increasing conflict between humans and wild elephants. Sohail Inayatullah's Causal layered analysis (CLA) is applied to understand the human-elephant conflict (HEC) situation. Gregory Bateson's "ecology of mind" (EoM; epistemology, recurrence, abduction, and metaphor) is also employed to focus on possible implications of metaphor, epistemology, and social-psychological misalignments. The article aims to inform multidisciplinary practitioners on the relevance of applying both CLA and EoM to social-ecological issues in the twenty-first century. CLA and EoM are compatible and complementary multilayered approaches which, as metaphorical approaches, share mixed entailments. Bateson's "double bind" theory is applied within CLA to explore the implications of possible Asian elephant extinction within the Anthropocene in respect to Indian (Hindu and Buddhist) cosmologies. © 2019 The Authors.

S.M. Common, Y. Yun, A. Silva-Fletcher, C. Thitaram, T. Janyamethakul, S. Khammesri & F.M. Molenaar

**Developing a non-invasive method of detecting elephant endotheliotropic herpesvirus infections using faecal samples**

*Vet Record 190 (2021) e833*

**Abstract.** Elephant endotheliotropic herpesvirus (EEHV)-associated haemorrhagic disease (EEHV-HD) is a leading cause of death in Asian elephant calves across the world. Cases of EEHV-HD have been detected in free-living calves through post-mortem examination (PME) indicating the presence of the virus in the wild. In the absence of a non-invasive sampling method, little research into free-living populations has been possible. This study aimed to provide evidence that faeces can be used as a non-invasive sampling method for the detection of EEHV excretion using quantitative polymerase chain reaction. Serial saliva swabs and faecal samples were taken from five captive Asian elephants in Thailand over 12 weeks. To ensure the presence of detectable elephant DNA within the sample, qPCR was run for amplification of the Asian elephant tumour necrosis factor (TNF-α) gene, EEHV1 and EEHV4. Of 28 sample pairs, seven saliva samples were positive for EEHV, of which two had paired positive faecal samples. This study presents the first evidence that EEHV is excreted in faeces at detectable levels. This method may in future be used for improved understanding of the epidemiology of EEHV in free-living elephant populations, as well as detection of EEHV excretion in captive herds. © 2021 British Veterinary Association.

P. Dagenais, S. Hensman, V. Haechler & M.C. Milinkovitch

**Elephants evolved strategies reducing the biomechanical complexity of their trunk**

*Current Biology 31 (2021) 4727-4737*

**Abstract.** The elephant proboscis (trunk), which functions as a muscular hydrostat with a virtually infinite number of degrees of freedom, is a spectacular organ for delicate to heavy object manipulation as well as social and sensory functions. Using high-resolution motion capture and functional morphology analyses, we show here that elephants evolved strategies that reduce the biomechanical complexity of their trunk. Indeed, our behavioral experiments with objects of various shapes, sizes, and weights indicate that (1) complex behaviors emerge from the combination of a finite set of basic movements; (2) curvature, torsion, and strain provide an appropriate kinematic representation, allowing us to extract motion primitives from the trunk trajectories; (3) transport of objects involves the proximal propagation of an inward curvature front initiated at the tip; (4) the trunk can also form pseudo-joints for point-to-point motion; and (5) the trunk tip velocity obeys a power law with its path curvature, similar to human hand drawing movements. We also reveal with unprecedented precision the functional anatomy of the African and Asian elephant trunks using medical imaging and macro-scale serial sectioning, thus drawing strong connections between motion primitives and muscular

synergies. Our study is the first combined quantitative analysis of the mechanical performance, kinematic strategies, and functional morphology of the largest animal muscular hydrostat on Earth. It provides data for developing innovative "soft-robotic" manipulators devoid of articulations, replicating the high compliance, flexibility, and strength of the elephant trunk. © 2021 The Authors.

Yunchuan Dai

**The overlap of suitable tea plant habitat with Asian elephant (*Elephus maximus*) distribution in southwestern China and its potential impact on species conservation and local economy**

*Environmental Science and Pollution Research 29 (2022) 5960-5970*

**Abstract.** No permission to print abstract.

R. De, R. Sharma, P. Davidar, N. Arumugam, A. Sedhupathy, J.-P. Puyravaud, K. M.Selvan, P.P.A. Rahim, S. Udayraj, J. Parida, D.K. Digal, R. Kanagaraj, K. Kakati, P. Nigam, A.C. Williams, B. Habib & S.P. Goyal

**Pan-India population genetics signifies the importance of habitat connectivity for wild Asian elephant conservation**

*Global Ecology and Conserv. 32 (2021) e01888*

**Abstract.** Asian elephants are endangered while they have faced ~70% population decline in India in the last 60 years. Climate change projections indicate exacerbation of ongoing habitat loss (>40%) by 2070, potentially impacting genetic structure of wild elephants across India. Therefore, we provide consolidated baseline data on genetic diversity and structure of elephants across four eco-regions of India, i.e., north-western (NW), north-eastern (NE), east-central (ECI), and southern India (SI), to identify populations at greater risk of further divergence. We genotyped 169 faecal samples across 14 microsatellites with 90.0% overall success rate. The genetic diversity levels were moderate and varied between the eco-regions ($H_E$ = 0.57–0.74). Allelic richness was higher in NE (3.73–3.78) and SI (3.62–3.71). We observed a high inbreeding coefficient in NE ($F_{IS}$ = 0.55–0.58) compared to the other elephant populations, probably due to the presence of related individuals in our samples. Genetic differentiation between populations using $F_{ST}$ statistics ($F_{ST}$ = 0.06–0.18) was significant. Bayesian and multivariate analyses identified three major genetic clusters in India – NW, NE, and combined ECI-SI, mostly consistent with their geographic distribution. We also observed an unexpected pattern of high genetic distance between adjacent populations. This fine-scale genetic structure suggests the presence of barriers (natural and anthropogenic) and complex social organisation. Additionally, incipient sub-structuring within NE and SI indicates potential genetic discontinuity. These results highlight the importance of maintaining genetic diversity, particularly of NE and ECI populations, by retaining habitat connectivity and ensuring gene flow for effective elephant conservation in India. © 2021 The Authors.

J.-M. Dubost, P. Kongchack, E. Deharo, P. Sysay, C. Her, L. Vichith, D. Sébastien & S. Krief

**Zootherapeutic uses of animals excreta: The case of elephant dung and urine use in Sayaboury province, Laos**

*Journal of Ethnobiology and Ethnomedicine 17 (2021) e262*

**Abstract.** Despite a widespread aversion towards faeces and urine, animal excreta are used in traditional medicine in many countries since centuries, but records are scattered and few therapeutic uses have been accurately documented while in the current context of emerging zoonoses such records may be of major interest. In this study, we investigated the therapeutic uses that mahouts in Xayaboury province, Lao PDR make of elephant urine and faeces as well as of the brood chamber that beetles (*Heliocopris dominus*) fashion from elephant dung. Semi-structured interviews were conducted with mahouts on elephant diet, health problems and responses to disease, andwhether they use elephant products. Data were supplemented by interviews with traditional healers. Seven respondents reported the use of elephant urine in ethnoveterinary care for elephants and in human medicine in case of diabetes and otitis. 25 respondents reported therapeutic use of elephant faeces (EF) and elephant dung beetle brood chambers. The major indications are gastrointestinal and skin problems. Macerations or decoctions are drunk or used externally as a lotion. The mahouts attribute the therapeutic effectiveness of EFs to their content which in-

cludes the remains of many species from the elephant diet which they consider to be medicinal. The indications of these uses are consistent with pharmacological and clinical studies highlighting the properties of different animals' urine and faeces and their curative potential tested in vivo. The acknowledgement by the mahouts of medicinal properties of elephant faecal bolus contrasts with the rare justifications of animal material use recorded in zootherapeutic studies, which falls within the symbolic domain. However, numerous studies highlight the preponderant role of the microbiota in physiological processes, raising the hypothesis of a curative action of EF, by rebalancing the user's microbiota. The therapeutic uses of EF preparations despite their possible curative properties are a potential source of zoonotic transmission from elephants to humans. In the current context of globalisation of trade which favours the emergence of zoonoses and in relation with the issue of One Health, it becomes crucial to further document the zootherapeutic practices to prevent emerging diseases. As elephants and local related ethnoethological knowledge are threatened, documenting them is urgent to contribute to their preservation. 

