Recent Publications on Asian Elephants

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If you need additional information on any of the articles, please feel free to contact me. You can also let me know about new (2020) publications on Asian elephants.

T.D. Allendorf, B. Gurung, S. Poudel, S. Dahal & S. Thapa
Using community knowledge to identify potential hotspots of mammal diversity in southeastern Nepal
Biodiversity and Conservation 29 (2020) 933-946
Abstract. No permission to print the abstract.

N.R. Anoop & T. Ganesh
The forests and elephants of Wayanad: Challenges for future conservation
Current Science 118 (2020) 362-367
Abstract. The Wayanad district of Kerala, India, is an important conservation and cultural landscape located in the Western Ghats biodiversity hotspot. It is a slightly east-sloping plateau with a unique geographical feature of small rolling hills interspersed with low-lying swamps and meandering streams. Extensive deforestation that occurred in the last century has severely fragmented and degraded the forest of Wayanad, leaving it as a mosaic of forests, wetlands, croplands and towns. The remaining forests in Wayanad are part of the Brahmagiri-Nilgiri-Eastern Ghats Elephant Landscape (NEG), which holds the single largest contiguous population of Asian elephants globally. The NEG is prone to seasonal fluctuation in resource availability, where a large tract of dry forest reduces its carrying capacity for elephants during summer. The Wayanad forests are a critical microhabitat for elephants in the NEG due to availability of fodder and perennial water sources during summer. Despite the importance of this region for elephants, the forest is 'degrading' drastically that will have a far-reaching impact on the long-term conservation of elephants in the NEG. Similarly, human-elephant conflict is on the rise and it is one of the biggest threats to the conservation of elephants and the well-being of rural communities in Wayanad. In this article we identify the current conservation issues and recommend future management of Asian elephants and their habitat in Wayanad.

L. Baker & R. Winkler
Asian elephant rescue, rehabilitation and rewilding
Animal Sentience 5 (28) (2020) e296
Abstract. Thailand has fewer than 10,000 elephants left. More of them are living in captivity to serve the tourist industry under grim conditions than are living free in what is left of their wild habitat. Conservation efforts need to be focused on all surviving members of the species, captive and free, but they need to take into account the inextricable entanglement of human and nonhuman animal lives in Thailand today. There is an opportunity for rescuing, rehabilitating and reintroducing captive elephants to the wild with the help of the traditional expertise of a mahout culture that has been elephant-keeping for centuries. We advocate a state of wildness that is meaningful to the elephants and can be attained in a way in which both elephant and human cultures are valued. This would be far better than the status quo for the elephants, restoring to them a life worth living.

P. Bansiddhi, J.L. Brown, C. Thitaram, V. Punya-pornwithaya & K. Nganvongpanit
Elephant tourism in Thailand: A review of animal welfare practices and needs
Journal of Applied Animal Welfare Science 23

(2020) 164-177

Abstract. Elephant tourism in Thailand has developed into an important socio-economic factor after a logging ban initiated in 1989 resulted in thousands of out-of-work elephants. However, the welfare of captive elephants has been a topic of intense debate among tourists, scientists and stakeholders because of the range of working conditions and management practices to which they are exposed. The aim of this paper is to summarize the current state of knowledge on captive elephant welfare, with an emphasis on tourist elephants in Thailand, and highlight information gaps and recommendations for future directions. Tourist-oriented elephant camps could improve the welfare of elephants through better management practices that take into account physiological and psychological needs of individual animals, including meeting social and nutritional requirements, providing good health care, and maintaining adequate facilities. Our goal is to develop science-based guidelines that government agencies can use to develop an enforceable set of practical regulations to ensure good management of tourist elephants in Thailand. © 2019 Informa UK Limited.

L.P. Barrett & S. Benson-Amram

Can Asian elephants use water as a tool in the floating object task?

Animal Behavior and Cognition 7 (2020) 310-326

Abstract. One of the greatest challenges in comparative cognition is to design tasks that accurately assess cognitive abilities across a diverse set of taxa with differing morphologies and behaviors. The floating object task was designed to test insightful problem solving via water tool use in animals but so far has been tested only in primates. In the floating object task, animals add water to a tube in order to reach a floating food reward. A similar task, the Aesop's fable task, which is solved by adding stones to the tube, has been used with corvids and raccoons in addition to human children. Elephants are considered to exhibit complex cognitive abilities on par with primates, and they possess a prehensile trunk appendage well-suited for tests of water tool use. Here, we presented the floating object task to 12 zoo-housed Asian elephants (*Elephas maximus*) to determine if they demonstrate innovative problem solving or social learning. One elephant solved the task on her own. Additionally, elephants at one zoo that observed a conspecific solve the task exhibited increased interest in the task compared to baseline elephants, demonstrating social learning via stimulus enhancement. Asian elephants are capable of learning to use water as a tool, but the cognitive abilities underpinning their ability to solve the floating object task remain unclear. Our findings may bolster support for the convergent cognitive evolution of problem solving in elephants and apes, but further research using additional paradigms is needed.

S. Biswas, S. Bhatt, S. Paul, S. Modi, T. Ghosh, B. Habib, P. Nigam, G. Talukdar, B. Pandav & S. Mondol

A practive faeces collection protocol for multidisciplinary research in wildlife science

Current Science 116 (2019) 1878-1885

Abstract. Faecal samples have become an important non- invasive source of information in wildlife biology and ecological research. Despite regular use of faeces, there is no universal protocol available for faeces collection and storage to answer various questions in wildlife biology. In this study we collected 1408 faeces from ten different species using a dry sampling approach, and achieved 77.49% and 75.25% success rate in mitochondrial and nuclear marker amplifications respectively. We suggest a universal framework to use the same samples to answer different questions. This protocol provides an easy, quick and cheap option to collect non-invasive samples from species living in different environmental conditions to answer multidisciplinary questions in wildlife biology.

H.M. Chel, R. Nakao, N. Ohsawa, Z.M. Oo, N. Nonaka & K. Katakura

First record and analysis of the COI gene of *Cobboldia elephantis* obtained from a captive Asian elephant from Myanmar

Parasitology International 75 (2020) e102035

Abstract. The stomach bot fly species in Asian elephants has long been known as *Cobboldia elephantis*. However, there is no genetic information available for this species to date.

Here, we report that a third-instar fly larva was excreted from a captive Asian elephant four months after export from an elephant camp in Myanmar to a zoological garden in Japan. Morphological characteristics of the larva were coincident with published descriptions of *C. elephantis*. The mitochondrial cytochrome c oxidase subunit I (COI) gene was amplified from the larva by PCR using primers modified from those designed for DNA barcoding of insects and amphibians. The COI gene of *C. elephantis* showed 76.6 % and 83.6 % identity at the nucleotide and amino acid levels, respectively, to that of *C. loxodontis*, the stomach bot fly species in African elephants. Phylogenetic analysis of the COI genes of several stomach bot fly species revealed that the two *Cobboldia* species formed a clade separate from the stomach bot fly species found in rhinoceros and equids.

S. Debata & K.K. Swain

Mammalian fauna in an urban in uenced zone of Chandaka-Dampara Wildlife Sanctuary in Odisha, India

Journal of Threatened Taxa 12 (2020) 15767-75

Abstract. A camera trapping survey to estimate the species richness and relative abundance of different mammalian fauna and various anthropogenic activities was carried out for four months within an urban influenced zone of Chandaka-Dampara Wildlife Sanctuary, Odisha. The survey extended over 120 days in January–April 2019 over 10% of the total sanctuary area. With nine cameras and a total effort of 771 trap days, 2,855 independent photographs including 14 species of wild mammals and birds, human traffic, and movement of stray animals were captured. Among the mammalian fauna, golden jackal was the most photographed species whereas the Asian elephant, striped hyaena, and common palm civet were the least photographed species. Various anthropogenic activities like intensive movement of departmental vehicles, staff, feral livestock, and stray dogs and cats were also recorded and these activities need to be addressed in management activities for long term conservation of the area and its mammalian fauna. In order to enhance biological connectivity and improve movement of wildlife between the main part of the Chandaka Sanctuary and its near-detached reserved forests in Jagannathprasad-Bharatpur, the study recommends removal of feral cattle, extensive plantations, and construction of a fly-over for vehicular traffic. © 2020 The Authors.

