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Abhijith, T. V., et al. (2018). "Gastrointestinal parasites of Asian elephants (Elephas maximus L. 1798) in south Wayanad forest division, Kerala, India." <u>J Parasit Dis</u> **42**(3): 382-390.
>   Microscopic-coprological examination of Asian Elephant (Elephas maximus L., 1798) dung piles (n = 55) in South Wayanad Forest Division from March to August, 2017 revealed 74.5% prevalence of parasites in elephants. Ancylostoma sp. Anoplocephala sp., Strongyle type egg and Strongyloides sp. were the major parasites recorded. Strongyloides sp. and Strongyle type egg were observed more frequently (58.1%). Ancylostoma sp. and Anoplocephala sp. were constituted 1.8% each; mixed parasitic species infections were recorded. The frequency distribution of parasitic load in elephants showed skewed distribution of propagules. Centrifugal sedimentation and floatation methods of fecal examination of outer and inner regions of dung did not show significant difference in number of propagules. The highest number of parasitic propagules was recorded in floatation method. The number of propagules varied among dung samples of different herds collected from different localities. There were no relation between the parasitic load and age of elephants. The mean density of parasite eggs was higher in solitary animals (214.3 +/- 155.4 epg) than herd elephants (147.78 +/- 111.1 epg). Though parasitic load was higher in solitary males, based on the occurrence of parasites using logistic regression it was found that females had 1.83 times higher occurrence for parasitic infection than males. Both length and width of parasite egg size classes were used to classify into different taxonomic groups using discriminate function analysis. Three distinct size clusters were identified. Nematode and Cestode eggs were classified correctly with 95.7% accuracy. Since, the egg size was similar in nematode group separation into genus was difficult. Further, inclusion of stages of development of egg and larvae enable better separation.

Acharya, K. P., et al. (2018). "Animal Welfare in Nepal." <u>J Appl Anim Welf Sci</u>: 1-15.
>   The small densely populated country of Nepal rises from just above sea level to more than 8800 m and encompasses many agro-ecological zones. Rich in both nature and culture, livestock are integral to household and national economies. Most Nepalese consider the cow sacred, and slaughter is forbidden. Other nonhuman animals are less esteemed, slaughter is not proscribed, and many are sacrificed during religious festivals. Limited financial and material resources, inadequate feed supplies, poor access to veterinary services, absence of appropriate legislation, and ignoring the needs of livestock as sentient beings can compromise welfare and lead to inhumane treatment. This article reviews the welfare status of various groups (food-producing stock, work animals, street dogs, experimental animals, and elephants in captivity). Several animal welfare charities are represented. Suggestions for improved welfare are discussed, but the prognosis is not encouraging especially in view of the widespread struggle and people's own struggle for survival.

Ahrestani, F. S., et al. (2018). "Estimating densities of large herbivores in tropical forests: Rigorous evaluation of a dung-based method." <u>Ecol Evol</u> **8**(15): 7312-7322.
>   When sighting-based surveys to estimate population densities of large herbivores in tropical dense forests are not practical or affordable, surveys that rely on animal dung are sometimes used. This study tested one such dung-based method by deriving population densities from observed dung densities of six large herbivores (chital, elephant, gaur, muntjac, sambar, and wild pig) in two habitats, dry deciduous forests (DDF) and moist deciduous forests (MDF), within Nagarahole National Park, southern India. Using the program DUNGSURV, dung pile counts, decay rates estimated from field experiments, and defecation rates derived from literature were analyzed together by a model that

allows for random events affecting dung decay. Densities of chital were the highest, followed by sambar. Wild pig densities were similar in the two habitats, sambar densities were higher in DDF, and densities of the other species were higher in MDF than in DDF. We compared DUNGSURV estimates with densities estimated using distance sampling in the same season. DUNGSURV estimates were substantially higher for all species in both habitats. These differences highlight the challenges that researchers face in computing unbiased estimates of dung decay rates and in relying on defecation rates from literature. Besides the elephant, this study is the first to rigorously test the efficacy of using a dung-based approach to estimate densities of large herbivore species in Asia, and based on this evaluation, we provide specific recommendations to address issues that require careful consideration before observed dung densities are used to derive animal densities. Our results underline the need for an experimental study of a known population in a fenced reserve to validate the true potential of using dung-based approaches to estimate population densities.

Ajike, S. O., et al. (2018). "Lateral Proboscis (Elephant Tusk) with Orofacial Clefts: A Report of a Rare Case." Case Rep Pediatr **2018**: 6820972.

Lateral proboscis is a rare congenital anomaly. Lateral proboscis is a rare craniofacial malformation characterized by a rudimentary tubular, nose-like structure occurring in association with a wide spectrum of other anomalies. We presented a seven-month-old girl's lateral proboscis, cleft lip, and palate. Proboscis was excised by an elliptical incision, and the cleft was repaired at the same surgery.

Akcakaya, H. R., et al. (2018). "Quantifying species recovery and conservation success to develop an IUCN Green List of Species." Conserv Biol **32**(5): 1128-1138.

Stopping declines in biodiversity is critically important, but it is only a first step toward achieving more ambitious conservation goals. The absence of an objective and practical definition of species recovery that is applicable across taxonomic groups leads to inconsistent targets in recovery plans and frustrates reporting and maximization of conservation impact. We devised a framework for comprehensively assessing species recovery and conservation success. We propose a definition of a fully recovered species that emphasizes viability, ecological functionality, and representation; and use counterfactual approaches to quantify degree of recovery. This allowed us to calculate a set of 4 conservation metrics that demonstrate impacts of conservation efforts to date (conservation legacy); identify dependence of a species on conservation actions (conservation dependence); quantify expected gains resulting from conservation action in the medium term (conservation gain); and specify requirements to achieve maximum plausible recovery over the long term (recovery potential). These metrics can incentivize the establishment and achievement of ambitious conservation targets. We illustrate their use by applying the framework to a vertebrate, an invertebrate, and a woody and an herbaceous plant. Our approach is a preliminary framework for an International Union for Conservation of Nature (IUCN) Green List of Species, which was mandated by a resolution of IUCN members in 2012. Although there are several challenges in applying our proposed framework to a wide range of species, we believe its further development, implementation, and integration with the IUCN Red List of Threatened Species will help catalyze a positive and ambitious vision for conservation that will drive sustained conservation action.

Alberic, M., et al. (2018). "The three-dimensional arrangement of the mineralized collagen fibers in elephant ivory and its relation to mechanical and optical properties." Acta Biomater.