K.L. Edwards, E.M. Latimer, J. Siegal-Willott, W. Kiso, L.R. Padilla, C.R. Sanchez, D. Schmitt & J.L. Brown

**Patterns of serum immune biomarkers during elephant endotheliotropic herpesvirus viremia in Asian and African elephants**

*PLoS ONE 16 (2021) e0252175*

**Abstract.** Hemorrhagic disease (HD) caused by a group of elephant endotheliotropic herpesviruses (EEHV) is one of the leading causes of death for young elephants in human care. These viruses are widespread and typically persist latently in adult elephants with no negative effects; however, in juvenile Asian and more recently young African elephants, the onset of disease can be rapid and the mortality rate high. Measuring biomarkers associated with the immune response could be beneficial to understanding underlying disease processes, as well as the management of infection and HD. The goal of this study was to measure acute phase proteins and cytokines in serum collected from elephants infected with EEHV (13 Asian and 1 African) and compare concentrations according to presence, severity and outcome of disease. Serum amyloid A (SAA) and haptoglobin (HP) were higher in elephants with EEHV viremia than those without; concentrations increased with increasing viral load, and were higher in fatal cases compared to those that survived. In Asian elephants, SAA was also higher during EEHV1 viremia compared to EEHV5. Cytokine concentrations were typically low, and no statistical differences existed between groups. However, in individuals with detectable levels, longitudinal profiles indicated changes in tumor necrosis factor alpha (TNF-α) and interleukin-2 (IL-2) that may reflect an immune response to EEHV infection. However, the overall low concentrations detected using previously validated assays do not support the presence of a 'cytokine storm' and suggest more work is needed to understand if sub-optimal immune responses could be involved in disease progression. These results highlight the potential benefit of measuring circulating biomarker concentrations, such as APPs and cytokines, to improve our understanding of EEHV viremia and HD, assist with monitoring the progression of disease and determining the impact of interventions.

P. Fernando & J. Pastorini

**Whither the science in wildlife management? (Commentary)**

*Animal Conservation 24 (2021) 735-737*

**Abstract.** none.

Adam Fish

**Crash theory: Entrapments of conservation drones and endangered megafauna**

*Science, Technology & Human Values 46 (2021) 425-451*

**Abstract.** Drones deployed to monitor endangered species often crash. These crashes teach us that using drones for conservation is a contingent practice ensnaring humans, technologies, and animals. This article advances a crash theory in which pilots, conservation drones, and endangered megafauna are relata, or related actants, that intra-act, cocreating each other and a mutually constituted phenomena. These phenomena are entangled, with either reciprocal dependencies or erosive entrapments. The crashing of conservation drones and endangered species requires an ethics of care, re-

pair, or reworlding. Diffractions, disruptions that expose difference, result from crashes and reveal the precarious manner by which technologies, laws, and discourses bring nature and culture together. To support crash theory, this article presents three ethnographic cases. A drone crash in the United Kingdom near white rhinoceroses while building machine learning training data exhibits the involvement of the electromagnetic spectrum; the threat of crashes in the Pacific Northwest near Puget Sound orcas discloses the impacts of drone laws; and drone crashes in Sri Lanka among Asian elephants presents the problems of technoliberal ideals around programming natural worlds. Throughout the article, a methodology is developed, parallelism, which attends to the material similarities in lateral phenomena. © 2020 The Authors.

E. Fuchs, V.C. Beeck, A. Baotic & A.S. Stoeger
**Acoustic structure and information content of trumpets in female Asian elephants (*Elephas maximus*)**
*PLoS ONE 16 (2021) e0260284*
**Abstract.** Most studies on elephant vocal communication have focused on the low-frequency rumble, with less effort on other vocalization types such as the most characteristic elephant call, the trumpet. Yet, a better and more complete understanding of the elephant vocal system requires investigating other vocalization types and their functioning in more detail as well. We recorded adult female Asian elephants (*Elephas maximus*) at a private facility in Nepal and analyzed 206 trumpets from six individuals regarding their frequency, temporal and contour shape, and related acoustic parameters of the fundamental frequency. We also tested for information content regarding individuality and context. Finally, we recorded the occurrence of non-linear phenomena such as bifurcation, biphonation, subharmonics and deterministic chaos. We documented a mean fundamental frequency ± SD of 474 ± 70 Hz and a mean duration ± SD of 1.38 ± 1.46 s ($N_{indiv.}$ = 6, $N_{calls}$ = 206). Our study reveals that the contour of the fundamental frequency of trumpets encodes information about individuality, but we found no evidence for trumpet subtypes in greeting versus disturbance contexts. Non-linear phenomena prevailed and varied in abundance among individuals, suggesting that irregularities in trumpets might enhance the potential for individual recognition. We propose that trumpets in adult female Asian elephants serve to convey an individual's identity as well as to signal arousal and excitement to conspecifics. © 2021 The Authors.

S. Fuktong, P. Yuttasaen, V. Punyapornwithaya, J.L. Brown, C. Thitaram, N. Luevitoonvechakij & P. Bansiddhi
**A survey of stereotypic behaviors in tourist camp elephants in Chiang Mai, Thailand**
*Applied Animal Behaviour Science 243 (2021) e105456*
**Abstract.** Stereotypies are abnormal behaviors found in a wide range of animals that have been used as indicators of poor welfare. Elephants used in tourism have been reported to perform stereotypic behavior, but the occurrence has not been systematically assessed. The aims of this study were to ascertain the percentage of stereotypic behaviors exhibited by tourist camp elephants and relationship with demographic variables. This study surveyed 283 elephants from 20 elephant camps in Chiang Mai, Thailand. Amounts and types of stereotypic behavior were determined from 15-min direct observations. Additionally, demographic data and occurrence of stereotypic behavior (yes/no) were obtained from mahouts of 181 elephants using a questionnaire. Direct behavioral observations revealed that 57% (N = 161: 44 males and 117 females) of the elephants performed stereotypic behavior, while in mahout interviews, 58% were scored 'yes'. There were no differences in the least-squares mean score of stereotypic behaviors between males and females ($p = 0.32$), whereas there were differences among age groups ($p < 0.05$), with the highest in elephants 4–10 years of age, followed by 11–30 years of age, 31–50 years of age, > 50 years of age. Calves 0–3 years of age displayed the lowest rate of stereotypic behavior, when most were still with their mothers. The most common type of stereotypic behavior was swaying. Our results indicate that scores of stereotypic behaviors in elephants used in tourism differed among age categories. The next step will be to determine how management factors affect stereotypic behavior of elephants in this population and steps to mitigate it. © 2021 Reprinted with permission from Elsevier.

O. Hyvarinen, M.T. Beest, E. le Roux, G. Kerley, E. de Groot, R. Vinita & J.P.G.M. Cromsigt
**Megaherbivore impacts on ecosystem and earth system functioning: The current state of the science**
*Ecography 11 (2021) 1579-1594*
**Abstract.** Megaherbivores (adult body mass > 1000 kg) are suggested to disproportionately shape ecosystem and Earth system functioning. We systematically reviewed the empirical basis for this general thesis and for the more specific hypotheses that 1) megaherbivores have disproportionately larger effects on Earth system functioning than their smaller counterparts, 2) this is true for all extant megaherbivore species and 3) their effects vary along environmental gradients. We furthermore explored possible biases in our understanding of megaherbivore impacts. We found that there are too few studies to quantitatively evaluate the general thesis or any of the hypotheses for all but the African savanna elephant. Following this finding, we performed a qualitative vote counting analysis. Our synthesis of this analysis suggests that megaherbivores can elicit strong impacts on, for example, vegetation structure and biodiversity, and all the elephant species promote seed dispersal. We were, however, unable to evaluate whether these effects are disproportionate to smaller large herbivores. Although environmental conditions can mediate megaherbivore impact, few studies quantified the effect of rainfall or soil fertility on megaherbivore impacts, precluding prediction of megaherbivore effects on the Earth system, particularly under future climates. Moreover, our review highlights major taxonomic, thematic and geographic biases in our understanding of megaherbivore effects. Most of the studies focused on African savanna elephant impacts on vegetation structure and biodiversity, with other megaherbivores and Earth system functions comparatively neglected. Studies were also biased towards semi-arid and relatively fertile systems, with the arid, high-rainfall and/or nutrient-poor parts of the megaherbivores' distribution ranges largely unrepresented. Our findings highlight that the empirical basis of our understanding of the ecological effects of extant megaherbivores is still limited for all species, except the African savanna elephant, and that our current understanding is biased towards certain environmental and geographic areas. We further outline a detailed, urgently needed avenue for future research. © 2021 The Authors.

R. Joshi & K. Puri
**Asian elephant in Appendix I of the Convention on Migratory Species: Strengthening the ecological connectivity for trans-boundary conservation**
*National Academy Science Letters 44 (2021) 427-431*
**Abstract.** No permission to print abstract.