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

Theory of medical scoring systems and a practical method to evaluate Asian elephant (*Elephas maximus*) foot health in European zoos

Animal Welfare 29 (2020) 163-176

Abstract. Several established models in human and veterinary medicine exist to evaluate an individual health or disease status. Many of these seem unsuitable for further epidemiological research aimed at discovering underlying influential factors. As a case example for score development and choice, the present study analyses different approaches to scoring the foot health of Asian elephants (*Elephas maximus*) living in European facilities. Sum scores with varying degree of detail, and without or with a weighting method, were compared using descriptive statistics, ie kurtosis, skewness, Shannon entropy, total redundancy, their maximum and their actual ranges. With increasing score complexity, a higher level of differentiation was reached. In parallel, the distribution of score frequencies in the population shifted systematically: with the least complex scoring model the pattern indicated a severely unhealthy population with an opposite skew to a hypothetically healthy population, whereas the most complex scoring model indicated a mildly affected population with a skew corresponding to that expected for a healthy population. We propose the latter, in the form of the Particularised Severity Score (ParSev), which accounts for every nail and pad individually and weights the sub-scores by squaring, as the most relevant score for further investigations, either in assessing changes within an elephant population over time, or correlating foot health in epidemiological studies to potentially influencing factors. Our results emphasise the relevance of choosing appropriate scoring models for welfare-associated evaluations, due to implications for

the applicability as well as the perceived welfare status of the test population. © 2020 Universities Federation for Animal Welfare.

A.M. Greene, P. Panyadee, A. Inta & M.A. Huffman

Asian elephant self-medication as a source of ethnoveterinary knowledge among Karen mahouts in northern Thailand

J. of Ethnopharmacology 259 (2020) e112823

Abstract. Ethnoveterinary medicine is often assumed to be a subset of human medicinal knowledge. Here we investigate the possibility that some ethnoveterinary medicine rather originates from observations of animal self-medication. We document and analyze the ethnoveterinary medicine used by Karen mahouts for elephant care and attempt to determine whether this knowledge originated from humans or elephants. Elephant camp owners and mahouts in four communities in northern Thailand were interviewed about their knowledge and use of plants for ethnoveterinary elephant care. For each ethnoveterinary plant, data were collected on Karen human medicinal uses and whether elephants independently consume them. Based on overlaps between ethnoveterinary use, human medicinal use and elephant dietary use, plants were classified into three categories: those that originated from Karen human medicine, those that originated from Asian elephant self-medication, and those which were present in both human and elephant knowledge traditions. The use of 34 plants (32 identified at least to genus) and two additional non-plant remedies (salt and human urine) were reported to be used in ethnoveterinary elephant medicine. A total of 44 treatments in 11 use categories were recorded: tonic, wounds, compress, eye problems, indigestion, broken bones, galactagogue, snakebite, fatigue, skin and musth regulation. Of the ethnoveterinary plants, 55% had the same use in human medicine, 43% had different uses and 2% had no use. Elephants consume 84% of the ethnoveterinary plants as part of their natural diet. Analysis indicates that 32% of plant uses likely originated from Karen human medicine, 60% of plant uses likely existed independently in both human and elephant knowledge systems, and 8% of plant uses likely originated from elephant self-medicating behavior. The tonic use category shows the strongest evidence of influence from observations of elephant self-medication. The use of tonic medicines appears to be increasing as a way to mitigate the unnaturally limited diet of elephants in tourist camps. Ethnoveterinary medicine for elephant care is influenced by both human medicinal knowledge and elephant knowledge of plants for self-medication. The ethnoveterinary knowledge domain appears to be the result of an interactive process linked to convergent evolution or co-evolution between humans and Asian elephants. © 2020 Reprinted with permission from Elsevier.

T. Guntawang, T. Sittisak, S. Srivorakul, V. Kochagul, K. Photichai, C. Thitaram, N. Sthitmatee, W.-L. Hsu & K. Pringproa

In vivo characterization of target cells for acute elephant endotheliotropic herpesvirus (EEHV) infection in Asian elephants (*Elephas maximus*)

Scientific Reports 10 (2020) e11402

Abstract. Elephant endotheliotropic herpesvirus-hemorrhagic disease (EEHV-HD) is a dangerous viral infectious disease in young Asian elephants. Despite hypotheses underlying pathogenesis of the disease, it is unclear which cell types the virus targets during acute or persistent infections. This study investigated the tissues and target cells permissive for EEHV infection and replication in vivo. Rabbit polyclonal antibodies against the non-structural proteins of EEHV, DNA polymerase (EEHV DNAPol), were generated and validated. These were used to examine EEHV infection and replication in various tissues of acute EEHV-HD cases and compared to an EEHV-negative control. The results indicated that viral antigens were distributed throughout the epithelia of the alimentary tract and salivary glands, endothelia and smooth muscle cells, and monocytic lineage cells of the EEHV-infected elephants. Moreover, EEHV DNAPol proteins were also found in the bone marrow cells of the EEHV1A-HD and EEHV1A/4-HD cases. This study demonstrated for the first time the target cells that favor in vivo EEHV replication during acute infection, providing a promising foundation for investigating EEHV propagation in vitro. © 2020 Authors.

H. Hoelzig, T. Muenster, S. Blanke, G. Kloess, R. Garmasukis & A. Koenig

Ivory vs. osseous ivory substitutes – Non-invasive diffractometric discrimination

Forensic Science International 308 (2020) e110159

Abstract. A new discrimination method for the bioapatite materials bone, antler and ivory was developed using X-ray diffractometry and comprises non-invasive measurements in order to take valuable objects into account. Our approach deals with the analysis of peak intensity ratios resulting from several measurements on each object. For instance, the intensity ratio of the apatite reflections 002 and 310 has been described in the literature as representing the degree of apatite crystal orientation and varies depending on the sample orientation. The decisive factor for the material identification is the value dispersion of intensity ratios resulting from the total of all measurements on one object. This pattern of data points, visualised via kernel density estimation (KDE), is characteristic for ivory, bone and antler, respectively, and enables the discrimination of these materials. The observation is justifiable since apatite crystal orientation adapts to the collagen fibre arrangement which shows major differences between different sorts of bioapatite materials. The patterns of data points were received via analysis of 88 objects made of bone (n = 30), antler (n = 27) and ivory (n = 31). In order to verify several identifications X-ray computer tomography was supplemented. The presented method usefully supplements already existing approaches concerning microscopic, elementary and biochemical analyses.