Elephant tusks are composed of dentin or ivory, a hierarchical and composite biological material made of mineralized collagen fibers (MCF). The specific arrangement of the MCF is believed to be responsible for the optical and mechanical properties of the tusks. Especially the MCF organization likely contributes to the formation of the bright and dark checkerboard pattern observed on polished sections of tusks (Schreger pattern). Yet, the precise structural origin of this optical motif is still controversial. We hereby address this issue using complementary analytical methods (small and wide angle X-ray scattering, cross-polarized light microscopy and scanning electron microscopy) on elephant

ivory samples and show that MCF orientation in ivory varies from the outer to the inner part of the tusk. An external cohesive layer of MCF with fiber direction perpendicular to the tusk axis wraps the mid-dentin region, where the MCF are oriented mainly along the tusk axis and arranged in plywood-like structure with fiber orientations oscillating in a narrow angular range. This particular oscillating-plywood structure of the MCF and the birefringent properties of the collagen fibers, likely contribute to the emergence of the Schreger pattern, one of the most intriguing macroscopic optical patterns observed in mineralized tissues and of great importance for authentication issues in archeology and forensic sciences. STATEMENT OF SIGNIFICANCE: Elephant tusks are intriguing biological materials as they are composed of dentin (ivory) like teeth but have mineralized collagen fibers (MCF) similarly arranged to the ones of lamellar bones and function as bones or antlers. Here, we showed that ivory has a graded structure with varying MCF orientations and that MCF of the mid-dentin are arranged in plywood like layers with fiber orientations oscillating in a narrow angular range around the tusk axis. This organization of the MCF may contribute to ivory's mechanical properties and, together with the collagen fibers birefringence properties, strongly relates to its optical properties, i.e. the emergence of a macroscopic checkerboard pattern, well known as the Schreger pattern.

Azab, W., et al. (2018). "Subclinical infection of a young captive Asian elephant with elephant endotheliotropic herpesvirus 1." Arch Virol **163**(2): 495-500.
    Elephant endotheliotropic herpesviruses (EEHVs) are a continuous threat for young Asian elephants. We report a laboratory-confirmed infection of a 5-year-old female Asian elephant (AZ_2016) in the Berlin Zoologischer Garten. Initially, high EEHV-1 loads were detected in trunk swabs obtained from the young elephant during routine screening. The animal showed no clinical signs except for slight irritability. EEHV-1 was continuously shed for almost one year, with fluctuations in viral load from time to time. Our investigations highlight the continuous threat of EEHV-1 to young captive Asian elephants and stress the importance of routine monitoring of captive elephants to allow early detection of infection.

Bansiddhi, P., et al. (2018). "Changing trends in elephant camp management in northern Thailand and implications for welfare." PeerJ **6**: e5996.
    Background: Elephant camps are among the most attractive destinations in Thailand for tourists from many countries. A wide range of management strategies are used by these camps, which can have varied impacts on health and welfare of elephants. Methods: This study surveyed 33 camps with 627 elephants in northern Thailand to quantify the types of management practices and work activities experienced by captive elephants. The survey consisted of an interview with camp owners, and direct observations of camp operations. Results: Data revealed considerable variation in elephant demographics, work activities, elephant care (i.e., housing, restraint, nutrition, health care, and breeding), and mahout management among the camps. In general, older camps (those in existence for >16 years) were involved in more intensive activities, like riding with saddles and shows. By contrast, newer camps provided more one-on-one activities for tourists and elephants, and emphasized more intimate, relaxing experiences (e.g., feeding, bathing, walking) than entertainment. A demographic shift also was observed, with elephants 20 years of age and younger having a sex ratio closer to 1:1 compared to elephants in older age categories (1:4.1-1:9.8). Discussion: Shifts in elephant management to less intensive activities were observed, which could have positive implications for elephant welfare. The shifting sex ratio suggests successful captive breeding is resulting in the birth of more males, which could present new welfare challenges in the future, because bulls can be more difficult to manage and socialize, and are more likely to be kept isolated during musth. Ultimately, the goal is to understand how camp activities affect welfare, and to develop science-based guidelines and standards to aid in the management of both male and female elephants used in tourism.

Baotic, A., et al. (2018). "Field Propagation Experiments of Male African Savanna Elephant Rumbles: A Focus

on the Transmission of Formant Frequencies." Animals (Basel) **8**(10).

African savanna elephants live in dynamic fission(-)fusion societies and exhibit a sophisticated vocal communication system. Their most frequent call-type is the 'rumble', with a fundamental frequency (which refers to the lowest vocal fold vibration rate when producing a vocalization) near or in the infrasonic range. Rumbles are used in a wide variety of behavioral contexts, for short- and long-distance communication, and convey contextual and physical information. For example, maturity (age and size) is encoded in male rumbles by formant frequencies (the resonance frequencies of the vocal tract), having the most informative power. As sound propagates, however, its spectral and temporal structures degrade progressively. Our study used manipulated and resynthesized male social rumbles to simulate large and small individuals (based on different formant values) to quantify whether this phenotypic information efficiently transmits over long distances. To examine transmission efficiency and the potential influences of ecological factors, we broadcasted and re-recorded rumbles at distances of up to 1.5 km in two different habitats at the Addo Elephant National Park, South Africa. Our results show that rumbles were affected by spectral(-)temporal degradation over distance. Interestingly and unlike previous findings, the transmission of formants was better than that of the fundamental frequency. Our findings demonstrate the importance of formant frequencies for the efficiency of rumble propagation and the transmission of information content in a savanna elephant's natural habitat.

Barandongo, Z. R., et al. (2018). "DUST-BATHING BEHAVIORS OF AFRICAN HERBIVORES AND THE POTENTIAL RISK OF INHALATIONAL ANTHRAX." J Wildl Dis **54**(1): 34-44.

: Anthrax in herbivorous wildlife and livestock is generally assumed to be transmitted via ingestion or inhalation of Bacillus anthracis spores. Although recent studies have highlighted the importance of the ingestion route for anthrax transmission, little is known about the inhalational route in natural systems. Dust bathing could aerosolize soilborne pathogens such as B. anthracis, exposing dust-bathing individuals to inhalational infections. We investigated the potential role of dust bathing in the transmission of inhalational anthrax to herbivorous wildlife in Etosha National Park, Namibia, an area with endemic seasonal anthrax outbreaks. We 1) cultured soils from dust-bathing sites for the presence and concentration of B. anthracis spores, 2) monitored anthrax carcass sites, the locations with the highest B. anthracis concentrations, for evidence of dust bathing, including a site where a zebra died of anthrax on a large dust bath, and 3) characterized the ecology and seasonality of dust bathing in plains zebra (Equus quagga), blue wildebeest (Connochaetes taurinus), and African savanna elephant (Loxodonta africana) using a combination of motion-sensing camera traps and direct observations. Only two out of 83 dust-bath soils were positive for B. anthracis, both with low spore concentrations (</=20 colony-forming units per gram). We also detected no evidence of dust baths occurring at anthrax carcass sites, perhaps due to carcass-induced changes in soil composition that may deter dust bathing. Finally, despite observing some seasonal variation in dust bathing, preliminary evidence suggests that the seasonality of dust bathing and anthrax mortalities are not correlated. Thus, although dust bathing creates a dramatic cloud of aerosolized soil around an individual, our microbiologic, ecologic, and behavioral results in concert demonstrate that dust bathing is highly unlikely to transmit inhalational anthrax infections.

Bauer, K. L., et al. (2018). "Long-term, intermittent, low-level elephant endotheliotropic herpesvirus 1A viremia in a captive Asian elephant calf." J Vet Diagn Invest **30**(6): 917-919.