M.M. Keady, N. Prado, H.C. Lim, J. Brown, S. Paris & C.R. Muletz-Wolz
**Clinical health issues, reproductive hormones, and metabolic hormones associated with gut microbiome structure in African and Asian elephants**
*Animal Microbiome 3 (2021) e85*
**Abstract.** The gut microbiome is important to immune health, metabolism, and hormone regulation. Understanding host–microbiome relationships in captive animals may lead to mediating long term health issues common in captive animals. For instance, zoo managed elephants experience low reproductive rates, high body condition, and gastrointestinal (GI) issues. We leveraged an extensive collection of fecal samples and health records from the Elephant Welfare Study conducted across North American zoos in 2012 to examine the link between gut microbiota and clinical health issues, reproductive hormones, and metabolic hormones in captive elephants. We quantified gut microbiomes of 69 African and 48 Asian elephants from across 50 zoos using Illumina sequencing of the 16S rRNA bacterial gene. Elephant species differed in microbiome structure, with African elephants having lower bacterial richness and dissimilar bacterial composition from Asian elephants. In both species, bacterial composition was strongly influenced by zoo facility. Bacterial richness was lower in African elephants with recent GI issues, and richness was positively correlated with metabolic hormone total triiodothyronine (total T3) in Asian elephants. We found species-specific associations between gut microbiome composition and hormones: Asian elephant gut microbiome com-

position was linked to total T3 and free thyroxine (free T4), while fecal glucocorticoid metabolites (FGM) were linked to African elephant gut microbiome composition. We identified many relationships between bacterial relative abundances and hormone concentrations, including *Prevotella* spp., *Treponema* spp., and *Akkermansia* spp. We present a comprehensive assessment of relationships between the gut microbiome, host species, environment, clinical health issues, and the endocrine system in captive elephants. Our results highlight the combined significance of host species-specific regulation and environmental effects on the gut microbiome between two elephant species and across 50 zoo facilities. We provide evidence of clinical health issues, reproductive hormones, and metabolic hormones associated with the gut microbiome structure of captive elephants. 

S. Kongsawasdi, K. Wantanajittikul, W. Langkaphin, B. Chuatrakoon, K. Namwongprom, P. Prupetkaew & T. Angkawanish

**Optimal management to improve quality of life for an injured baby elephant: Thailand multidisciplinary care team**

*Kafkas Univ Vet Fak Derg 27 (2021) 655-659*

**Abstract.** This article aimed to report the care, management, and monitoring of an injured female baby elephant. The collaboration among the multidisciplinary team included veterinary medicines, elephant handling, engineering, and physical therapy in the 3-year-old elephant with its left forelimb phalanges amputated through being caught in a snare trap. The management comprised medical wound care, nutrition and applying a prosthetic shoe. The kinematic parameters and vital sign monitoring were analysed. The results show that biomechanics gait analysis and physiological responses revealed promising benefit of the prosthetic shoe by reflecting a greater symmetrical gait pattern without dyspnea and no sign of exertion during daily life activity.

C.A. LaDue, I. Eranda, C. Jayasinghe & R.P.G. Vandercone

**Mortality patterns of Asian elephants in a region of human–elephant conflict**

*Journal of Wildlife Management 85 (2021) 794-802*

**Abstract.** Many wildlife species suffer from human–wildlife conflict, especially crop-raiding. Long-term analyses of mortality patterns are needed to assess the efficacy of management strategies that address this issue. We report mortality patterns from necropsies of 498 Asian elephants from 2009–2018 in an area of northwestern Sri Lanka. Deaths were lowest in July and highest in October, a period of peak crop availability. Most (about 70%) deaths were human-related, and males were killed in these incidents more frequently than females. As gunshot deaths decreased, other forms of human-related deaths increased. Additionally, causes of death differed between districts, with more intentional human-related mortality observed in the district with the highest percent of protected land. These results highlight the importance of understanding the long-term spatial and temporal variation in wildlife mortality to effectively address human-wildlife conflict. 

J.A. Landolfi, P.M. Gaffney, R. McManamon, N.L. Gottdenker, A. E. Ellis, R.R. Rech, S. Han, L.J. Lowenstine, D. Agnew, M.M. Garner, D. McAloose, C. Hollinger, J. St. Leger, S.P. Terrell, M. Duncan & A.P. Pessier

**Reproductive tract neoplasia in adult female Asian elephants (*Elephas maximus*)**

*Veterinary Pathology 58 (2021) 1131-1141*

**Abstract.** Recent reports have highlighted a lower-than-expected prevalence of neoplasia in elephants and suggested mechanisms for cancer resistance. But despite infrequent reports in the literature, uterine neoplasia is common in managed Asian elephants (*Elephas maximus*). This study is an archival review of reproductive tract neoplasia in 80 adult female Asian elephant mortalities in managed care facilities in the United States from 1988 to 2019. Neoplasms occurred in 64/80 (80%) of cases. Most were in the uterus (63/64; 98%) with only a single case of ovarian neoplasia. Myometrial leiomyomas were present in 57/63 (90%) cases with uterine neoplasia. Uterine adenocarcinoma was present in 8/63 (13%) cases. Remaining cases included endometrial adenoma (2), focal carcinoma in situ in endometrial polyps (1), anaplastic carcinoma (1), endometrial hemangioma (1), primitive neuroectodermal tumor (PNET; 1), and angiosarcoma (1). One case with uterine adeno-

carcinoma had a separate pelvic mass histologically characterized as an anaplastic sarcoma. Distant metastases were documented in 5/8 (63%) cases of uterine adenocarcinoma, and in the uterine anaplastic carcinoma, PNET, and angiosarcoma. Four uterine adenocarcinomas and one carcinoma in situ were examined immunohistochemically for pan-cytokeratin, vimentin, and estrogen receptor. In all, neoplastic cells were pan-cytokeratin positive and vimentin negative, and in 2 cases were immunoreactive for estrogen receptor. Results show that female reproductive tract neoplasia, particularly of the uterus, is common in Asian elephants and is not limited to leiomyomas. Importantly, uterine neoplasms have the potential to impact fecundity and may represent obstacles to conservation in managed care. © 2021 The Authors.

M.-H. Lee, S.K.S.S. Nathan, L. Benedict, P. Nagalingam, E. Latimer, T. Hughes, D. Ramirez & J.R.A. Sukor

**The first reported cases of elephant endotheliotropic herpesvirus infectious haemorrhagic disease in Malaysia: Case report**

*Virology Journal 18 (2021) e231*

**Abstract.** Elephant endotheliotropic herpesvirus haemorrhagic disease (EEHV HD) is the leading cause of death in captive Asian elephant calves in Asia, North America, and Europe with a mortality rate of ~65% in calves that are under human care. Although EEHV HD was first found in elephant camps, more recently it was identified in wild populations which poses a greater threat to the elephant population. Deaths due to EEHV HD have been seen in wild elephants, but the in-situ prevalence and mortality rate is unknown. We report the first EEHV HD cases in Malaysia from 3 wild born endangered Bornean elephant calves from Sabah with known typical clinical signs. The first calf died within 24 h of the onset of clinical signs; the second calf died within 12 h of the onset of clinical signs. The third calf succumbed within 72 h. Necropsies revealed that all 3 calves had similar presentations of EEHV HD but in the third calf with less severity. We conducted conventional polymerase chain reaction (cPCR) assays and found EEHV DNA at all 7 loci in the 3 calves; it was identified as EEHV1A, the virus type that has been found in most other reported cases. Typical EEHV HD clinical signs and the molecular confirmation of EEHV by cPCR and sequencing point to EEHV as the cause of death. Further genetic investigation of the strain is in progress. © 2021 The Authors.

Y.M. Lekko, A. Che-Amati, P.T. Ooi, S. Omar, D.T. Mohd-Hamdan, L.S. Linazah, Z. Zakaria, S.Z. Ramanoon, M. Mazlan, F.F.A. Jesse, M.F.A. Abdul-Razak, S. Jasni & N. Abdul-Hamid

**Detection of *Mycobacterium tuberculosis* complex antibodies in free-ranged wild boar and wild macaques in selected districts in Selangor and reevaluation of tuberculosis serodetection in captive Asian elephants in Pahang, Peninsular Malaysia**

*Journal of Veterinary Medical Science 83 (2021) 1702-1707*

**Abstract.** Tuberculosis (TB) is a chronic inflammatory and zoonotic disease caused by *Mycobacterium tuberculosis* complex (MTBC) members, affecting several domestic animals, wildlife species and humans. The preliminary investigation was aimed to detect antibody against MTBC among indigenous wildlife which are free-ranged wild boar, free-ranged wild macaques and captive Asian elephants in selected areas of Selangor and elephant conservation centre in Pahang, respectively. The results indicate that MTBC serodetection rate in wild boar was 16.7% (7.3–33.5 at 95% confidence interval (CI)) using an in-house ELISA bPPD IgG and 10% (3.5–25.6 at 95% CI) by DPP®VetTB assay, while the wild macaques and Asian elephant were seronegative. The univariate analysis indicates no statistically significant difference in risk factors for sex and age of wild boar but there was a significant positive correlation ($P<0.05$) between bovine TB in dairy cattle and wild boar seropositivity in the Sepang district. © 2021 The Japanese Society of Veterinary Science.