F.G. Horgan & E.P. Kudavidanage

Farming on the edge: Farmer training to mitigate human-wildlife conflict at an agricultural frontier in south Sri Lanka

Crop Protection 127 (2020) e104981

Abstract. Efforts to increase food production across Asia have relied on the intensification of established farms, as well as the expansion of farming activities into previously wild areas. Farms at agricultural frontiers face distinct challenges from those in historically farmed regions and require distinct support structures. We interviewed 324 rice farmers at seven sites in southern Sri Lanka to determine challenges to rice production in the region and the propensity for human wildlife conflict. Farmers (80%) reported wildlife including peafowl (*Pavo cristatus*) and other birds, as well as free-ranging (semi-) domestic animals such as buffalo (*Bubalus bubalis*), as their principal biotic constraints across sites, with relatively few farmers regarding weeds, insect pests, or diseases as a constraint (mentioned by 25% of farmers in total). Farmers near wilderness areas reported elephants (*Elephas maximus*) and wild boar (*Sus scrofa*) as major constraints to rice production. 64% of farmers had received training from government and other support agencies during the five years prior to our survey. Training mainly addressed insect pests and diseases and focused on lethal product-based solutions (88% of training). Farmers did not receive support or advice to mitigate crop foraging and human-wildlife conflict; instead, farmers relied heavily on repellence (human activated) responses, such as early warning systems and active scaring. We suggest that Agriculture, Development and Wildlife authorities might increase intergovernmental cooperation and coordination of farmer training to better manage crop foraging in our study region. We present a review of possible non-lethal, farm-based methods that could be promoted during training programs for farmers facing challenges from wildlife in such a biologically diverse region. Currently, a wide range of low-cost avoidance, barrier and deterrence systems (that are not monitored or activated by humans) are available. These can be used to avoid harmful repellence practices.

S.R. Hota, S. Sahoo, M. Dash, A. Pahar, B. Mohanty & N. Sahoo

Molecular detection of *Murshidia linstowi* in a free-ranging dead elephant calf

Journal of Threatened Taxa 12 (2020) 15359-15363

Abstract. Gastrointestinal helminths are ubiquitous in both domestic and wild animals. Infections are often sub-clinical except in circumstances of destabilization of host-parasite equilibrium by innate or environmental factors.

The present case deals with microscopic and molecular diagnosis of *Murshidia linstowi* recovered from an elephant. A post-mortem examination of a free-ranging juvenile male elephant calf that had died of electrocution in Athagarh Wildlife Division revealed the presence of slender, whitish nematodes in the stomach. No gross lesions were noticed either in the site of predilection or any other internal organs. The average length of the parasites was 3.8cm. These parasites were collected for further gross as well as microscopic examination following routine parasitological techniques. Temporary mounts prepared after cleaning the nematodes in lactophenol were observed under a microscope. Morphological features such as a well-developed mouth collar, large and globular buccal capsule with fine tubercles, cone shaped oesophageal funnel, short bursa having indistinctly divided lobes and closely apposed ventral rays and stout spicules with club shaped tips bent dorsally corroborated with that of *M.linstowi* (male). Amplification of the rDNA from the internal transcribed spacer (ITS) region using universal nematode primers NC2 and NC5 revealed a product size of 870 bp. The PCR product was subjected to sequencing followed by NCBI-BLAST which revealed 98% homology with *M. linstowi*. A phylogenetic study showed a maximum similarity with *M.linstowi* recovered from elephants in Kenya. This particular nematode species belonging to the family Strongylidae and sub-family Cyathostominae appears to be the first documented report in India.

A. Jayadevan, R. Nayak, K.K. Karantha, J. Krishnaswamy, R. De Fries, K.U. Karantha & S. Vaidyanathan

Navigating paved paradise: Evaluating landscape permeability to movement for large mammals in two conservation priority landscapes in India

Biological Conservation 247 (2020) e108613

Abstract. Human land use and activity results in the loss of habitat and biodiversity, and alters how animals move through landscapes. Spatially explicit information on where animal movement is affected at large spatial scales is crucial for prioritizing conservation efforts. We evaluated landscape permeability to movement in two conservation priority landscapes in India, the Western Ghats (WG) and Central India (CI). Using an agent-based model we simulated movement and dispersal of five wide-ranging species in WG (elephant, gaur, leopard, sambar and sloth bear) and four in CI (gaur, leopard, sambar and sloth bear). For each species we compared movement in the presence and absence of land-use land-cover, infrastructure and human population to identify areas where movement is impeded and reduced due to high-resistance features; unrestricted due to relatively low-resistance features; and increased and channelled due to surrounding high-resistance areas. In both landscapes, median movement was reduced. Human land-use, human population and high linear infrastructure density contribute the highest to impeded movement for all species. Natural areas constitute only 20–55% and 50–70% of unrestricted, increased and channelled movement areas in WG and CI respectively. This suggests that a large percentage of the landscape crucial for maintaining movement is not completely permeable. Such areas are often neglected in conservation planning. Our spatially explicit results help identify and prioritize areas where restoration or mitigation should be planned to improve permeability to movement for large mammals. Our approach can be used for other landscapes where data on large mammal movement is lacking.

J. Kambe, Y. Sasaki, R. Inoue, S. Tomonaga, T. Kinjo, G. Watanabe, W. Jin & K. Nagaoka

Analysis of infant microbiota composition and the relationship with breast milk components in the Asian elephant (*Elephas maximus*) at the Zoo

Journal of Veterinary Medical Science 82 (2020) 983-989

Abstract. The prevention of diseases through health control is essential at zoos. Recently, the gut microbiota, which is an ecosystem consisting of the bacteria living in the digestive tract, has been found to be one of the key systems that mediates animal health. However, there is little basic knowledge about gut microbiota in zoo animals, particularly the relationship between mothers and infants during lactation. Here, we

investigated the formation of the gut microbiota during infancy in an Asian elephant (*Elephas maximus*) in Okinawa Zoo and compared the composition between infant and mother. In addition, we analyzed the components of breast milk and examined the correlation with the infant gut microbiota. Analysis revealed that the gut microbiota of the infant contained high amount of Lactobacillales and its diversity was relatively low compared to that of the mother. We found several milk components, such as lactose, threonine and estradiol-17β, which showed a positive correlation with the change of Lactobacillales during the lactation period. In conclusion, the present study sheds light on the mechanism of gut microbiota formation during infancy in an Asian elephant and provides important insights into the health control of Asian elephants in zoos. © 2020 Japanese Society of Veterinary Science.

S. Kandel, S. Sripiboon, P. Jenjaroenpun, D.W. Ussery, I. Nookaew, M.S. Robeson II, & T. Wongsurawata

16S rRNA gene amplicon profiling of baby and adult captive elephants in Thailand

Microbiology Resource Announcements 9 (2020) e00248-20

Abstract. Here, we present a 16S rRNA gene amplicon sequence data set and profiles demonstrating the bacterial diversity of baby and adult elephants from four different geographical locations in Thailand. The dominant phyla among baby and adult elephants were Bacteroidetes, Firmicutes, Proteobacteria, Kiritimatiellaeota, Euryarchaeota, and Tenericutes. © 2020 The Authors.

Krithi K. Karanth & Anubhav Vanamamalai

Wild seve: A novel conservation intervention to monitor and address human-wildlife conflict

Frontiers in Ecology and Evolution 8 (2020) e198

Abstract. Human-wildlife interactions resulting in conflict remains a global conservation challenge, requiring innovative solutions to ensure the persistence of wildlife amidst people. Wild Seve was established in July 2015 as a conservation intervention program to assist people affected by conflict to file and monitor claims and receive ex-gratia payments from the Indian government. In 48 months of operation, Wild Seve filed and tracked 13,808 claims on behalf of those affected from 19 forest ranges around the Bandipur and Nagarahole National Parks in Karnataka, India. This included 10,082 incidents of crop loss, 1,176 property damage incidents, and 1,720 incidents where crop and property loss occurred together. Wild Seve also filed claims for 782 livestock predation incidents, and assisted in 45 human injury incidents and three human fatalities. Elephant related losses comprised 93.9%, and big cat losses comprised 5.5% of reported cases. Wild Seve provides an immediate response to human-wildlife conflict incidents and improves access to ex-gratia payment schemes. Wild Seve is a low cost intervention that uses open-source technology and leverages existing policies to facilitate ex-gratia payments. The Wild Seve model of monitoring and addressing human-wildlife conflict is adaptable and scalable to high conflict regions globally, to the benefit of people and wildlife. © 2020 The Authors.