A 2-y-old male Asian elephant (Elephas maximus), with an elevated platelet count (1,100 x 10(9)/L [1,100 x 10(3)/mm(3)]), tested positive for elephant endotheliotropic herpesvirus 1A (EEHV-1A) on conventional PCR (cPCR) of EDTA whole blood. No clinical signs were ever reported and no treatment was administered, but low-level viremia persisted for 2.5 y based on results of cPCR and/or real-time PCR (rtPCR). Sequencing confirmed that the EEHV-1A detected was identical at the beginning through the end of the time period. No other elephants in the herd tested positive for EEHV-1 during this time period. Platelet counts remained elevated throughout the viremia and throughout the animal's life, and

direct correlation between the elevated platelet counts and EEHV-1A viremia could not be confirmed. We document long-term, intermittent, low-level viremia of EEHV-1A and provide additional information to consider when determining if treatment is warranted in a case of EEHV infection.

Biggs, D., et al. (2018). "Response-Ivory crisis." Science **360**(6386): 277-278.

Boonsri, K., et al. (2018). "ELEPHANT ENDOTHELIOTROPIC HERPESVIRUS ASSOCIATED WITH CLOSTRIDIUM PERFRINGENS INFECTION IN TWO ASIAN ELEPHANT (ELEPHAS MAXIMUS) CALVES." J Zoo Wildl Med **49**(1): 178-182.
>   Elephant endotheliotropic herpesvirus (EEHV) is an infection associated with fatal hemorrhagic disease in young Asian elephants (Elephas maximus). This brief communication describes the postmortem evaluation of two Asian elephant calves diagnosed with EEHV4 and EEHV1A in conjunction with Clostridium perfringens infection. Case 1 was a 7-mo-old, male captive-born Asian elephant that developed diarrhea and died 2 days after clinical presentation. Examination of the heart, lungs, liver, and spleen revealed predominantly basophilic intranuclear inclusion bodies in the endothelial cells of the blood vessels. Case 2 was a 3-mo-old, female wild-born Asian elephant that showed signs of lethargy, anorexia, and convulsions and died 6 hr after clinical presentation. No intranuclear inclusion bodies were observed. The heart, lung, liver, and spleen of both calves tested positive for EEHV by polymerase chain reaction. Phylogenetic analysis identified EEHV4 and EEHV1A in Case 1 and 2, respectively. Additionally, liver, spleen, and hemorrhagic intestinal tissue samples tested positive for C. perfringens alpha, beta, and epsilon toxins. This is the first reported case to describe coinfection of EEHV and C. perfringens in Asian elephant calves.

Boukens, B. J. D., et al. (2018). "The electrocardiogram of vertebrates: Evolutionary changes from ectothermy to endothermy." Prog Biophys Mol Biol.
>   The electrocardiogram (ECG) reveals that heart chamber activation and repolarization are much faster in mammals and birds compared to ectothermic vertebrates of similar size. Temperature, however, affects electrophysiology of the heart and most data from ectotherms are determined at body temperatures lower than those of mammals and birds. The present manuscript is a review of the effects of temperature on intervals in the ECG of ectothermic and endothermic vertebrates rather than a hypothesis-testing original research article. However, the conclusions are supported by the inclusion of original data (Iguana iguana, N=4; Python regius, N=5; Alligator mississippiensis, N=4). Most comparisons were of animals of approximately 1kg. Compared to mammals and birds, the reptiles at 35-37 degrees C had 4 fold lower heart rates, 2 fold slower atrial and ventricular conduction (longer P- and QRS-wave durations), and 4 fold longer PR intervals (atrioventricular delay) and QT intervals (total ventricular repolarization). We conclude that the faster chamber activation in endotherms cannot be explained by temperature alone. Based on histology, we show that endotherms have a more compact myocardial architecture. In mammals, disorganization of the compact wall by fibrosis associates with conduction slowing and we suggest the compact tissue architecture allows for faster chamber activation. The short cardiac cycle that characterizes mammals and birds, however, is predominantly accommodated by shortening of the atrioventricular delay and the QT interval, which is so long in a 1kg iguana that it compares to that of an elephant.

Bourgeois, S., et al. (2018). "Single-nucleotide polymorphism discovery and panel characterization in the African forest elephant." Ecol Evol **8**(4): 2207-2217.
>   The continuing decline in forest elephant (Loxodonta cyclotis) numbers due to poaching and habitat reduction is driving the search for new tools to inform management and conservation. For dense rainforest species, basic ecological data on populations and threats can be challenging and expensive to collect, impeding conservation action in the field. As such, genetic monitoring is being increasingly implemented to complement or replace more burdensome field techniques. Single-nucleotide

polymorphisms (SNPs) are particularly cost-effective and informative markers that can be used for a range of practical applications, including population census, assessment of human impact on social and genetic structure, and investigation of the illegal wildlife trade. SNP resources for elephants are scarce, but next-generation sequencing provides the opportunity for rapid, inexpensive generation of SNP markers in nonmodel species. Here, we sourced forest elephant DNA from 23 samples collected from 10 locations within Gabon, Central Africa, and applied double-digest restriction-site-associated DNA (ddRAD) sequencing to discover 31,851 tags containing SNPs that were reduced to a set of 1,365 high-quality candidate SNP markers. A subset of 115 candidate SNPs was then selected for assay design and validation using 56 additional samples. Genotyping resulted in a high conversion rate (93%) and a low per allele error rate (0.07%). This study provides the first panel of 107 validated SNP markers for forest elephants. This resource presents great potential for new genetic tools to produce reliable data and underpin a step-change in conservation policies for this elusive species.

Braczkowski, A., et al. (2018). "Reach and messages of the world's largest ivory burn." Conserv Biol.
    Recent increases in ivory poaching have depressed African elephant populations. Successful enforcement has led to ivory being stockpiled. Stockpile destruction is becoming increasingly popular, and most destruction has occurred in the last five years. Ivory destruction is intended to send a strong message against ivory consumption, both in promoting a taboo on ivory use and catalyzing policy change. However, there has been no effort to establish the distribution and extent of media reporting on ivory destruction events globally. We analyze media coverage across eleven important nation states of the largest ivory destruction event in history (Kenya, 30 April 2016). We used a well-accepted online media crawling tool and key language translations to search online and print newspapers. We found most online news on the ivory burn came from the US (81% of articles), while print news was dominated by Kenya (61% of articles). We subjected online articles from five key countries and territories to content analysis and found 86-97% of all online articles reported the burn as a positive conservation action, while between 4-50% discussed ivory burning as having a negative impact on elephant conservation. Most articles discussed law enforcement and trade bans as effective for elephant conservation. There was more relative search interest globally on the 2016 Kenyan ivory burn than any other in five years. Our study is the first attempt to track the spread of media around an ivory burn and is a case study in tracking the effects of a conservation-marketing event. This article is protected by copyright. All rights reserved.

Braczkowski, A., et al. (2018). "Reach and messages of the world's largest ivory burn." Conserv Biol **32**(4): 765-773.
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Brown, J. L. (2018). "Comparative ovarian function and reproductive monitoring of endangered mammals." Theriogenology **109**: 2-13.