L.-L. Li, J.M. Plotnik, S.-W. Xia, E. Meaux, & R.-C. Quan

**Cooperating elephants mitigate competition until the stakes get too high**

*PLoS Biology 19 (2021) e3001391*

**Abstract.** Cooperation is ubiquitous in the animal kingdom as it aims to maximize benefits through joint action. Selection, however, may

also favor competitive behaviors that could violate cooperation. How animals mitigate competition is hotly debated, with particular interest in primates and little attention paid thus far to nonprimates. Using a loose-string pulling apparatus, we explored cooperative and competitive behavior, as well as mitigation of the latter, in semi-wild Asian elephants (*Elephas maximus*). Our results showed that elephants first maintained a very high cooperation rate (average = 80.8% across 45 sessions). Elephants applied "block," "fight back," "leave," "move side," and "submission" as mitigation strategies and adjusted these strategies according to their affiliation and rank difference with competition initiators. They usually applied a "fight back" mitigation strategy as a sanction when competition initiators were low ranking or when they had a close affiliation, but were submissive if the initiators were high ranking or when they were not closely affiliated. However, when the food reward was limited, the costly competitive behaviors ("monopoly" and "fight") increased significantly, leading to a rapid breakdown in cooperation. The instability of elephant cooperation as a result of benefit reduction mirrors that of human society, suggesting that similar fundamental principles may underlie the evolution of cooperation across species. 

D.J. Liyanage, P. Fernando, P.N. Dayawansa, H.K. Janaka & J. Pastorini

**The elephant at the dump: How does garbage consumption impact Asian elephants?**

*Mammalian Biology 101 (2021) 1089-1097*

**Abstract.** We studied garbage consumption by Asian elephants at the Uddakandara garbage dump in southern Sri Lanka. Garbage at the dump was classified under six categories and quantified using a grid overlay. Elephants visiting the dump were individually identified by morphological criteria and items and quantities consumed by them were determined by focal animal sampling. Dung of elephants that did not consume garbage and those from the dump were compared quantitatively and dung constituents assessed by washing through three layered sieves. A total of 17 individual elephants visited the garbage dump during the study period, all of who were males. The observed sexual bias could be related to behavioural differences between the sexes. Elephants mostly consumed 'fruits and vegetables' and 'prepared food', possibly due to their higher palatability and nutritional value. Ingestion of polythene was incidental and associated with consuming prepared food. Proportions of the six categories in elephant diet and garbage piles were significantly different, indicating that elephants were highly selective when feeding. Elephant arrivals increased in response to unloading of garbage, suggesting attraction to fresh garbage. Dung analysis found that garbage consumption did not change the quantity and constituents of dung, except for the presence of anthropogenic items. As consumed anthropogenic items were regularly excreted, retention and obstruction of the alimentary tract are unlikely in elephants. Elephants feeding on garbage had better body condition than non-garbage consuming elephants, indicating that garbage provided better nutrition than natural food and was not detrimental to their health. © 2021 The Authors.

M. Mandal & N.D. Chatterjee

**Geospatial approach-based delineation of elephant habitat suitability zones and its consequence in Mayurjharna Elephant Reserve, India**

*Environment, Development and Sustainability 23 (2021) 17788-17809*

**Abstract.** No permission to print abstract.

G. Maurer, O. Gimenez, B. Mulot & N. Lescureux

**Under pressure: How human-wild-captive elephant social-ecological system in Laos is teetering due to global forces and sociocultural changes**

*People and Nature 3 (2021) 1047-1063*

**Abstract.** Few empirical studies have described social-ecological systems (SESs) in transition. Some studies focused on external drivers that impact the SES and communities' responses to adapt to changes, including economic, land and conservation policies. Others have considered the effect of social and cultural changes on communities' capacity to sustain their activities. While sociocultural changes are increasingly common through globalization and world-wide economic development, there is an urgent need to better understand and document how these changes affect individual and com-

munity agency to adapt or transform a system that is facing a combination of powerful internal and external forces. The human–Asian elephant relationship appears particularly illustrative of a complex SES because of the dual status of the elephant being wild or under human care, and the entanglement of ecological, cultural, social and economic dimensions. The ongoing and rapid political, socio-economic and environmental changes occurring in Laos for the last decades have strongly affected this relationship. We conducted an ethnological survey to assess how the SES has evolved in Laos and its consequences for human-wild-captive elephant interactions and elephant handling practices. We show that in the 1990s, the SES was based on the principles of common access to natural resources and social control over nature and spirits, and led to a form of elephant handling with close interactions between captive and wild elephants. Husbandry practices then could be likened to pastoralism as a mode of production associated with a mode of relation close to seasonal freedom. Since the turn of the present century, the commodification of nature and of increasingly divided access to natural resources led eventually to the segregation of wild elephants and captivity of their working conspecifics. With the intensification of workload, owners switched to a ranching-like economy, based on the accumulation of monetary capital from the employment of elephants in logging or tourism. We discuss how the combination of external drivers, such as economic liberalization, land and conservation policies, and internal drivers linked to sociocultural changes could affect a SES in transition, leading to a fading interest of the new generation in their family heritage. © 2021 The Authors.

F.M. Molenaar & P. Silvestre

**Clinical approach to colic and collapse in an Asian elephant (*Elephas maximus*) with *Salmonella* saintpaul septicaemia and subsequent ileus**

*Vet Record Case Reports 10 (2022) e214*

**Abstract.** An adult female Asian elephant (*Elephas maximus*) presented with clinical signs of colic unresponsive to analgesia, which progressed to hypothermia and collapse within 48 hours. Repeated sedations using butorphanol and detomidine were performed for initial diagnostic sampling, first aid and subsequent treatment. Initial haematology showed evidence of septicaemia and disseminated intravascular coagulation; urine analysis was consistent with metabolic acidosis. The initial treatment focused on rectal administration of enrofloxacin, metronidazole and fluids. By Day 7, the immune system was recovering as demonstrated by blood parameters but ileus had developed. Sedation interventions were discontinued and treatment consisted of oral ranitidine, fibre provision and rehydration. *Salmonella saintpaul* was cultured from the faeces and a disease risk analysis identified a possible infection route through food contamination. Serial haematology provided direction in clinical decision making throughout this challenging case. © 2021 British Veterinary Association.

R.P. Nair & E.A. Jayson

**Estimation of economic loss and identifying the factors affecting the crop raiding behaviour of Asian elephant (*Elephas maximus*) in Nilambur part of the southern Western Ghats, Kerala, India**

*Current Science 121 (2021) 521-528*

**Abstract.** The crop damage by the Asian elephant (*Elephas maximus*) on the livelihood of farmers is a major impediment to the conservation of the endangered mammals. The study was carried out in Malappuram district, Kerala, India from January 2013 to May 2016, to estimate the extent of crop damage by Asian elephants and to identify the factors affecting human-elephant conflict. To estimate the monetary loss, the method of running quadrats was employed. The major cash- crops destroyed by the Asian elephant were plantain (*Musa paradisiaca*), rubber (*Hevea brasiliensis*), areca nut (*Areca catechu*) and coconut (*Cocos nucifera*). A potential loss of Rs 5,076,827 (US$ 72,948) per annum (Rs 2,217,363 (US$ 31,861) (other crops) + Rs 2859,464 (US$ 41,087) (rubber)) was estimated. Fifty per cent of the encounters occurred at early midnight. The presence of areca nut cultivation and distance to the Reserve Forest were identified as the two factors affecting crop raiding. The damage to rubber trees by feeding on the bark has also been reported.