N. Kido, S. Tanaka, T. Omiya, Y. Kamite, K. Sawada, Y. Komatsu, Y. Shoji, M. Senzaki, S. Hanzawa, M. Ando & I. Suto

Emotion estimation using a wearable heart rate monitoring device in Asian elephants (*Elephas maximus*) during veterinary clinical procedures

Journal of Veterinary Medical Science 82 (2020) 856-860

Abstract. Fatal accidents in captive elephants occasionally occur because humans are unable to gauge elephants' emotions solely by their behavior. The intellectual capacity of elephants makes them capable of understanding circumstantial changes and associated emotions, allowing them to react accordingly. Physiological markers, such as heart rate variability, may be effective in determining an elephant's emotional state. In this study, a wearable heart rate monitor was used to determine the emotional state of a female Indian captive elephant (*Elephas maximus indicus*). The average heart rate was higher when the elephant underwent painful treatment than when it underwent non-painful treatment. In addition, the heart rate increased both before and after the treatment, which included radiography

and blood collection. © 2020 Japanese Society of Veterinary Science.

R. Kobayashi, K. Nagaoka, N. Nishimura, S. Koike, E. Takahashi, K. Niimi, H. Murase, T. Kinjo, T. Tsukahara & Ryo Inoue

Comparison of the fecal microbiota of two monogastric herbivorous and five omnivorous mammals

Animal Science Journal 91 (2020) e13366

Abstract. Fecal microbiota in seven different monogastric animal species, elephant, horse, human, marmoset, mouse, pig and, rat were compared using the same analytical protocol of 16S rRNA metagenome. Fecal microbiota in herbivores showed higher alpha diversity than omnivores except for pigs. Additionally, principal coordinate analysis based on weighted UniFrac distance demonstrated that herbivores and pigs clustered together, whereas other animal species were separately aggregated. In view of butyrate- and lactate-producing bacteria, predominant genera were different depending on animal species. For example, the abundance of *Faecalibacterium*, a known butyrate producer, was 8.02% ± 3.22% in human while it was less than 1% in other animal species. Additionally, *Bifidobacterium* was a predominant lactate producer in human and marmoset, while it was rarely detected in other omnivores. The abundance of lactate-producing bacteria in herbivores was notably lower than omnivores. On the other hand, herbivores as well as pig possess Fibrobacter, a cellulolytic bacterium. This study demonstrated that fecal microbiota in herbivorous animals is similar, sharing some common features such as higher alpha diversity and higher abundance of cellulolytic bacterium. On the other hand, omnivorous animals seem to possess unique fecal microbiota. It is of interest that pigs, although omnivore, have fecal microbiota showing some common features with herbivores. © 2020 The Authors.

A. Kshettry, S. Vaidyanathan, R. Sukumar & V. Athreya

Looking beyond protected areas: Identifying conservation compatible landscapes in agro-forest mosaics in north- eastern India

Global Ecology and Conserv. 22 (2020) e00905

Abstract. Small-sized protected areas face increasing pressures from developmental activities and are often rendered inadequate and isolated to conserve wide-ranging species. However, in situations where wildlife persists outside protected areas, conservation goals may be met by aligning the ecological needs of wildlife with the socio-economic needs of local communities and offsetting losses arising due to shared spaces. We explore the potential of a tea-plantation dominated landscape of multiple land-use in north-eastern India to conserve the Asian elephant and the Indian leopard. We assess conservation potential by identifying predictors of species use of particular habitats using species distribution models and identify challenges by reviewing the available literature. Elephants used ~680 km^2 of this 1200 km^2 non-forested landscape; within this area, habitats with a higher proportion of deciduous forest patches were favored. Leopards were found to be ubiquitous in tea-plantation and used ~950 km^2 of the study area, with the proportion of tea cover being the single best predictor of leopard habitat-use. With more than 30 human deaths and 100 injuries per year caused by these two species in the study area alone, the high frequency of human casualties and economic losses remain the prime hurdles to long-term conservation efforts. We discuss specific mitigation measures to reduce human casualties and call for the inclusion of important stakeholders in the mitigation process. The study provides a template for identifying conservation-compatible landscapes outside protected areas and a framework for identifying challenges and potential to mitigate current or future conservation conflicts. © 2020 The Authors.

A. Larramendi, H. Zhang, M.R. Palombo & M.P. Ferretti

The evolution of *Palaeoloxodon* skull structure: Disentangling phylogenetic, sexually dimorphic, ontogenetic, and allometric morphological signals

Quaternary Science Reviews 229 (2020) e106090

Abstract. This paper presents a reappraisal of evolution in the extinct Pleistocene straight-tusked elephant *Palaeoloxodon*, based on cranial morphology. Particular emphasis is given to the parieto-occipital crest (POC), a specialised

structure of the *Palaeoloxodon* skull. A key aim of this contribution is to discuss the systematic significance of the so-called "Stuttgart" and "namadicus" cranial morphs among Eurasian *Palaeoloxodon*. Materials examined and discussed mostly represent large-sized continental species from several Afro-Eurasian localities, but includes also the small-sized endemic elephant *Palaeoloxodon* cf. *mnaidriensis* from the late Middle-early Late Pleistocene of Sicily. In Africa, where the lineage originated, the morphological evolution of *Palaeoloxodon* concerned both skull and molariform teeth, which became strongly hypsodont and bore up to 19 lamellae. This dental morphology underwent little notable evolutionary change in Eurasian *Palaeoloxodon*, contrasting to the marked disparity in their cranial morphology, best elucidated by variations in the POC. Maturation of a strong POC in *Palaeoloxodon antiquus*, *P. namadicus* and *P.* cf. *mnaidriensis* (Puntali Cave, Sicily) during ontogeny shows a consistent pattern: incipient folding at the M1 stage; complete folding at the M2 stage; further downward migration of the POC towards the nasals at the M3 stage. The POC morphology and variation result from complex interactions of factors, which include, to varying degrees, ontogeny (juvenile vs adult), allometry (e.g. skull size and shape) and possible phylogenetic inertia. Some evidence of sexual dimorphism in POC development is observed in *P. namadicus*, *P. naumanni*, and possibly *P. antiquus*, this is a possible allometric effect which reflects on the markedly greater body size of males at full maturity compared to females. Skull shape and variability of the POC, as well as postcranial proportions, support the specific separation of *P. namadicus* and *P. antiquus*. However, the observed pattern of intrapopulational POC variability from German and Italian *P. antiquus* samples does not support a turnover of the two distinct *Palaeoloxodon* species in Europe during the Middle Pleistocene (MIS 11–MIS 7). The poorly known *P. turkmenicus* might represent a separate Middle Pleistocene *Palaeoloxodon* species from Central Asia more plesiomorphic than either *P. antiquus* or *P. namadicus*. *P. naumanni* from Japan possesses a combination of primitive and derived, autapomorphic characters, supporting its interpretation as an early offshoot during Eurasian *Palaeoloxodon* evolution.