> The ability to track gonadal function is facilitated by the use of endocrine and ultrasound techniques, both of which are important tools for optimizing reproduction and ensuring sustainability of fragile populations. With so many species now endangered, captive breeding is increasingly viewed as a means to sustain important insurance populations. As reproduction is key to species survival, understanding how to control and monitor ovarian function is vital. Through decades of study, we now have a greater understanding of the diversity, and plasticity, of reproductive mechanisms across taxa. Even within related species, there are marked differences in seasonal, environmental and social influences on ovarian cycle dynamics, ovulatory mechanisms, and responses to assisted reproductive/ovulation induction protocols. For most wildlife species, endocrine function is assessed noninvasively through analyses of hormones or their metabolites excreted in urine or feces. Perhaps it should not be surprising then, that major differences in metabolism and routes of excretion exist, not only between species, but also among hormone types within a species. This means that a species by species, and sometimes hormone by hormone, approach is essential for developing effective reproductive monitoring and control strategies. Over the past 30 years, our laboratory has developed and validated a number of reproductive assay techniques, which has led to our amassing a database of ovarian cycle dynamics on over 100 species. This paper presents an overview of ovarian physiology, and summarizes comparative ovarian function research on some of our most well-studied species: felids, elephants, rhinos, tapirs and the giant panda, and how that information has been used to aid ex situ management. Each of these species represents a range of reproductive strategies, from the highly seasonal, monestrus giant panda to the aseasonal, polyestrus elephant. Some species exhibit spontaneous ovulations, while others are induced ovulators or both, with variations in ovarian cycle lengths that range from a few days to several months. These differences reinforce the need for studies of species basic biology to optimize breeding strategies.

Camoin, M., et al. (2018). "Adaptation and evaluation of an ELISA for Trypanosoma evansi infection (surra) in elephants and its application to a serological survey in Thailand." Parasitology **145**(3): 371-377.

> Trypanosoma evansi, the causative agent of surra, is widespread in domestic livestock and wildlife in South East Asia. Surra can affect cattle, buffaloes, horses and also Asian elephants (Elephas maximus). Despite the 'threatened to extinction' CITES status of elephant, surra's impact has not been thoroughly assessed yet in this species. This work offers to adapt an antibody enzyme-linked immunosorbent assay (ELISA) protocol, to detect Trypanosoma evansi antibodies in elephant serum. The test was validated with 365 negative-reference samples, which allowed the determination of a 16% positive threshold. The test was applied to a serological survey including 375 individuals. The estimated global seroprevalence was 2·1% (95% CI 1·1-4·2%). Therefore, surra does not appear to be endemic in Thai domestic elephants, but occasional outbreaks were reported to our laboratory during the survey period. These outbreaks seemed to be linked to close proximity to cattle or buffaloes, and led to severe clinical signs in elephants. Frequent relapses were observed after treatment with diminazene aceturate, the only trypanocide drug currently available in Thailand. Therefore, care should be taken to keep elephants away from bovine reservoirs, and to monitor the disease in this endangered species. ELISA proved to be reliable for screening purposes as well as for post-treatment monitoring. Copyright © Cambridge University Press 2017.

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Canestro, C. and V. Roncalli (2018). "Gene losses did not stop the evolution of big brains." Elife **7**.
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Cardon, J. H., et al. (2018). "Interacting circadian and homeostatic processes with opportunity cost: A mathematical model of sleep with application to two mammalian species." PLoS ONE **13**(12): e0208043.
This paper introduces a new model of sleep for mammals. It extends the classic 'two-process' model of sleep to account for differences in external circumstances. We apply this model to previously-collected data on elephants and sloths, comparing sleep patterns in the wild with sleep patterns in captivity. We find that the model does very well in explaining sleeping patterns for both types of animals, in both the captive state and in the wild state.

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Carpenter, S. (2018). "A cross-national comparison of the efficacy of community-based and national governance approaches on the protection of the African elephant." J Environ Manage **231**: 336-344.
This study uses a longitudinal cross-national carcass database to analyze the relative effectiveness of community-based and national governance approaches at conserving elephant populations. Controlling for variables previously identified as impacting poaching levels, an increase in land area under either community or national governance is found to be correlated with an increased likelihood of illegal elephant deaths, with community-based governance being associated with an increase roughly twice that of national governance. This finding suggests that community-based governance may be less effective than national governance at protecting commercially valuable wildlife such as elephants, but neither approach has been able to demonstrate sustained success. Consequently, rather than declaring either conservation approach as clearly preferable, policymakers should instead focus on ensuring that selected conservation approaches are tailored to site-specific natural, institutional, and socio-economic characteristics.

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Chaichanathong, S., et al. (2018). "Immunohistochemical localization of inhibin/activin subunits in adult Asian elephant (Elephas maximus) testes." J Vet Med Sci.

> Immunolocalization of inhibin-alpha and inhibin/activin betaA and betaB subunits in the testes of Asian elephant was determined. Testicular sections were immunostained with polyclonal antisera against inhibin subunit-alpha and inhibin/activin betaA and betaB using the avidin-biotin-peroxidase complex method. Positive immunostaining against inhibin-alpha subunit was strongly present in Sertoli cells, and positive immunostaining for the inhibin/activin betaA and betaB subunits was observed in both Sertoli and Leydig cells. These results indicated that while Sertoli cells are the predominant source of inhibin and activin secretions in the testes of adult male Asian elephant, Leydig cells are a source of activin but not inhibin.

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> Immunolocalization of inhibin-alpha and inhibin/activin betaA and betaB subunits in the testes of Asian elephant was determined. Testicular sections were immunostained with polyclonal antisera against inhibin subunit-alpha and inhibin/activin betaA and betaB using the avidin-biotin-peroxidase complex method. Positive immunostaining against inhibin-alpha subunit was strongly present in Sertoli cells, and positive immunostaining for the inhibin/activin betaA and betaB subunits was observed in both Sertoli and Leydig cells. These results indicated that while Sertoli cells are the predominant source of inhibin and activin secretions in the testes of adult male Asian elephant, Leydig cells are a source of activin but not inhibin.

Chusyd, D. E., et al. (2018). "Adiposity and Reproductive Cycling Status in Zoo African Elephants." Obesity (Silver Spring) **26**(1): 103-110.

> OBJECTIVE: The majority of zoo African elephants exhibit abnormal reproductive cycles, but it is unclear why. Acyclicity has been positively associated with body condition scores. The objective of this study was to measure body composition and examine the relationship between adiposity and cyclicity status, mediated by glucose, insulin, leptin, and inflammation. METHODS: Body composition was assessed by deuterium dilution in 22 African elephants. Each elephant was weighed and given deuterated water orally (0.05 mL/kg), and blood was collected from the ear prior to and five times after deuterium administration. Glucose, insulin, leptin, and proinflammatory biomarker concentrations in serum were determined. RESULTS: Body fat percentage ranged from 5.24% to 15.97%. Fat adjusted for fat free mass (FFM) and age was not significantly associated with cyclicity status (P = 0.332). Age was the strongest predictor of cyclicity status (P = 0.040). Fat was correlated with weight (rho = 0.455, P = 0.044) and when adjusted for FFM with circulating glucose (rho = 0.520, P = 0.022) and showed a

trend for association with leptin (unadjusted: rho = 0.384, P = 0.095; adjusted for FFM: rho = 0.403, P = 0.087). CONCLUSIONS: Deuterium dilution appears to be an available technique to measure body composition in African elephants. In this sample, fat was not associated with cyclicity status, and age may be more important to cyclicity status.