L. Natarajan, A. Kumar, Q. Qureshi, A.A. Desai & B. Pandav

**Evaluation of wall-barriers to manage human conflict with Asian elephants in India**
*Wildlife Society Bulletin 45 (2021) 215-220*
**Abstract.** The Terai Arc Landscape (TAL) in the foothills of the Himalayas is one of the four major elephant ranges in India. In response to the escalating problem of crop raiding by elephants, the State Forest Department of Uttarakhand (UKFD) has built walls along the forest boundary in several protected areas and multiple-use forest divisions. Given the high costs of constructing walls and the growing demand from farmers, the UKFD solicited an evaluation of wall efficacy. In response, we surveyed 98.4 km of walls in the TAL to assess frequency of breaches. We used generalized linear models to examine the influence of 7 explanatory variables on variation in breach frequencies between stretches of the wall. We observed 598 breaches and 87 weak spots in the 98.4 km of walls. Elephants caused 48% of the breaches, suggesting that walls in the TAL were not effective barriers against elephants. Explanatory variables of wall length, forest division, relative density of elephants, and land use along the wall stretches explained variation in wall breach frequencies. Based on our results, walls would only reduce elephant intrusion on 9 stretches (>1 km) totaling 11.8 km (approximately 12% of the wall stretches built in TAL). © 2021 The Wildlife Society.

L. Ni'am, S. Koot & J. Jongerden
**Selling captive nature: Lively commodification, elephant encounters, and the production of value in Sumatran ecotourism, Indonesia**
*Geoforum 127 (2021) 162-170*
**Abstract.** Ecotourism has become an increasingly important market-based practice in nature conservation. Several scholars and non-governmental organizations have discussed this as a commodification of nature in the context of capitalist expansion, but only a few have examined how value is produced in this process. Focusing on ecotourism in Tangkahan, in the Sumatra Island of Indonesia, this paper looks at how value is produced in human-elephant encounters. It builds on the concepts of lively commodities and encounter value to show how the incorporation of captive elephants in ecotourism generates value from two layers of interactions between humans and nonhumans. First, captive elephants are trained by mahouts for the encounters with tourists; then, the production of value takes place through tourists' encounters with the elephants in ecotourism activities (elephant bathing, elephant grazing, and trekking alongside the elephants). We argue that the expansion of the commodification of nature in some cases requires an understanding of the way this encounter value produces a 'captive nature': lively beings that are enclosed, managed, and employed to sell experiences. © 2021 The Authors.

L. Ong, A. Campos-Arceiz, V.P.W. Loke, P. bin Pura, C. Muhamad T. bin Tunil, H.S. A/L Din, R. bin Angah, N.A. binti Amirrudin, W.H. Tan, O. Lily, A. Solana-Mena & K.R. McConkey
**Building ecological networks with local ecological knowledge in hyper-diverse and logistically challenging ecosystems**
*Methods in Ecology and Evolution 12 (2021) 2042-2053*
**Abstract.** Collecting interaction data to build frugivory or seed dispersal networks is logistically challenging in ecosystems that have very high plant and animal diversity and/or where fieldwork is difficult or dangerous. Consequently, the majority of available networks are from ecosystems with low species diversity or they represent a subset of the community. Here, we propose an approach applying local ecological knowledge (LEK) of indigenous communities to build quantitative interaction databases and networks that would otherwise be difficult to achieve with direct observations. Indigenous communities live in many hyper-diverse ecosystems and the people within these communities often have detailed knowledge of ecological processes. Working in a Sundaland biodiversity hotspot – Royal Belum State Park, Peninsular Malaysia – we used visually oriented interviews with indigenous people (Orang Asli, in the Jahai and Temiar ethnic subgroups), field data and published records to collate interactions, and their estimated frequency of occurrence, of animal fruit consumption and seed dispersal. We documented 2,063 fruit consumption and 1,360 seed dispersal interactions among 164 plant species and 34 animal taxa, the latter representing groups of closely related species or

individual species. The majority of the interactions (97%) were identified by the LEK interviews, with the additional methods (field data and published records) used to support and marginally expand the interview data. The metrics for the networks we built reflect those of networks structured by biological mechanisms, supporting the validity of our novel approach. LEK is highly relevant for building detailed databases for ecological interactions in hyperdiverse and/or challenging ecosystems. Such ecosystems are among the most vulnerable on earth, harbouring ecological interactions that are often poorly documented at a community level. We show how LEK can broaden our knowledge of such sensitive ecosystems, but our approach is useful for any ecosystem in which people hold rich LEK. 

M.R. Palombo, R. Carlini & S. Gippoliti

**Critical inventory of *Loxodonta* and *Elephas* (Mammalia, Proboscidea) cranial remains in the collections of the Museo Civico di Zoologia of Rome (Italy)**

*Bollettino del Museo Civico di Storia Naturale di Verona, Botanica Zoologia 45 (2021) 17-60*

**Abstract.** The osteological collection of the Museo Civico di Zoologia of Rome (MCZR) counts 2 complete skeletons, 4 skulls with mandible, 4 skulls, 5 mandibles, 1 molariform tooth, and 11 more or less complete tusks of extant elephants. This research aims to identify to which elephant among those that lived in captivity and died at the Zoological Garden of Rome (ZGR) the cranial material belongs. The results of the qualitative and quantitative analysis, the inferred sex and age estimates permit to assert that the elephant cranial remains of MCZR's osteological collections belong to at least four taxa (*Loxodonta africana*, *Loxodonta cyclotis*, *Elephas maximus maximus*, and *Elephas maximus sumatranus*). 4 Asian and 3 African among the 14 Asian and the 6 African elephants that died at the ZGR from 1910 to 2012 were identified, while for 2 Asian elephants the identification was doubtful or highly uncertain. In addition, we acknowledged the presence of a large cranium of an African bush male of unknown provenance, a skull of an African forest male that lived at the Zoo of Naples from 1952 to 1955, and of a skull of a very young Asian elephant of unknown origin. 

S. Paudel, E.P. Brenner, S.A. Hadi, Y. Suzuki, C. Nakajima, T. Tsubota, K.P. Gairhe, B. Maharjan & S. Sreevatsan

**Genome sequences of two *Mycobacterium tuberculosis* isolates from Asian elephants in Nepal**

*Microbiology Resource Announcement 10 (2021) e00614-21*

**Abstract.** This report describes the genome sequences of two *Mycobacterium tuberculosis* isolates, S1 and S3, recovered from Asian elephants in Nepal. These genome sequences will enhance our understanding of the genomic epidemiology of *M. tuberculosis* in Asian elephants. 

W.P.T.A. Perera, P.H.K.L.A. Prematilaka, M.H.A. Haseena, A.H.L.C.M. Athapaththu & M.R. Wijesinghe

**Changes in habitat coverage from 2005 to 2019 in the Udawalawe National Park, Sri Lanka**

*Ceylon Journal of Science 50 (2021) 467-474*

**Abstract.** In protected areas (PAs) designated for the conservation of biodiversity, temporal landscape changes do occur, driven by natural and anthropogenic factors. Such changes may impact on the conservation value of the PA. In a wildlife PA, changes in habitat extents could adversely affect some of the faunal species. Our objective was to assess temporal changes in the cover of three major habitat types in the Udawalawe National Park (UWNP) that have occurred over a short term. Based on the outcome, we aimed to determine the potential impacts such changes would have on the wildlife. Considering that UWNP was established primarily for conserving the nationally threatened and flagship species *Elephas maximus*, we carried out field studies and decided on three relevant habitat types - forest, scrub, and grassland. We used multi-temporal satellite images with ground truthing for assessing habitat extents in the years 2005, 2010, 2015, and 2019. Habitat cover maps were prepared using supervised classification and changes in the extents of the selected habitats were assessed. Between

2005 and 2019, the areas under forest and scrub had increased. The grassland has considerably decreased, mainly owing to invasion by scrub. Grassland depletion adversely impacts the elephant whose preferred food is grass and the high population of elephants in UWNP aggravates the situation. Depletion of food resources within the park would also lead to an increase in the human-elephant conflicts in border villages. Thus, in this study we highlight the importance of monitoring temporal changes in habitat cover in order to manage the PA and the inhabiting wild elephants.

J.-P. Puyravaud & P. Davidar

**Wildlife managers ignore previous knowledge at great risk: The case of Rivaldo, the iconic wild Asian elephant *Elephas maximus* L. of the Sigur Region, Nilgiri Biosphere Reserve, India**

*J. of Threatened Taxa 13 (2021) 20249-20252*

**Abstract.** Management of wildlife depends mostly on scientific data; ignoring this can lead to unintended consequences. We take the case study of the wild male Asian Elephant Rivaldo of the Sigur Region, who was translocated out of his range. Rivaldo returned to his home range within a few days, which could have been expected if scientific publications had been consulted. We suggest that a simple checklist of relevant publications can help park managers to decide on a proper management procedure. We also used a simple Bayesian framework to visually show how the probability of predicting a management outcome is increased by prior knowledge. The expensive and risky effort to relocate the elephant could have been avoided altogether if prior knowledge had been taken into consideration. © 2021 The Authors.