V.P.W. Loke, T. Lim & A. Campos-Arceiz

Hunting practices of the Jahai indigenous community in northern peninsular Malaysia

Global Ecology and Conservation 21 (2020) e00815

Abstract. Humans have been part of the ecology of Southeast Asian rainforests for millennia. Understanding the hunting practices of forest-dwelling people is important for designing policies and practices aimed to protect both vulnerable wildlife populations and human communities. The Jahai people are forest-dwelling hunter-gatherers living in northern Peninsular Malaysia and believed to be direct descendants of the first anatomically modern humans that arrived to the Malay Peninsula at least 50,000 years ago. We conducted semi-structured interviews in three Jahai villages around the Royal Belum State Park, asking about their knowledge and hunting habits of 11 wild mammal species. Specifically, we asked whether they were able to identify and whether they hunted the 11 animals, their relative prey preference, perceived trends of the animals' populations, and how they hunted and handled them. Our respondents were familiar with all the species in the survey. None of the 87 respondents claimed to hunt tigers and elephants. The most preferred and commonly hunted species were medium-sized arboreal animals (gibbons and giant squirrels, hunted by >80% of respondents), whereas larger and more dangerous animals (gaur, sun bear, and tapir) were only hunted by a minority (<10%). The Jahai use traditional hunting methods, mainly blowpipes, spears, traditional snares, and fire traps (for smoking animals out of burrows). Only two respondents reported using firearms. Elephant numbers were perceived to be stable; all the other species were perceived to be declining moderately. Almost all the meat caught by the Jahai is for self-consumption, very little is traded with outsiders. The impacts of Jahai hunting on wildlife populations remain unclear, but our study provides a fundamental understanding of Jahai hunting practices for future management and conservation purposes.

F. Li, S. Lu, X. Xie, S. Fan, D. Chen, S. Wu & J. He

Antiviral properties of extracts of *Streptomyces* sp. SMU 03 isolated from the feces of *Elephas maximus*

Fitoterapia 143 (2020) e104600

Abstract. Actinobacteria are historically and continued to be an important source for drug discovery. The annual epidemics and periodic pandemics of humans induced by influenza A virus (IAV) prompted us to develop new effective antiviral drugs with different modes of action. An actinobacterium of *Streptomyces* sp. SMU 03 was identified from the feces of *Elephas maximus* in Yunnan Province, China. By employing an H5N1 pseudo-typed virus drug screening system, the anti-IAV effect of the dichloromethane extracts (DCME) of this bacterium was investigated. DCME showed broad and potent activities against several influenza viruses, including the H1N1 and H3N2 subtypes and influenza B virus, with IC50 values ranging from 0.37 ± 0.22 to 14.44 ± 0.79 μg/ml. A detailed modes-of-action study indicated that DCME might interact with the HA2 subunit of hemagglutinin (HA) of IAV by interrupting the fusion process between the viral and host cells' membranes thereby inhibiting the entry of the virus into host cells. Furthermore, the in vivo anti-IAV activity test of DCME showed that compared with the no-drug treated group, the survival rates, appearances, weights, lung indices and histopathological changes were all significantly alleviated. Based on these results, the chemical constituent study of DCME was then investigated, from which a number of antiviral compounds with various structural skeletons have been isolated and identified. Overall, these data indicated that the DCME from *Streptomyces* sp. SMU 03 might represent a good source for antiviral compounds that can be developed as potential antivirus remedies.

Imke Lueders & W.R. Twink Allen

Managed wildlife breeding – An undervalued conservation tool?

Theriogenology 150 (2020) 48-54

Abstract. Knowledge of and the technologies and resources applied to the ex situ care for wildlife have improved greatly in recent years. This has resulted in numerous successes bringing back populations from the brink of extinction by the reintroduction or restoration of animals from conservation breeding programmes. Controlled breeding of wildlife by humans is discussed controversially in society and in scientific circles and it faces a number of significant challenges. When natural breeding fails, Assisted Reproduction Technologies (ART) have been postulated to increase reproductive output and maintain genetic diversity. Furthermore, technical advances have improved the potential for successful collection and cryopreservation of gametes and embryos in many wildlife species. With the aim of creating a better understanding of why ex situ and in situ conservation of threatened species must complement each other, and under which circumstances ART provide additional tools in the rescue of a threatened population, we elucidate the current situation here by using as examples three different megavertebrate families: elephantidae, rhinoceridae and giraffidae. These mammal families consist of charismatic species, and most of their members are currently facing dramatic declines in population numbers. On the basis of these and other examples, we highlight the importance of captive zoo and other managed wildlife populations for species survival in a human dominated world. Without the possibility to study reproductive physiology in trained or habituated captive individuals, major advances made in wildlife ART during the past 20 years would not have been possible. This paper reviews the benefits and future challenges of large mammal conservation breeding and examines the role of assisted reproduction in such efforts.

C.L. Lynsdale, N.O. Mon, D.J. F. dos Santos, H.H. Aung, U K. Nyein, W. Htut, D. Childs & V. Lummaa

Demographic and reproductive associations with nematode infection in a long-lived mammal

Scientific Reports 10 (2020) e9214

Abstract. Infection by macroparasites, such as nematodes, varies within vertebrate host systems; elevated infection is commonly observed in juveniles and males, and, for females, with different reproductive states. However, while

such patterns are widely recognized in short-lived model systems, how they apply to long-lived hosts is comparatively understudied. Here, we investigated how infection varies with host age, sex, and female reproduction in a semi-captive population of individually marked Asian elephants *Elephas maximus*. We carried out 1,977 faecal egg counts (FECs) across five years to estimate nematode loads for 324 hosts. Infection patterns followed an established age-infection curve, whereby calves (5 years) exhibited the highest FECs and adults (45 years) the lowest. However, males and females had similar FECs across their long lifespan, despite distinct differences in life-history strategy and clear sexual dimorphism. Additionally, although mothers invest two years in pregnancy and a further three to five years into lactation, nematode load did not vary with four different measures of female reproduction. Our results provide a much-needed insight into the host-parasite dynamics of a long-lived host; determining host-specific associations with infection in such systems is important for broadening our knowledge of parasite ecology and provides practical applications for wildlife medicine and management. © 2020 The Authors.

Z.M. Oo, Y.H. Aung, T.T. Aung, N. San, Z.M. Tun, G.S. Hayward & A. Zachariah

Elephant endotheliotropic herpesvirus hemorrhagic disease in Asian elephant calves in logging camps, Myanmar

Emerging Infectious Diseases 26 (2020) 63-69

Abstract. In recent years, an alarming number of cases of lethal acute hemorrhagic disease have occurred in Asian elephant calves raised in logging camps in Myanmar. To determine whether these deaths were associated with infection by elephant endotheliotropic herpesvirus (EEHV), we conducted diagnostic PCR subtype DNA sequencing analysis on necropsy tissue samples collected from 3 locations. We found that EEHV DNA from 7 PCR loci was present at high levels in all 3 calves and was the same EEHV1A virus type that has been described in North America, Europe, and other parts of Asia. However, when analyzed over 5,610 bp, the strains showed major differences from each other and from all previously characterized EEHV1A strains. We conclude that these 3 elephant calves in Myanmar died from the same herpesvirus disease that has afflicted young Asian elephants in other countries over the past 20 years.

H. Padalia, S. Ghosh, C.S. Reddy, S. Nandy, S. Singh & A.S. Kumar

Assessment of historical forest cover loss and fragmentation in Asian elephant ranges in India

Environmental Monitoring and Assessment 191 (2019) e802

Abstract. No permission to print the abstract.

S. Paudel & S. Sreevatsan

Tuberculosis in elephants: Origins and evidence of interspecies transmission

Tuberculosis 123 (2020) e101962

Abstract. Tuberculosis (TB) is a devastating disease in elephants caused by either *Mycobacterium tuberculosis* or *M. bovis*. It is an ancient disease, and TB in elephants was first reported over two millennia ago in Sri Lanka. Outbreaks of TB worldwide, in captive and free-ranging elephant populations, have been recorded. Interspecies transmission of TB among elephants and humans has been confirmed in several geographic localities using spoligotyping, MIRU-VNTR analysis, and/or comparative genomics. Active surveillance of TB in wild and captive elephants and their handlers is necessary to prevent TB transmission at the elephant-human interface and to aid in the conservation of Asian and African elephants. In this review, we present an overview of diagnosis, reports of TB outbreaks in the past 25 years, TB in wild elephants, its transmission, and possible prevention and control strategies that can be applied at the elephant-human interface. © 2020 Reprinted with permission from Elsevier.