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Cook, R. M., et al. (2018). "African honeybees as a mitigation method for elephant impact on trees." Biological Conservation **217**: 329-336.

Courchamp, F., et al. (2018). "The paradoxical extinction of the most charismatic animals." PLoS Biol **16**(4): e2003997.

A widespread opinion is that conservation efforts disproportionately benefit charismatic species. However, this doesn't mean that they are not threatened, and which species are "charismatic" remains unclear. Here, we identify the 10 most charismatic animals and show that they are at high risk of imminent extinction in the wild. We also find that the public ignores these animals' predicament and we suggest it could be due to the observed biased perception of their abundance, based more on their profusion in our culture than on their natural populations. We hypothesize that this biased perception impairs conservation efforts because people are unaware that the animals they cherish face imminent extinction and do not perceive their urgent need for conservation. By freely using the image of rare and threatened species in their product marketing, many companies may participate in creating this biased perception, with unintended detrimental effects on conservation efforts, which should be compensated by channeling part of the associated profits to conservation. According to our hypothesis, this biased perception would be likely to last as long as the massive cultural and commercial presence of charismatic species is not accompanied by adequate information campaigns about the imminent threats they face.

Du, K., et al. (2018). "Ancient duplications and functional divergence in the interferon regulatory factors of vertebrates provide insights into the evolution of vertebrate immune systems." Dev Comp Immunol **81**: 324-333.

Interferon regulatory factors (IRFs) were first discovered as transcription factors that regulate the transcription of human interferon (IFN)-beta. Increasing evidence shows that they might be important players involved in Adaptive immune system (AIS) evolution. Although numbers of IRFs have been identified in chordates, the evolutionary history and functional diversity of this gene family during the

early evolution of vertebrates have remained obscure. Using IRF HMM profile and HMMER searches, we identified 148 IRFs in 11 vertebrates and 4 protochordates. For them, we reconstructed the phylogenetic relationships, determined the synteny conservation, investigated the profile of natural selection, and analyzed the expression patterns in four "living fossil" vertebrates: lamprey, elephant shark, coelacanth and bichir. The results from phylogeny and synteny analysis imply that vertebrate IRFs evolved from three predecessors, instead of four as suggested in a previous study, as results from an ancient duplication followed by special expansions and lost during the vertebrate evolution. The profile of natural selection and expression reveals functional dynamics during the process. Together, they suggest that the 2nd whole-genome duplication (2WGD) provided raw materials for innovation in the IRF family, and that the birth of type-I IFN might be an important factor inducing the establishment of IRF-mediated immune networks. As a member involved in the AIS evolution, IRF provide insights into the process and mechanism involved in the complexity and novelties of vertebrate immune systems.

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Esakkimuthu, S., et al. (2018). "A study on food-medicine continuum among the non-institutionally trained siddha practitioners of Tiruvallur district, Tamil Nadu, India." J Ethnobiol Ethnomed **14**(1): 45.
BACKGROUND: Medicinal properties of the food species are one of the poorly documented and important areas of ethnopharmacology. The present survey quantitatively documented the medicinal foods prescribed by the non-institutionally trained siddha practitioners of Tiruvallur district of Tamil Nadu. METHODS: Field work was carried out between December 2014 and April 2017 using a questionnaire. The illnesses mentioned by the informants were grouped as illness categories on the basis of emic perceptions. Sufficiency of sampling of this survey was assessed by plotting the cumulative number of UR and Shannon-Wiener's index. The indices such as informant consensus factor (FIC), Index of Agreement on Remedies (IAR), and Cultural Food Significance Index (CFSI) were calculated. RESULTS: This study documented 165 medicinal foods used by 82 non-institutionally trained siddha practitioners of Tiruvallur district, and 73.93% of these preparations were plant based. Among the animal taxa, 82.05% were represented by fish taxa. The illness category gastrointestinal ailments is the majorly cited illness category treated with plant-based formulations. The illness categories viz., gastrointestinal ailments, hemorrhoids, and neural ailments had high consensus under the group of plant-based medicinal foods. In animal-based medicinal foods, kapha ailments had gained 23.07% of UR. The illness categories such as bone fractures, male reproductive ailments, blood ailments, and anabolic had high FIC values. CONCLUSIONS: Deeper studies on different dietary cultures of India may help to derive better interpretations on food-medicine continuum. This study identified some important claims such as the use of citron, pomegranate and Solanum americanum (gastrointestinal ailments), Abutilon indicum, onions and elephant foot yam (hemorrhoids), Boerhavia diffusa (urinary ailments), Moringa oleifera (anemia), Aloe vera (gynecological ailments), Eclipta prostrata (liver ailments), ivy gourd (diabetes), citron (hypertension), Centella asiatica (psychological ailments), spade nose shark (lactogogue), reticulate whipray (wheezing and bronchitis), Katelysia opima (impotence), Indian squid (anemia), and Indian oil sardine (anabolic). More studies on these claims will help identify novel functional foods to add to the field of medical nutrition therapy, with traditional brand identity. Robust studies on the documentation of the traditional knowledge on marine resources will yield a good database for various stakeholders and policy makers.

Evans, L. J., et al. (2018). "Protected area management priorities crucial for the future of Bornean elephants." Biological Conservation **221**: 365-373.
Tropical protected area management strategies have traditionally been heavily skewed towards high carbon, primary forests. This focus can result in areas, such as heavily logged forests, being viewed as low quality and thus offered up for conversion. We assessed the importance of intact to heavily logged forests for the Bornean elephant in the Malaysian state of Sabah. By modelling distributions of elephants throughout Sabah based on GPS telemetry tracking of 29 individuals and airborne three-dimensional forest mapping, we present the most wide-scale analysis of forest use by Bomean elephants to date. Forests of 13 m in stature were found to be of highest suitability for elephants, especially when these areas were flat and low lying. Forest statures of this order are consistent with degraded landscapes, often viewed as suitable for oil palm conversion. Less than a quarter of fully-protected intact forests in Sabah were of suitable stature for elephants, whereas disturbed commercial forest reserves were found to be highly suitable. We suggest that the importance of degraded landscapes for the future of elephants is currently underestimated, and thus, the need for the preservation of such habitats is not seen as a priority. The loss of these landscapes to large-scale

agriculture could prove detrimental to the longevity of the species in Borneo.

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Ferris, E., et al. (2018). "Accelerated Evolution in Distinctive Species Reveals Candidate Elements for Clinically Relevant Traits, Including Mutation and Cancer Resistance." Cell Rep **22**(10): 2742-2755.