A.K. Ram, S. Mondol, N. Subedi, B.R. Lamichhane, H.S. Baral, L. Natarajan, R. Amin & B. Pandav

**Patterns and determinants of elephant attacks on humans in Nepal**

*Ecology and Evolution 11 (2021) 11639-50*

**Abstract.** Attacks on humans by Asian elephant (*Elephas maximus*) is an extreme form of human–elephant conflict. It is a serious issue in southern lowland Nepal where elephant-related human fatalities are higher than other wildlife. Detailed understanding of elephant attacks on humans in Nepal is still lacking, hindering to devising appropriate strategies for human–elephant conflict mitigation. This study documented spatiotemporal pattern of elephant attacks on humans, factors associated with the attacks, and human/elephant behavior contributing to deaths of victims when attacked. We compiled all the documented incidences of elephant attacks on humans in Nepal for last 20 years across Terai and Chure region of Nepal. We also visited and interviewed 412 victim families (274 fatalities and 138 injuries) on elephant attacks. Majority of the victims were males (87.86%) and had low level of education. One fourth of the elephant attacks occurred while chasing the elephants. Solitary bulls or group of subadult males were involved in most of the attack. We found higher number of attacks outside the protected area. People who were drunk and chasing elephants using firecrackers were more vulnerable to the fatalities. In contrast, chasing elephants using fire was negatively associated with the fatalities. Elephant attacks were concentrated in proximity of forests primarily affecting the socioeconomically marginalized communities. Integrated settlement, safe housing for marginalized community, and community grain house in the settlement should be promoted to reduce the confrontation between elephants and humans in entire landscape for their long-term survival. © 2021 The Authors.

M. Ranjini, P.M. Deepa, K. Vijayakumar, A. Janus & K. Karthyayini

**Haemato-biochemical changes in tuberculosis infected and healthy Asian elephants (*Elephas maximus*) from South India**

*Journal of Veterinary and Animal Sciences 52 (2021) 345-349*

**Abstract.** Tuberculosis is known to be a disease of elephants for the past 2000 years. The main causative agent isolated from reported tuberculosis (TB) cases were *Mycobacterium tuberculosis*. The study focuses on the haematological and serum biochemical changes in the blood of TB infected Asian elephants (*Elephas maximus*). Twelve apparently healthy elephants and twelve TB infected elephants (confirmed by trunk wash smear positive for acid fast bacilli) were selected for the study. Neonates, pregnant elephants and elephants in musth were not in-

cluded in the study. The study animals were subjected to haematological and serum biochemical evaluation. The data were analysed statistically. The results showed a significant increase in total leukocyte count, lymphocyte count, monocyte count, thrombocyte count and ESR in TB affected animals compared with apparently healthy animals. Serum creatinine, total bilirubin, direct bilirubin, globulin was significantly high in TB affected animals compared with healthy controls. Assessment of haematological and serum biochemical parameters in TB affected elephants aid in diagnosis and tracking of the infection. © 2021 The Authors.

L. Rutherford & L.E. Murray

**Personality and behavioral changes in Asian elephants (*Elephas maximus*) following the death of herd members**

*Integrative Zoology 16 (2021) 170-188*

**Abstract.** Elephants are highly social beings with complex individual personalities. We know that elephants have a general interest in death, investigating carcasses, not just limited to kin; however, research does not explore in depth whether individuals change their behavior or personality following traumatic events, such as the death of a conspecific. Within a captive herd of Asian elephants (*Elephas maximus*) housed at Chester Zoo, UK, we measured social behaviour and proximity and personality using the TIPI, and found age-related and relationship-related changes in both behavior and personality following the deaths of herd members. Overall, the herd spent less time socialising and engaging in affiliative behaviors following the death of the adult female when compared to baseline data, yet spent more time engaging in these behaviors after the death of two calves. The death of the central female had a dramatic impact on her infant calf, resulting in increasingly withdrawn behavior, yet had the opposite effect on her adult daughter, who subsequently established a more integrated role within the herd. Emotional Stability fell in the motherless calf but rose in an adult female, who had lost her adult daughter, but had a new calf to care for. We suggest that the greater impact on the behaviour and personality of surviving herd members following the deaths of calves, compared to an adult member, attests to the significance of the unifying role played by calves within an elephant herd. © 2020 International Society of Zoological Sciences.

N. Sahoo, S.K. Sahu, A.K. Das, D. Mohapatra, S.K. Panda, S.K. Gupta, B.K. Behera, A. Pahari & M. Dash

**Elephant endotheliotropic herpesvirus hemorrhagic disease outbreak in an Indian zoo**

*Journal of Zoo and Wildlife Medicine 52 (2021) 1286-1297*

**Abstract.** Elephant endotheliotropic herpesvirus hemorrhagic disease (EEHV HD) is an acute viral infection of growing Asian elephants (*Elephas maximus*). Four apparently healthy subadult Asian elephants aged between 6 and 10 yr at Nandankanan Zoological Park (NKZP), India, died of EEHV HD during August–September 2019. All four elephants were rescued from different reserved forests of Odisha state at less than 1 yr of age and hand reared in the NKZP. Elephants exhibited the clinical signs of lethargy, head swelling, fever, loss of appetite, abdominal distension, scant urination and defecation, signs of colic, lameness, trunk discharge, cyanosis/ulceration of tongue, erratic behavior, and recumbence before death. Period of illness varied between 28 and 42 h. Thrombocytopenia was the common significant hematological observation. No significant biochemical alterations were recorded except for higher creatinine concentrations. Analysis of blood samples in RT-PCR assay using two different sets of primers and probes that targeted terminase gene and major DNA-binding protein gene followed by cPCR and sequencing was positive for EEHV-1A in all four animals. Postmortem examination of all four carcasses showed hemorrhages in internal organs, including the hard palate, heart, lungs, stomach, mesenteric lymph nodes, mesentery, colon serosa, spleen, liver, kidney, and meninges. Histopathology showed congestion and/or hemorrhages in heart, lung, brain, kidney, and liver. There was presence of intranuclear inclusion bodies in the sinusoidal epithelial cells. The outbreak of EEHV HD that resulted in the acute death of four juvenile captive Asian elephants within <30 d, the first of its kind documented in India, is increasing the fear of similar outbreaks in the future. © 2021 American Association of Zoo Veterinarians.

N. Sathiandran, P.J. Vineesh & S.K. Thomas
**Dung preference and trophic association of dung beetles (Coleoptera: Scarabaeidae) in the moist forests of the South-western Ghats of the Indian subcontinent**
*J. Asia-Pacific Entomology 24 (2021) 739-748*
**Abstract.** First quantitative dung beetle-feeding trophic network analysis for the Oriental region is carried out by investigating trophic network interaction between dung beetles and mammal dung types in the moist forests of the Western Ghats a global biodiversity hot spot in south-western India. Dung-beetle assemblage associated with the dung of the prominent mammals, such as the macaque, boar, gaur, elephant and deer, showed differences in richness, abundance and composition among different dung types. Most dung beetles were generalists with low resource specificity and community-wide generalist feeding on herbivore and omnivore dung types. Dung beetles in the region displayed high species richness and abundance in boar dung. The high attraction and specificity of dung beetles towards the odoriferous boar dung indicate that the omnivore mammal *Sus scrofa* has a major role in maintaining the dung beetle community in the forests of the Western Ghats. Network interaction analysis shows that the vast majority in the assemblage are generalist species, and the few specialist species were all with low abundance. Low overall specialisation and low resource partitioning with high species richness is recorded in the assemblage. The assemblage's trophic level preference is reflected in the high dung specificity recorded in the omnivore and herbivore dung types. © 2021 Reprinted with permission from Elsevier.