M. Perera & R. Vandercone

Some aspects of seed dispersal by Asian elephants (*Elephas maximus*) in Kaudulla National Park, Sri Lanka

Current Science 118 (2020) 648-654

Abstract. Our understanding of the qualitative and quantitative aspects of seed dispersal by Asian elephants is at its infancy. We explored some of these aspects at Kaudulla National Park, Sri Lanka, focusing on the germination

potential of dispersed seeds, and the influence of gut passage on germination and latency in the seeds of *Bauhinia racemosa*. Seeds of ten species were dispersed and their germination potential was generally poor. However, gut passage significantly reduced the latency period of *B. racemosa*. Long-term research on frugivory, passage times of seeds and ranging behaviour will help develop wildlife management plans.

M.J. Potoczniak, M. Chermak, L. Quarino, S.S. Tobe & J. Conte

Development of a multiplex, PCR-based genotyping assay for African and Asian elephants for forensic purposes

International Journal of Legal Medicine 134 (2020) 55–62

Abstract. No permission to print the abstract.

M.R. Puspaningrum, G.D. van den Bergh, A.R. Chivas, E. Setiabudi & I. Kurniawan

Isotopic reconstruction of Proboscidean habitats and diets on Java since the Early Pleistocene: Implications for adaptation and extinction

Quaternary Science Reviews 228 (2020) e106007

Abstract. Since its sub-aerial emergence, Java has experienced multiple tectonic, geographic and climatic changes, which affected the megafaunal occupation, adaptation and succession. Six Proboscidean taxa have been found from various localities throughout Java extending back to the Early to Late Pleistocene. The six taxa are: *Stegoloxodon indonesicus*, *Sinomastodon bumiajuensis*, pygmy *Stegodon* sp., *Stegodon trigonocephalus*, *Elephas hysudrindicus* and *Elephas maximus*, in which respective taxa are included in successive faunal stages. The aim of this research was to reconstruct the succession of Proboscidea in Java and the adaptation of each taxon to environmental changes by incorporating stable isotope analysis with the fossil faunal record, geology and stratigraphy. We conducted stable carbon ($\delta^{13}C$) and oxygen ($\delta^{18}O$) isotope analysis of the carbonate phase in the tooth enamel of six proboscidean taxa from numerous localities and ages. Our results suggest that for the earliest terrestrial fauna from Java, represented by *Stegoloxodon indonesicus*, the feeding ecology was restricted to a closed canopy rainforest during the earliest Pleistocene, while towards the late Early Pleistocene, the successive taxon, *Sinomastodon bumiajuensis*, was adapted to different or increasingly drier grassy habitats. C_4 expansion on the island took place since the later part of the Early Pleistocene (before 1.5 Ma) and continued until the Middle Pleistocene, as suggested by the carbon and oxygen isotope composition of assemblages of proboscidean taxa from Sangiran, Kedung Brubus, Trinil, and western Java, which also predominantly display the expected range of C_4-dominant feeders. However, the occurrence of mixed C_3/C_4 feeder Proboscidea in the Ngandong Fauna suggests that fragmented dense evergreen forests, shrubby or woodland vegetation reappeared towards the end of the Middle Pleistocene. This environmental shift is detected in the later stage of the Middle Pleistocene, as the dietary preference of all analysed samples from individuals from this age shifted back from a C_4-dominated into a C_3-dominated diet, which suggests a change from a dry to more humid climate conditions.

R. Rajapakse, K.L.T. Pham, K.J.K. Karunathilakea, S.P. Lawton & T.H. Leb

Characterization and phylogenetic properties of the complete mitochondrial genome of *Fascioloides jacksoni* (syn. *Fasciola jacksoni*) support the suggested intergeneric change from *Fasciola* to *Fascioloides* (Platyhelminthes: Trematoda: Plagiorchiida)

Infection Genetics and Evolution 82 (2020) e104281

Abstract. *Fascioloides jacksoni* (syn. *Fasciola jacksoni*, Cobbold, 1869) (Platyhelminthes: Echinostomatoidea), is a liver fluke that causes severe morbidity and mortality of Asian elephants (*Elephas maximus maximus*). Understandings on molecular diagnosis, epidemiology, genetics and evolution of this flatworm are limited. In this study, we present the complete mitochondrial DNA (mt) sequence of 14,952 bp obtained from an individual fluke and comparative characterization of mitogenomic features with fasciolids, primarily, *Fascioloides magna* and other taxa in the superfamily Echinostomatoidea. Taxonomic relationship within and between Echinostomatoidea, Opisthorchioidea and

Paramphistomoidea in the order Plagiorchiida, are also taxonomically considered. The complete circular mt molecule of *F. jacksoni* contained 12 protein-coding, two ribosomal RNA, 22 transfer RNA genes, and a non-coding region (NCR) rich in tandem repeat units. As common in digenean trematodes, *F. jacksoni* has the usual gene order, the absence of atp8 and the overlapped region by 40 bp between nad4L and nad4 genes. The NCR located between tRNA(Glu) (trnE) and cox3 contained nine nearly identical tandem repeat units (TRs of 113 bp each). Special DHU-arm missing tRNAs for Serine were found for both, tRNA(S1(AGN)) and tRNA(S2(UCN)). Base composition indicated that cox1 of *F. jacksoni* showed the lowest (11.8% to *F. magna*, 12.9–13.6% to Fasciola spp. and 18.1% to *Fasciolopsis buski*) and nad6 the highest divergence rate (19.2%, 23.8–26.5% and 27.2% to each fasciolid group), respectively. A clear bias in nucleotide composition, as of 61.68%, 62.88% and 61.54%, with a negative AT-skew of the corresponding values (-0.523, -0.225 and -0.426) for PCGs, MRGs and mtDNA for *F. jacksoni* and likewise data for the fasciolids. Phylogenetic analysis confirmed the sister branch of *F. jacksoni* and *F. magna* with the nodal support of 100%, clearly separated from the taxonomically recognized *Fasciola* spp. With the previous studies, mitogenomic data presented in this study are strongly supportive for *Fasciola jacksoni* reappraisal as *Fascioloides jacksoni* in the *Fascioloides* genus.

T. Revathe, S. Anvitha & T.N.C. Vdiya

Development of motor control and behaviour in Asian elephants in the Kabini elephant population, southern India

International Journal of Developmental Biology 64 (2020) 377-392

Abstract. Although neonates of precocial mammals are capable of locomotory, sensory, nutritional, and thermoregulatory independence to some extent soon after birth, they attain their adult body mass more slowly than altricial mammals, allowing for an extended period of learning or perfecting skills to an adult-like degree. Asian elephants are precocial but are nutritionally dependent on the mother for at least two years and are long-lived and social. We wanted to examine the ontogeny of trunk motor control and various behaviours in Asian elephant calves and see whether the former develops faster than the latter since limb motor control is achieved soon after birth. We collected field data on trunk use, lateralisation, and behaviours from individually identified, free-ranging elephants in southern India and examined how they were affected by age and other factors. Unlike limb motor control, we found trunk motor skills and behaviours to develop gradually with age. Trunk lateralisation occurred very early on, was not highly dependent on trunk motor skills, and is probably not a developmental marker in Asian elephants. Adult-like behaviours that required low trunk usage emerged within 3 months, while some feeding behaviours emerged later. Calves spent less time resting and more time feeding as they grew, and their activity budgets resembled those of adults only after a year; hence, mother-offspring behavioural synchrony was low for young calves and increased with age. Behavioural development and trunk motor control in Asian elephants are both gradual processes, taking about a year to mature.