> The identity of most functional elements in the mammalian genome and the phenotypes they impact are unclear. Here, we perform a genome-wide comparative analysis of patterns of accelerated evolution in species with highly distinctive traits to discover candidate functional elements for clinically important phenotypes. We identify accelerated regions (ARs) in the elephant, hibernating bat, orca, dolphin, naked mole rat, and thirteen-lined ground squirrel lineages in mammalian conserved regions, uncovering approximately 33,000 elements that bind hundreds of different regulatory proteins in humans and mice. ARs in the elephant, the largest land mammal, are uniquely enriched near elephant DNA damage response genes. The genomic hotspot for elephant ARs is the E3 ligase subunit of the Fanconi anemia complex, a master regulator of DNA repair. Additionally, ARs in the six species are associated with specific human clinical phenotypes that have apparent concordance with overt traits in each species.

French, F., et al. (2018). "High tech cognitive and acoustic enrichment for captive elephants." J Neurosci Methods **300**: 173-183.

> This paper investigates the potential for using technology to support the development of sensory and cognitive enrichment activities for captive elephants. It explores the usefulness of applying conceptual frameworks from interaction design and game design to the problem of developing species-specific smart toys that promote natural behaviours and provide stimulation. We adopted a Research through Design approach, and describe how scientific inquiry supported our design process, while the creation of artefacts guided our investigations into possible future solutions. Our fieldwork resulted in the development of an interactive prototype of an acoustic toy that elephants are able to control using interface elements constructed from a range of natural materials.

Fuery, A., et al. (2018). "Asian Elephant T Cell Responses to Elephant Endotheliotropic Herpesvirus." J Virol **92**(6).

> Elephant endotheliotropic herpesvirus (EEHV) can cause lethal hemorrhagic disease in juvenile Asian elephants, an endangered species. One hypothesis to explain this vulnerability of some juvenile elephants is that they fail to mount an effective T cell response to the virus. To our knowledge, there have been no studies of Asian elephant T cell responses to EEHV. To address this deficiency, we

validated the gamma interferon (IFN-gamma) enzyme-linked immunospot assay for tracking antigen-directed T cell activity by monitoring rabies-specific responses in vaccinated elephants. In addition, we generated monoclonal antibodies to Asian elephant CD4 and CD8 to facilitate phenotypic T cell profiling. Using these tools, we screened healthy elephants with a history of EEHV infection for reactivity against nine EEHV proteins whose counterparts in other herpesviruses are known to induce T cell responses in their natural hosts. We identified glycoprotein B (gB) and the putative regulatory protein E40 as the most immunogenic T cell targets (IFN-gamma responses in five of seven elephants), followed by the major capsid protein (IFN-gamma responses in three of seven elephants). We also observed that IFN-gamma responses were largely from CD4(+) T cells. We detected no activity against the predicted major immediate early (E44) and large tegument (E34) proteins, both immunodominant T cell targets in humans latently infected with cytomegalovirus. These studies identified EEHV-specific T cells in Asian elephants for the first time, lending insight into the T cell priming that might be required to protect against EEHV disease, and will guide the design of effective vaccine strategies.IMPORTANCE Endangered Asian elephants are facing many threats, including lethal hemorrhagic disease from elephant endotheliotropic herpesvirus (EEHV). EEHV usually establishes chronic, benign infections in mature Asian elephants but can be lethal to juvenile elephants in captivity and the wild. It is the leading cause of death in captive Asian elephants in North America and Europe. Despite the availability of sensitive tests and protocols for treating EEHV-associated illness, these measures are not always effective. The best line of defense would be a preventative vaccine. We interrogated normal healthy elephants previously infected with EEHV for T cell responses to nine EEHV proteins predicted to induce cellular immune responses. Three proteins elicited IFN-gamma responses, suggesting their potential usefulness as vaccine candidates. Our work is the first to describe T cell responses to a member of the proposed fourth subfamily of mammalian herpesviruses, the Deltaherpesvirinae, within a host species in the clade Afrotheria. An EEHV vaccine would greatly contribute to the health care of Asian and African elephants that are also susceptible to this disease.

Gagneux, S. (2018). "Ecology and evolution of Mycobacterium tuberculosis." Nat Rev Microbiol **16**(4): 202-213.

Tuberculosis (TB) is the number one cause of human death due to an infectious disease. The causative agents of TB are a group of closely related bacteria known as the Mycobacterium tuberculosis complex (MTBC). As the MTBC exhibits a clonal population structure with low DNA sequence diversity, methods (such as multilocus sequence typing) that are applied to more genetically diverse bacteria are uninformative, and much of the ecology and evolution of the MTBC has therefore remained unknown. Owing to recent advances in whole-genome sequencing and analyses of large collections of MTBC clinical isolates from around the world, many new insights have been gained, including a better understanding of the origin of the MTBC as an obligate pathogen and its molecular evolution and population genetic characteristics both within and between hosts, as well as many aspects related to antibiotic resistance. The purpose of this Review is to summarize these recent discoveries and discuss their relevance for developing better tools and strategies to control TB.

Gaynor, K. M., et al. (2018). "The influence of human disturbance on wildlife nocturnality." Science **360**(6394): 1232-1235.

Rapid expansion of human activity has driven well-documented shifts in the spatial distribution of wildlife, but the cumulative effect of human disturbance on the temporal dynamics of animals has not been quantified. We examined anthropogenic effects on mammal diel activity patterns, conducting a meta-analysis of 76 studies of 62 species from six continents. Our global study revealed a strong effect of humans on daily patterns of wildlife activity. Animals increased their nocturnality by an average factor of 1.36 in response to human disturbance. This finding was consistent across continents, habitats, taxa, and human activities. As the global human footprint expands, temporal avoidance of humans may facilitate human-wildlife coexistence. However, such responses can result in marked shifts away from

natural patterns of activity, with consequences for fitness, population persistence, community interactions, and evolution. 2017 © The Authors

Gaynor, K. M., et al. (2018). "The influence of human disturbance on wildlife nocturnality." <u>Science (Washington)</u> **360**(6394): 1235-1239.

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Goldenberg, S. Z., et al. (2018). "Inter-generational change in African elephant range use is associated with poaching risk, primary productivity and adult mortality." <u>Proc Biol Sci</u> **285**(1879).

Repeated use of the same areas may benefit animals as they exploit familiar sites, leading to consistent home ranges over time that can span generations. Changing risk landscapes may reduce benefits associated with home range fidelity, however, and philopatric animals may alter movement in response to new pressures. Despite the importance of range changes to ecological and evolutionary processes, little tracking data have been collected over the long-term nor has range change been recorded in response to human pressures across generations. Here, we investigate the relationships between ecological, demographic and human variables and elephant ranging behaviour across generations using 16 years of tracking data from nine distinct female social groups in a population of elephants in northern Kenya that was heavily affected by ivory poaching during the latter half of the study. Nearly all groups-including those that did not experience loss of mature adults-exhibited a shift north over time, apparently in response to increased poaching in the southern extent of the study area. However, loss of mature adults appeared to be the primary indicator of range shifts and expansions, as generational turnover was a significant predictor of range size increases and range centroid shifts. Range expansions and northward shifts were associated with higher primary productivity and lower poached carcass densities, while westward shifts exhibited a trend to areas with higher values of primary productivity and higher poached carcass densities relative to former ranges. Together these results suggest a trade-off between resource access, mobility and safety. We discuss the relevance of these results to elephant conservation efforts and directions meriting further exploration in this disrupted society of a keystone species.