M. Seewald, C. Gohl, M. Egerbacher, S. Handschuh & K. Witter
**Endodontic treatment of a traumatic tusk fracture with exposed pulp in an Asian elephant (*Elephas maximus*)**
*J. of Veterinary Dentistry 38 (2021) 139-151*
**Abstract.** Tusk fracture in elephants is a common incident often resulting in pulp exposure and pulpitis. Extensive lavage, endodontic therapy, direct pulp capping, or extraction are treatment options. In this report, the successful management of a broken tusk of a juvenile male Asian elephant (*Elephas maximus*) including morphological analysis of the tusk tip 2 years after surgery are presented. Treatment was carried out under barn conditions and included antimicrobial photodynamic therapy and partial pulpotomy with direct pulp capping. Immediate pain relief was reached. The fractured tusk was preserved and continued to grow. The therapeutic filling material remained intact for over 1 year but was absent 2 years after treatment. The former pulp cavity of the tusk tip was filled with reparative dentin, osteodentin, and bone, but the seal between these hard tissues and pulp chamber dentin was incomplete. Radiographs obtained 3 years after treatment showed no differences in pulp shape, pulp width, and secondary dentin formation between the treated right and the healthy left tusk. It can be concluded that in case of an emergency, the endodontic therapy of a broken elephant tusk can be attempted under improvised conditions with adequate success. Photodynamic therapy might contribute to prevent infection and inflammation of the pulp. The decision tree published by Steenkamp (2019) provides a valuable tool to make quick decisions regarding a suitable therapy of broken tusks. © 2021 The Authors.

Y. Shah & S. Paudel
**Protect elephants from tuberculosis**
*Science 374 (2021) 832-833*
**Abstract.** None.

W.H. Tan, A. Hii, A. Solana-Mena, E.P. Wong, V.P.W. Loke, A.S.L. Tan, A. Kromann-Clausen, N. Hii, P. bin Pura, M.T. bin Tunil, S.A.L. Din, C.F. Chin & A. Campos-Arceiz
**Long-term monitoring of seed dispersal by Asian elephants in a Sundaland rainforest**
*Biotropica 53 (2021) 453-465*
**Abstract.** Asian elephants (*Elephas maximus*) have inhabited almost all forests in tropical Asia until recently, yet little is known about their role in ecological processes, particularly in the Sundaic forests of South-East Asia. These forests are peculiar in their phenology, with supra-annual and highly irregular episodes of mast fruiting. Here, we present a long-term (6-year) monitoring of the seeds dispersed by elephants in dipterocarp forests of northern Peninsular Malaysia. We conducted monthly dung surveys at two mineral licks (11.3 km apart) frequently visited by elephants. Additionally, we recorded haphazard observations of seeds and

seedlings in elephant dung at other locations. We recorded a minimum of 48 morphospecies from at least 25 plant families dispersed by elephants. Elephant seed dispersal was very heterogenous in space, with only 30.3% of the morphospecies dispersed at both sites (Jaccard dissimilarity index = 0.48). Temporally, elephants dispersed seeds in sporadic pulses of abundance and diversity, without any apparent seasonality (seeds appeared in 19.1% of 1,284 dung piles and 57.1% of the 63 months in which we found dung) and with long periods without any seed being dispersed. Nearly half (48%) of the plants dispersed by elephants belong to a megafaunal dispersal syndrome. Our long-term approach allowed us to unravel an important aspect of Asian elephants' role and effectiveness in the seed dispersal cycle. Sundaland's forests are undergoing a rapid loss of their previously common megaherbivores (rhinos and elephants), with profound and long-term consequences for ecosystem functioning. 

S. Terada
**Building human-elephant relationships based on science and local ownership: A long-lasting issue in the era of sustainable development goals (Commentary)**
*Animal Conservation 24 (2021) 738-739*
**Abstract.** None.

L. N. Tiller & H. F. Williams
**The elephant in the farm: Long-term solutions are the key to coexistence (Commentary)**
*Animal Conservation 24 (2021) 733-734*
**Abstract.** None.

J.A. de la Torre, E.P. Wong, A.M. Lechner, N. Zulaikha, A. Zawawi, P. Abdul-Patah, S. Saaban, B. Goossens & A. Campos-Arceiz
**There will be conflict – agricultural landscapes are prime, rather than marginal, habitats for Asian elephants**
*Animal Conservation 24 (2021) 720-732*
**Abstract.** Misconceptions about species' ecological preferences compromise conservation efforts. Whenever people and elephants share landscapes, human–elephant conflicts (HEC) occur in the form of crop raiding, elephant attacks on people and retaliatory actions from people on elephants. HEC is considered the main threat to the endangered Asian elephant *Elephas maximus*. Much of HEC mitigation in Asia is based on rescuing elephants from conflict areas and returning them to nature, for example, by means of 'problem elephant' translocation. Here, we used two independent and extensive datasets comprising elephant GPS telemetry and HEC incident reports to assess the relationship between elephant habitat preferences and the occurrence of HEC at a broad spatial scale in Peninsular Malaysia. Specifically, we assessed (a) the habitat suitability of agricultural landscapes where HEC incidents occur and (b) sexual differences in habitat preferences with implications for HEC mitigation and elephant conservation. We found strong differences in habitat use between females and males and that the locations of HEC incidents were areas of very high habitat suitability for elephants, especially for females. HEC reports suggest that in Peninsular Malaysia females are involved in more crop damage conflicts than males, whereas males are more prone to direct encounters with people. Our results show that human-dominated landscapes are prime elephant habitat, and not merely marginal areas that elephants use in the absence of other options. The high ecological overlap between elephants and people means that conflict will continue to happen when both species share landscapes. HEC mitigation strategies, therefore, cannot be based on elephant removal (e.g. translocation) and need to be holistic approaches that integrate both ecological and human social dimensions to promote tolerated human-elephant coexistence. 

D. Vasudev, V.R. Goswami, N. Srinivas, B.L.N. Syiem & A. Sarma
**Identifying important connectivity areas for the wide-ranging Asian elephant across conservation landscapes of Northeast India**
*Diversity and Distributions 27 (2021) 2510-26*
**Abstract.** Connectivity is increasingly important for landscape-scale conservation programmes. Yet there are obstacles to developing reliable connectivity maps, including paucity of data on animal use of the non-habitat matrix. Our aim was to identify important connectivity

areas for the endangered Asian elephant *Elephas maximus* across a 21,210 km$^2$ region using empirical data and recently developed animal movement models. We interviewed 1,184 respondents, primarily farmers, residing across our study region, to collect crowd-sourced data on elephant use of the matrix. We generated a classified land use/land cover map and collated remotely sensed data on environmental and anthropogenic covariates. We used logistic regression to estimate the influence of these covariates on resistance, based on elephant detections recorded via interviews. We modelled elephant movement within the randomised shortest path framework, which allows for scenarios ranging from optimal movement with complete information on the landscape to random movement with no information on the landscape. We calculated the passage of elephants through pixels in our study region, a parameter that denotes the expected number of elephant movements through a particular pixel across movement routes. We overlaid linear infrastructure sourced from secondary data, and human-elephant conflict hotspots generated from our interview data, on passage maps. Elephants preferred locations with high vegetation cover, close to forests and with low human population density. We mapped important connectivity areas across the study region, including in three important conservation landscapes. Whilst forests facilitated connectivity, the matrix also played an important contributory role to elephant dispersal. Incorporating information on environmental and anthropogenic drivers of elephant movement added value to connectivity predictions. Fine-scale mapping of connectivity, using empirical data and realistic movement models, such as the approach we use, can provide for informed and more effective landscape-scale conservation. 

S.C. Vernes, B.P. Kriengwatana, V.C. Beeck, J. Fischer, P.L. Tyack, C. ten Cate & V.M. Janik

**The multi-dimensional nature of vocal learning**

*Philosophical Transactions of the Royal Society B 376 (2021) e20200236*

**Abstract.** How learning affects vocalizations is a key question in the study of animal communication and human language. Parallel efforts in birds and humans have taught us much about how vocal learning works on a behavioural and neurobiological level. Subsequent efforts have revealed a variety of cases among mammals in which experience also has a major influence on vocal repertoires. Janik and Slater (Anim. Behav.60, 1–11) introduced the distinction between vocal usage and production learning, providing a general framework to categorize how different types of learning influence vocalizations. This idea was built on by Petkov and Jarvis (Front. Evol. Neurosci.4, 12) to emphasize a more continuous distribution between limited and more complex vocal production learners. Yet, with more studies providing empirical data, the limits of the initial frameworks become apparent. We build on these frameworks to refine the categorization of vocal learning in light of advances made since their publication and widespread agreement that vocal learning is not a binary trait. We propose a novel classification system, based on the definitions by Janik and Slater, that deconstructs vocal learning into key dimensions to aid in understanding the mechanisms involved in this complex behaviour. We consider how vocalizations can change without learning, and a usage learning framework that considers context specificity and timing. We identify dimensions of vocal production learning, including the copying of auditory models (convergence/divergence on model sounds, accuracy of copying), the degree of change (type and breadth of learning) and timing (when learning takes place, the length of time it takes and how long it is retained). We consider grey areas of classification and current mechanistic understanding of these behaviours. Our framework identifies research needs and will help to inform neurobiological and evolutionary studies endeavouring to uncover the multi-dimensional nature of vocal learning. 