S. Saaban, M.N. Yasak, M. Gumal, A. Oziar, F. Cheong, Z. Shaari, M. Tyson & S. Hedges

Viability and management of the Asian elephant (*Elephas maximus*) population in the Endau Rompin landscape, Peninsular Malaysia

PeerJ 8 (2020) e8209

Abstract. The need for conservation scientists to produce research of greater relevance to practitioners is now increasingly recognized. This study provides an example of scientists working alongside practitioners and policy makers to address a question of immediate relevance to elephant conservation in Malaysia and using the results to inform wildlife management policy and practice including the National Elephant Conservation Action Plan for Peninsular Malaysia. Since ensuring effective conservation of elephants in the Endau Rompin Landscape (ERL) in Peninsular Malaysia is difficult without data on population parameters we (1) conducted a survey to assess the size of the elephant population, (2) used that information to assess

the viability of the population under different management scenarios including translocation of elephants out of the ERL (a technique long used in Malaysia to mitigate human-elephant conflict (HEC)), and (3) assessed a number of options for managing the elephant population and HEC in the future. Our dung-count based survey in the ERL produced an estimate of 135 (95% CI [80-225]) elephants in the 2,500 km^2 area. The population is thus of national significance, containing possibly the second largest elephant population in Peninsular Malaysia, and with effective management elephant numbers could probably double. We used the data from our survey plus other sources to conduct a population viability analysis to assess relative extinction risk under different management scenarios. Our results demonstrate that the population cannot sustain even very low levels of removal for translocation or anything other than occasional poaching. We describe, therefore, an alternative approach, informed by this analysis, which focuses on in situ management and non-translocation-based methods for preventing or mitigating HEC. The recommended approach includes an increase in law enforcement to protect the elephants and their habitat, maintenance of habitat connectivity between the ERL and other elephant habitat, and a new focus on adaptive management.© 2020 The Authors.

F. Sach, E.S. Dierenfeld, S.C. Langley-Evans, E. Hamilton, R.M. Lark, L. Yon & M.J. Watts

Potential bio-indicators for assessment of mineral status in elephants

Scientific Reports 10 (2020) e8032

Abstract. The aim of this study was two-fold: (1) identify suitable bio-indicators to assess elemental status in elephants using captive elephant samples, and (2) understand how geochemistry influences mineral intake. Tail hair, toenail, faeces, plasma and urine were collected quarterly from 21 elephants at five UK zoos. All elephant food, soil from enclosure(s), and drinking water were also sampled. Elemental analysis was conducted on all samples, using inductively coupled plasma mass spectrometry, focusing on biologically functional minerals (Ca, Cu, Fe, K, Mg, Mn, Na, P, Se and Zn) and trace metals (As, Cd, Pb, U and V). Linear mixed modelling was used to identify how keeper-fed diet, water and soil were reflected in sample bio-indicators. No sample matrix reflected the status of all assessed elements. Toenail was the best bio-indicator of intake for the most elements reviewed in this study, with keeper-fed diet being the strongest predictor. Calcium status was reflected in faeces, (p 0.019, R^2 between elephant within zoo - 0.608). In this study urine was of no value in determining mineral status here and plasma was of limited value. Results aimed to define the most suitable bio-indicators to assess captive animal health and encourage onward application to wildlife management. © 2020 The Authors.

Willem Schaftenaar

The challenge of obtaining reference values for use in captive animals like elephants

Veterinary Quarterly 40 (2020) 115-117

Abstract. none.

A. Sengupta, V.V. Binoy & . Radhakrishna

Human-elephant conflict in Kerala, India: A rapid appraisal using compensation records

Human Ecology 48 (2020) 101-109

Abstract. No permission to print the abstract.

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

Behavioural responses of free-ranging Asian elephants (*Elephas maximus*) towards dying and dead conspecifics

Primates 61 (2020) 129-138

Abstract. Reactions to dying and dead conspecifics have been observed in many non-human animals. Elephants, particularly African elephants, are thought to have an awareness of the death of their conspecifics, as they show compassionate behaviour towards others in distress. However, there is a paucity of scientific documentation on thanatological responses displayed by Asian elephants. Here, we report three detailed, directly observed cases of free-ranging Asian elephants (*Elephas maximus*) responding to dying and dead conspecifics. Behavioural responses were recorded opportunistically and described as pre-, peri- and post-mortem phases based on the status of the individual before, near or after its death. In all three observations, elephants

showed approach and exploratory (sniffing and inspecting) behaviours, and epimeletic or helping (physically supporting dying calves) in pre- and peri-mortem phases. We also recorded high-frequency vocalizations (trumpets) by an adult female in the presence of a dying calf. Our observations indicate that, like their African counterparts, Asian elephants might experience distress in response to the death of conspecifics, and may have some awareness of death. This information furthers our understanding of the emotional and cognitive complexities of highly social elephants, and contributes to the growing field of elephant thanatology.

N. Sharma, V. Prakash S., S. Kohshima & R. Sukumar

Asian elephants modulate their vocalizations when disturbed

Animal Behaviour 160 (2020) 99-111

Abstract. When disturbed, animals use various modes of communication to alert conspecifics about the source of danger. Some species have evolved graded or continuous signals specific to the type of threats. African elephants, *Loxodonta africana*, are known to differentiate between threats from bees and humans by changing the energy concentrations of their alarm calls. However, the mechanism by which Asian elephants, *Elephas maximus*, use vocalizations to alert conspecifics about imminent danger remains poorly explored. To understand disturbance-induced communication in free-ranging Asian elephants, we compared two call types, 'rumbles' (low-frequency calls) and 'trumpets' (high-frequency calls), produced in disturbed (by humans or other animals) and undisturbed (social interaction) states. We then analysed acoustic characters for both call types: absolute frequency parameters including fundamental frequency (F0), mean, minimum, maximum and range; temporal parameters including call duration, time to minimum F0, time to maximum F0, peak time and minimum time; and filter-related parameters including mean, minimum and maximum of first (F1) and second (F2) formant locations. We found that under disturbed conditions, Asian elephants increased the duration of rumbles and decreased the duration of trumpets. Similarly, the mean F0 and mean positions of F1 and F2 of rumbles decreased compared with the undisturbed condition; among trumpets, no significant differences were observed in mean F0 or formant position in either F1 or F2 between the two contexts. We also found that the duration of rumbles was influenced by an interaction between group size and context: smaller groups produced longer rumbles when disturbed. These results suggest that when disturbed Asian elephants can modify vocal signals whose likely function could be to alert conspecifics about potential threats.

P. Sharma, S. Panthi, S.K. Yadav, M. Bhatta, A. Karki, T. Duncan, M. Poudel & K.P. Acharya

Suitable habitat of wild Asian elephant in Western Terai of Nepal

Ecology and Evolution 10 (2020) 6112-6119

Abstract. There is currently very little available research on the habitat suitability, the influence of infrastructure on distribution, and the extent and connectivity of habitat available to the wild Asian elephant (*Elephas maximus*). Information related to the habitat is crucial for conservation of this species. In this study, we identified suitable habitat for wild Asian elephants in the Western Terai region of Nepal using Maximum Entropy (MaxEnt) software. Of 9,207 km^2, we identified 3194.82 km^2 as suitable habitat for wild Asian elephants in the study area. Approximately 40% of identified habitat occurs in existing protected areas. Most of these habitat patches are smaller than previous estimations of the species home range, and this may reduce the probability of the species continued survival in the study area. Proximity to roads was identified as the most important factor defining habitat suitability, with elephants preferring habitats far from roads. We conclude that further habitat fragmentation in the study area can be reduced by avoiding the construction of new roads and connectivity between areas of existing suitable habitat can be increased through the identification and management of wildlife corridors between habitat patches.