Harvey, N. D., et al. (2018). "Social Interactions in Two Groups of Zoo-Housed Adult Female Asian Elephants (Elephas maximus) that Differ in Relatedness." <u>Animals (Basel)</u> **8**(8).

Opportunities for positive social interaction are important in captive animals, and social interactions can be used as a welfare indicator. Wild elephants live in related multigenerational herds; however, in captivity they are often managed in less related groups, which could impact the quality of their social interactions, and thus their welfare. Here, we used a limited social network analysis to investigate the social interactions in two groups of four female captive Asian elephants, one of which contained individuals that were all related to one another, whilst the other was a mix of related and unrelated individuals. Data on pairwise social interactions was collected from eight days of video footage using an all-occurrence sampling technique. More affiliative, and fewer agonistic interactions were observed in the related elephant group. Additionally, non-contact displacement was observed at a higher frequency in the related elephant group, which we theorise represents an established functioning hierarchy,

avoiding the need for overt aggression over resources. Although kinship is not likely to be the only factor affecting captive elephant social behaviour, these findings support the recommendation that for optimal welfare, elephants should be managed in multigenerational family herds. Evaluations of social interactions such as those conducted here would have wider applicability for aiding the management of any captive social species to identify when groups might be incompatible.

Hermes, R., et al. (2018). "Bronchoalveolar lavage for diagnosis of tuberculosis infection in elephants." Epidemiol Infect **146**(4): 481-488.

Tuberculosis (TB) has been known to affect elephants for thousands of years. It was put into spotlight when few circus elephants were diagnosed carrying Mycobacterium (M.) tuberculosis. Because of the zoonotic risk and high susceptibility to M. tuberculosis, periodic testing was enacted since, in captive breeding programmes. Presently, trunk wash is the recommended diagnostic procedure for TB. Trunk wash, however, puts the operator at risk, has low sensitivity, and is prone to contamination. Here, bronchoalveolar lavage is described for the first time for TB diagnosis in elephants. Bronchial, trunk and mouth fluids were investigated using bacterial culture, M. tuberculosis complex (MTC)-specific real-time quantitative PCR (qPCR) and mycobacterial genus-specific qPCR for overall presence of mycobacteria or mycobacterial DNA including bacteria or DNA of closely related genera, respectively, in 14 elephants. Neither bacteria of the MTC nor their DNA were identified in any of the elephants. Yet, 25% of the cultures grew non-tuberculous mycobacteria (NTM) or closely related bacterial species. Furthermore, 85% of the samples contained DNA of NTM or closely related bacterial genera. This finding might explain continued false-positive results from various serological tests. From a zoonotic point of view, bronchoalveolar lavage is safer for the testing personal, has higher probability of capturing MTC and, through PCR, identifies DNA NTM in elephants. Yet, necessary endoscopic equipment, animal sedation and access to a TB reference laboratory might pose challenging requirements in remote conditions in some elephant range countries.

Hu, L., et al. (2018). "Longitudinal and transverse variation of trace element concentrations in elephant and giraffe hair: implication for endogenous and exogenous contributions." Environ Monit Assess **190**(11): 644.

The spatial distribution of trace elements in hair is highly heterogeneous at the microscale. The relatively mild spatial variation of endogenous signal incorporated during hair growth may be amplified by orders of magnitude due to later exogenous contaminations. Here, we studied the longitudinal and transverse distributions of trace elements in elephant and giraffe hair and discussed the possible endogenous and exogenous contributions. Laser ablation ICP-MS analyses were performed on cross sections of hair to assess the surface contamination and transverse variation. We also removed the contaminated surface layer at various distances from hair root of single hair strands using physical abrasion and measured the concentrations by microwave digestion followed by ICP-MS. By comparing the concentrations of 11 trace elements between the intact and abraded hair segments as a function of distance from root and their laser ablation profiles, we rationalized the endogenous and exogenous contributions: Al and Ti concentrations are dominated by the exogenous contamination on the elephant hair surface, probably in the form of insoluble particles, but not in the giraffe hair; Mg, Ca, Sr, Ba, and Mn are enhanced on the elephant hair surface by exogenous contaminations, but a comparable amount was found in the hair interior suggesting migration of these elements from the surface towards the core; Cu, Zn, Se, and Pb did not have surface accumulation and thus were dominated by the endogenous signal. Overall, giraffe hair had minimal surficial contamination, suggesting the origin of its trace elements is predominantly endogenous, except for Mn, which might get contaminated with airborne particles. We thus demonstrate that contamination of hair may be strongly related to behavioral traits and that the interpretation of trace elemental analyses in hair as a biomonitor or for provenance studies would be highly dependent on the species considered.

Hufenus, R., et al. (2018). "Seasonality of reproduction in Asian elephants Elephas maximus and African

elephants Loxodonta africana: underlying photoperiodic cueing?" <u>Mammal Review</u> **48**(4): 261-276.

> Animals in seasonal environments often rely on photoperiodicity to time their reproduction. Elephants have a gestation length of approximately two years and a historical geographic distribution including higher latitudes than at present, so the evolution of a seasonal breeding pattern cued by photoperiodicity and timed to the long-day period is a theoretical option in both species. We reviewed literature on reproductive patterns in free-ranging, semi-captive and captive Asian and African elephants, photoperiodic cueing, seasonal variation in body condition, and other factors influencing their reproduction, as well as data from zoological collections on the timing of births. Most of the free-ranging and all the semi-captive and captive elephant populations showed a moderate yet distinct seasonal breeding pattern. Peak breeding activity of free-ranging Asian elephants took place in either the dry or the wet season, with no preference for short-day or long-day breeding at low latitudes (close to the equator) but a preference for long-day breeding at higher latitudes. Semi-captive Asian elephants mainly bred in the dry season when body condition was lowest and day-lengths were increasing. Peak conception often occurred in the wet season in free-ranging African elephants when body condition was highest, with no evident preference for short-day or long-day breeding at low latitudes but preference for long-day breeding at higher latitudes. Asian and African elephants in zoos at latitudes from 43 to 53°N tended to conceive more often during spring and summer, i.e. when day-lengths were increasing. Body condition was not reported to vary significantly throughout the year and was rather high compared to in the wild. We hypothesise that elephants are 'long-day breeders' in which the photoperiodic timing of conception can be influenced by many additional factors. Strategies to encourage natural conception in captive populations should include measures aimed at increasing breeding incentives in the northern hemisphere spring. © 2018 The Mammal Society and John Wiley & Sons Ltd

Hunninck, L., et al. (2018). "Erratum: Being stressed outside the park-conservation of African elephants (Loxodonta africana) in Namibia." <u>Conserv Physiol</u> **6**(1): cox080.

> [This corrects the article DOI: 10.1093/conphys/cox067.][This corrects the article DOI: 10.1093/conphys/cox067.].

Ihwagi, F. W., et al. (2018). "Night-day speed ratio of elephants as indicator of poaching levels." <u>Ecological Indicators</u> **84**: 38-44.