H. Wang, P. Wang, X. Zhao, W. Zhang, J. Li, C. Xu & P. Xie

**What triggered the Asian elephant's northward migration across southwestern Yunnan?**

*The Innovation 2 (2021) e100142*

**Abstract.** None.

M.E. Weston, K.E. Mills & M.A.G. von Keyserlingk

**Your happiness or mine: Influence of affective states and level of contact on public perceptions of elephant tourism**

*Animal Welfare 30 (2021) 279-293*

**Abstract.** Many captive Asian elephants (*Elephas maximus*) in Thailand participate in the tourism industry at attractions known as 'elephant camps.' There has been significant criticism of low welfare venues, where the elephants may experience injuries, poor nutrition, unnatural social environments and aversive handling. Despite increasing concern for animal welfare, the general public often have difficulty identifying the welfare issues affecting captive animals. The aim of this study was to investigate participants' willingness to support an elephant attraction and their perceived emotional value from the experience, based on the affective state of the captive elephant and their level of contact with it. Participants (n = 590) from the United States were randomly assigned to one of four vignettes (using a 2×2 experimental design) that described an elephant attraction, varying the affective state of the elephant (feels excellent, feels terrible) and the level of contact they could have with the elephant (low, high). A mixed methods approach was used, where participants provided answers to Likert-type questions, followed by an open-ended response. Participants showed greater willingness to support the elephant attraction and greater perceived emotional value from the experience when the elephant felt excellent, as opposed to when the elephant felt terrible. There were no significant differences between low and high contact for the measures included in this study. Qualitative responses varied greatly, with participants making many assumptions about the elephant and the attraction, revealing potential misconceptions that they had regarding the welfare of captive elephants. This research may be used to encourage a shift in tourism preferences to venues that reflect positive elephant welfare. © 2021 Universities Federation for Animal Welfare.

E.P. Wong, A. Campos-Arceiz, N. Zulaikha, P. Chackrapani, A.G. Quilter, J.A. de la Torre, A. Solana-Mena, W.H. Tan, L. Ong, M.A. Rusli, S. Sinha, V. Ponnusamy, T.W. Lim, O.C. Or, A.F. Aziz, N. Hii, A.S.L. Tan, J. Wadey, V.P.W. Loke, A. Zawawi, M. M. Idris, P.A. Patah, M.T.A. Rahman & S. Saaban

**Living with elephants: Evidence-based planning to conserve wild elephants in a megadiverse south east Asian country**

*Frontiers in Conservation Science 2 (2021) e682590*

**Abstract.** Theory of Change (ToC) and Social Return of Investment (SROI) are planning tools that help projects craft strategic approaches in order to create the most impact. In 2018, the Management & Ecology of Malaysian Elephants (MEME) carried out planning exercises using these tools to develop an Asian elephant conservation project with agriculture communities. First, a problem tree was constructed together with stakeholders, with issues arranged along a cause-and-effect continuum. There were 17 main issues identified, ranging from habitat connectivity and fragmentation, to the lack of tolerance toward wild elephants. All issues ultimately stemmed from a human mindset that favors human-centric development. The stakeholders recognize the need to extend conservation efforts beyond protected areas and move toward coexistence with agriculture communities for the survival of the wild elephants. We mapped previous Human-Elephant Conflict (HEC) management methods and other governmental policies in Malaysia against the problem tree, and provided an overview of the different groups of stakeholders. The ToC was developed and adapted for each entity, while including Asian elephants as a stakeholder in the project. From the SROI estimation, we extrapolated the intrinsic value of the wild Asian elephant population in Johor, Malaysia, to be conservatively worth at least MYR 7.3 million (USD 1.8 million) per year. From the overall calculations, the potential SROI value of the project is 18.96 within 5 years, meaning for every ringgit invested in the project, it generates MYR 18.96 (USD 4.74) worth of social return value. There are caveats with using these value estimations outside of the SROI context, which was thoroughly discussed. The SROI provides projects with the ability to justify to funders the social return values of its activities, which we have adapted to include the intrinsic value of an endangered megafauna. Moreover, SROI encourages projects to consider unintended impacts (i.e., replacement, displacement, and deadweight), and acknowledge contributions from stakeholders. The development of the problem tree and ToC

via SROI approach, can help in clarifying priorities and encourage thinking out of the box. For this case study, we presented the thinking process, full framework and provided evidences to support the Theory of Change. 

D. Yin, Z. Yuan, J. Li & H. Zhu
**Mitigate human-wildlife conflict in China**
*Science 373 (2021) 500-501*
**Abstract.** none.

Y. Yun, S. Sriphiboon, K. Pringproa, P. Chuammitri, V. Punyapornwithaya, K. Boonprasert, P. Tankaew, T. Angkawanish, K. Namwongprom, O. Arjkumpa, J.L. Brown & C. Thitaram
**Clinical characteristics of elephant endotheliotropic herpesvirus (EEHV) cases in Asian elephants (*Elephas maximus*) in Thailand during 2006–2019**
*Veterinary Quarterly 41 (2021) 268-279*
**Abstract.** Elephant endotheliotropic herpesvirus causes a hemorrhagic disease (EEHV-HD) that is a major cause of death in juvenile Asian elephants with EEHV1 and EEHV4 being the most prevalent. Aim: To perform a retrospective clinical data analysis. Records of a total of 103 cases in Thailand confirmed by polymerase chain reaction (PCR) on blood and/or tissue samples. The severity of clinical signs varied among EEHV subtypes. EEHV1A was the most prevalent with 58%, followed by EEHV4 with 34%, EEHV1B with 5.8% and EEHV1&4 co-infection with 1.9%. Overall case fatality rate was 66%. When compared among subtypes, 100% case fatality rate was associated with EEHV1&4 co-infection, 83% with EEHV1B, 75% with EEHV1A, and the lowest at 40% for EEHV4. Calves 2- to 4-year old were in the highest age risk group and exhibited more severe clinical signs with the highest mortality. Majority of cases were found in weaned or trained claves and higher number of cases were observed in rainy season. A gender predilection could not be demonstrated. Severely affected elephants presented with thrombocytopenia, depletion of monocytes, lymphocytes and heterophils, a monocyte:heterophil (M:H) ratio lower than 2.37, hypoproteinemia (both albumin and globulin), severe grade of heterophil toxicity, and low red blood cell counts and pack cell volumes. Survival was not affected by antiviral drug treatment in the severely compromised animals. Early detection by laboratory testing and aggressive application of therapies comprising of supportive and antiviral treatment can improve survival outcomes of this disease. 

N. Zainol, T.M. Taher, S.N.A. Razak, N.A.I. Noh, N.A.M. Nazir, A.M. Shukor, A. Ibrahim & S.M. Nor
**Wildlife crossings at Felda Aring - Tasik Kenyir road, Malaysia**
*Pertanika Journal of Tropical Agricultural Science 44 (2021) 401-427*
The Felda Aring - Tasik Kenyir road was identified as one of the most threatening roads to wildlife in Malaysia. The present study was conducted to assess the road crossing activities involving the medium- to large-mammal species due to the problem stated. The objectives of this study were to (1) predict the suitability of the road and its surroundings as the roaming areas for the Asian elephant (*Elephas maximus*, n = 104) and Malayan tapir (*Tapirus indicus*, n = 66), (2) identify the mammalian species inhabiting the forest beside the road, (3) compare the forest's common species [photographic capture rate index (PCRI) > 10/ detection probability (P) ≥ 0.05] with the ones utilising the road crossing structures; the viaducts and the bridges, and (4) determine the most impacted species from traffic collisions. The road and its surroundings were classified as moderately suitable to the elephant and tapir (suitability values = 0.4 – 0.8). A total of 16 mammal species were recorded at the forest edges, in which the wild pig (PCRI = 118.96, P = 0.3719 ± 0.027), barking deer (PCRI = 68.89, P = 0.2219 ± 0.0232), sun bear (PCRI = 11.13, P = 0.0507 ± 0.0159), tapir (PCRI = 11.13, P = 0.0469 ± 0.0118), elephant (PCRI = 10.7, P = 0.0787 ± 0.0195), and Malayan porcupine (PCRI = 10.7, P = 0.103 ± 0.0252) were the common species utilising the crossing structures. In contrast, the Asian palm civet and leopard cat were the most frequently hit species on the road [$F(7,398) = 28.53$, $p < 0.0005$]. The present study found that large-mammal species were utilising the crossing structures at a higher frequency, whereas more medium-mammal species were involved in traffic collisions. 