J.E. Smith, C.A. Ortiz, M.T. Buhbe & M. van Vugt

Obstacles and opportunities for female leadership in mammalian societies: A comparative perspective

The Leadership Quarterly 31 (2020) e101267

Abstract. Women remain universally underrepresented in the top leadership positions. A comparative evolutionary framework may offer new insights into the value of and potential barriers to female leadership. Here we define leaders as individuals who impose a disproportional influence on the collective behaviors of group members. We reviewed data for 76 social species of non-human mammals to reveal the circumstances favoring female leadership and species exhibiting female-biased leadership in two or more contexts (e.g., collective movements, group foraging, conflict resolution within groups, or conflicts between groups). Although rare across the lineage, female-biased leadership is pervasive in killer whales, lions, spotted hyenas, bonobos, lemurs, and elephants; leaders emerge without coercion and followers benefit from the social support and/or ecological knowledge from elder females. Our synthesis elucidates barriers to female leadership, but also reveals that traditional operationalizations of leadership are themselves male-biased. We therefore propose a new agenda for assessing the overlooked ways that females exert influence in groups. © 2018 Reprinted with permission from Elsevier.

C. Soundararajan, K.P. Prabhu, K. Nagarajan & T. Divya

Wound and gastric myiasis due to *Chrysomyia bezziana* and *Cobbaldia elephantis* and its pathological lesions in wild elephants in the Nilgiris hills of Tamil Nadu

Journal of Parasitic Diseases 43 (2019) 134-138

Abstract. Thirty-five years old female and 12 years old male wild elephant were found dead at Seviyodu and Cherangode of Cherambadi range at Nilgiris district, Tamil Nadu state. On post mortem examination, maggots were recovered from palate of oral cavity and gastric mucosa of the stomach and identified as *Chrysomyia bezziana* and *Cobbaldia elephantis*, respectively. Histopathology of oral tissue specimen revealed myonecrosis of soft palate due to myiasis and cross section of encysted larvae surrounded by fibrous capsule and inflammatory cells. This study reports the mixed infection of wound and gastric myiasis due to *C. bezziana* and *C. elephantis* and its histopathological lesions in wild elephants. © 2018 Indian Society for Parasitology.

S. Sripiboon, W. Ditcham, R. Vaughan-Higgins, B. Jackson, I. Robertson, C. Thitaram, T. Angkawanish, S. Phatthanakunanan, P. Lertwatcharasarakul & K. Warren

Subclinical infection of captive Asian elephants (*Elephas maximus*) in Thailand with elephant endotheliotropic herpesvirus

Archives of Virology 165 (2020) 397-401

Abstract. No permission to print the abstract.

K. Takehana, R, Kitani, K. Hatate, R, Onomi & N. Yamagishi

Anthropometric and blood data on a hand-reared captive Asian elephant (*Elephas maximus*) calf: A retrospective case report

J. of Vet. Medical Science 82 (2020) 943-947

Abstract. The anthropometric and blood data of an unsuccessfully hand-reared Asian elephant (*Elephas maximus*) calf were retrospectively compared with the data for calves raised by their real mothers or allomothers, to identify potential reasons for poor outcomes in the hand-reared case. The hand-reared calf grew normally in terms of body weight and withers height. However, blood biochemical data suggested reduced bone metabolism, low immune status, and malnutrition during its life. Blood bone markers were measured to determine whether a skeletal disorder was present in the Asian elephant calf, which was not clear from the anthropometric data. Monitoring these parameters in hand-reared Asian elephant calves, with the aim of keeping them within the normal range, may increase the success rate of hand-rearing of Asian elephant calves. © 2020 The Japanese Society of Veterinary Science.

S.N. Teng, C. Xu, L. Teng & J.-C. Svenning

Long-term effects of cultural filtering on megafauna species distributions across China

PNAS 117 (2020) 486-493

Abstract. Human activities currently play a dominant role in shaping and eroding Earth's biodiversity, but the historical dynamics leading to this situation are poorly understood and contentious. Importantly, these dynamics are

often studied and discussed without an emphasis on cultural evolution, despite its potential importance for past and present biodiversity dynamics. Here, we investigate whether cultural filtering, defined as the impact of cultural evolution on species presence, has driven the range dynamics of five historically widespread megafauna taxa (Asiatic elephant, rhinoceroses, tiger, Asiatic black bear, and brown bear) across China over the past 2 millennia. Data on megafauna and sociocultural history were compiled from Chinese administrative records. While faunal dynamics in China are often linked to climate change at these time scales, our results reveal cultural filtering as the dominant driver of range contractions in all five taxa. This finding suggests that the millennia-long spread of agricultural land and agricultural intensification, often accompanied by expansion of the Han culture, has been responsible for the extirpation of these megafauna species from much of China. Our results suggest that cultural filtering is important for understanding society's role in the assembly of contemporary communities from historical regional species pools. Our study provides direct evidence that cultural evolution since ancient times has overshadowed climate change in shaping broadscale megafauna biodiversity patterns, reflecting the strong and increasing importance of sociocultural processes in the biosphere.

D.Vasudev, V.R. Goswami, P. Hait, P. Sharma, B. Joshi, Y. Karpate & P.K. Prasad

Conservation opportunities and challenges emerge from assessing nuanced stakeholder attitudes towards the Asian elephant in tea estates of Assam, Northeast India

Global Ecology and Conserv. 22 (2020) e00936

Abstract. Interactions between wildlife and people lie at the core of conservation planning in heterogeneous landscapes. Understanding stakeholder perspectives towards wildlife is a key endeavour in this regard. In particular, it can be useful to separate notional or generic attitudes towards wildlife, from those that pertain to more practical considerations at localised scales. We assessed nuances in stakeholder attitudes and underlying beliefs towards the endangered Asian elephant *Elephas maximus* – a wide-ranging species that needs landscape-scale conservation, while also being an animal that is both culturally revered and conflict-prone. We instrumented semi-structured questionnaire surveys using a 5-point Likert score, to 2252 respondents representing tea estate labour and management across 17 estates in the Kaziranga–Karbi Anglong landscape of Assam, Northeast India. Respondents were overwhelmingly positive (80–98%) towards elephants notionally. In our landscape, this stemmed more from cultural links and beliefs about the animal's intrinsic right to persist, rather than utilitarian benefits in terms of ecosystem health. At localised scales, responses were more varied with issues relating to safety concerns and crop loss maximally inciting non-positive responses. Similarly, stakeholder attitudes towards elephant conservation at localised scales were varied. Elephant use of lands outside forests, for instance, incited equivocal responses. Interestingly, while safety concerns clearly limit the potential for human-elephant co-occurrence, stakeholders still believed that elephants do not harm people unprovoked; this highlights the opportunities a culture of tolerance provides for stakeholder support of, and engagement with, wildlife conservation. Ultimately, understanding stakeholder attitudes can determine our ability to encourage 'wildlife-friendly' behavioural change and shape human-wildlife interactions into the future.

Z. Wang, Z. Li, Y. Tang, C. Yao, Y. Liu, G. Jiang, F. Wang, L. Liang, W. Zhao, G. Zhu & M. Chen

China's dams isolate Asian elephants

Science 367 (2020) 373-374

Abstract. none.

Elephants at Minneriya National Park, Sri Lanka