Ishida, Y., et al. (2018). "Evolutionary and demographic processes shaping geographic patterns of genetic diversity in a keystone species, the African forest elephant (Loxodonta cyclotis)." <u>Ecol Evol</u> **8**(10): 4919-4931.

> The past processes that have shaped geographic patterns of genetic diversity may be difficult to infer from current patterns. However, in species with sex differences in dispersal, differing phylogeographic patterns between mitochondrial (mt) and nuclear (nu) DNA may provide contrasting insights into past events. Forest elephants (Loxodonta cyclotis) were impacted by climate and habitat change during the Pleistocene, which likely shaped phylogeographic patterns in mitochondrial (mt) DNA that have persisted due to limited female dispersal. By contrast, the nuclear (nu) DNA phylogeography of forest elephants in Central Africa has not been determined. We therefore examined the population structure of Central African forest elephants by genotyping 94 individuals from six localities at 21 microsatellite loci. Between forest elephants in western and eastern Congolian forests, there was only modest genetic differentiation, a pattern highly discordant with that of mtDNA. Nuclear genetic patterns are consistent with isolation by distance. Alternatively, male-mediated gene flow may have reduced the previous regional differentiation in Central Africa suggested by mtDNA patterns, which likely reflect forest fragmentation during the Pleistocene. In species like elephants, male-mediated gene flow erases the nuclear genetic signatures of past climate and habitat changes, but these continue to persist as patterns in mtDNA because females do not disperse. Conservation implications of these results are discussed.

Jebb, D. and M. Hiller (2018). "Recurrent loss of HMGCS2 shows that ketogenesis is not essential for the evolution of large mammalian brains." Elife **7**.

> Apart from glucose, fatty acid-derived ketone bodies provide metabolic energy for the brain during fasting and neonatal development. We investigated the evolution of HMGCS2, the key enzyme required for ketone body biosynthesis (ketogenesis). Unexpectedly, we found that three mammalian lineages, comprising cetaceans (dolphins and whales), elephants and mastodons, and Old World fruit bats have lost this gene. Remarkably, many of these species have exceptionally large brains and signs of intelligent behavior. While fruit bats are sensitive to starvation, cetaceans and elephants can still withstand periods of fasting. This suggests that alternative strategies to fuel large brains during fasting evolved repeatedly and reveals flexibility in mammalian energy metabolism. Furthermore, we show that HMGCS2 loss preceded brain size expansion in toothed whales and elephants. Thus, while ketogenesis was likely important for brain size expansion in modern humans, ketogenesis is not a universal precondition for the evolution of large mammalian brains.

Jin, Y. and H. Fan (2018). "Land use/land cover change and its impacts on protected areas in Mengla County, Xishuangbanna, Southwest China." Environ Monit Assess **190**(9): 509.

> Land use/land cover change (LUCC) in tropical areas threatens biodiversity and protected area integrity and then affects global ecosystem functions and services. In this study, the spatiotemporal patterns and processes of LUCC in Mengla County, Xishuangbanna, which is located on the northern edge of tropical Asia, were examined using a modified post-classification change detection technique based on random forest classifiers and Landsat images acquired at a 5-year time interval (e.g., 1994, 1999, 2004, 2009, and 2014) from 1994 to 2014, with a special focus on protected areas and their surroundings. The overall accuracies of land use/land cover classification reached 90.13-97.90%, with kappa coefficients of 0.84-0.96. Massive but decelerating conversion from forests to artificial plantations has occurred in recent decades. From 1994 to 2014, the area of plantations increased by 1833.85 km(2), whereas that of forests decreased by 1942.67 km(2). The expanded areas of artificial plantations decreased from 158.41 km(2) per year in 1994-1999 to 59.70 km(2) per year in 2009-2014. More considerable transformation from forests to artificial plantations occurred in lowland areas with elevations below 1000 m and at the edges of National Nature Reserves, which observed a forest loss rate of greater than 40% between 1994 and 2014. This poses serious challenges for sustaining both protected areas and surrounding human communities and to solve the increasingly escalating human-elephant conflicts. The complex food, biodiversity, and land use nexus in this region remain to be untangled in future study.

Johnson, G., et al. (2018). "USE OF GLUE-ON SHOES TO IMPROVE CONFORMATIONAL ABNORMALITIES IN TWO ASIAN ELEPHANTS (ELEPHAS MAXIMUS)." J Zoo Wildl Med **49**(1): 183-188.

This report describes the use of custom-made, glue-on shoes for the front feet of two female adult Asian elephants (Elephas maximus) with conformational abnormalities. Both elephants had unequal leg lengths. The first elephant also had bilateral fetlock varus causing recurrent nail infections of the fourth digits of the front feet. The second elephant displayed weight shifting. Over several years, multiple shoe prototypes were tested. The current version is made of two types of shoe rubber, glued together and attached to the pad of the shorter leg with a liquid adhesive. The first elephant also has bilateral wedge pads to offload pressure from the fourth nails. The shoes are removed each month for foot care, then replaced. Within several months of wearing shoes, the first elephant's nail infections healed and the second elephant stopped weight shifting. Both elephants' gaits became smoother. This is the first description of corrective shoeing in elephants.

Jones, T., et al. (2018). "Age structure as an indicator of poaching pressure: Insights from rapid assessments of elephant populations across space and time." Ecological Indicators **88**: 115-125.
Detecting and monitoring illegal harvesting pressure on wild populations is challenging due to the cryptic nature of poaching activities. Although change in population age structure has been suggested as an indicator of harvesting pressure, few studies have tested its validity when based on short-term field surveys. Using data from rapid demographic assessment surveys carried out in 2009 at six sites in Tanzania, we examined whether African elephant populations experiencing contrasting levels of poaching pressure showed significant differences in their age structure, operational sex ratio (i.e. adult males to adult females), dependent individual to adult female ratio at the group level, and proportion of tuskless individuals. We also compared similar metrics between the population sampled in Ruaha National Park in 2009 and again in 2015 following a suspected increase in poaching. Elephant populations experiencing medium and high levels of poaching in 2009 were characterised by fewer calves and old individuals, a reduced number of adult males relative to adult females, and a lower ratio of calves to adult females within groups. We also found a higher proportion of tuskless individuals in poached populations (>6%). Changes in age structure in the Ruaha population between 2009 and 15 were similar to those observed across sites in 2009. Our findings are consistent with previous work documenting how the loss of older individuals – targeted for their larger tusks – decreases recruitment and survival of elephant calves. Illegal killing for ivory is a huge threat to the survival of African elephants. In this context, the present study contributes towards validating the use of age structure as an indicator of poaching pressure in elephant populations, but also in other wildlife populations where illegal offtake is targeted at specific age classes. © 2018 Elsevier Ltd

Kamminga, J., et al. (2018). "Poaching Detection Technologies-A Survey." Sensors (Basel) **18**(5).
Between 1960 and 1990, 95% of the black rhino population in the world was killed. In South Africa, a rhino was killed every 8 h for its horn throughout 2016. Wild animals, rhinos and elephants, in particular, are facing an ever increasing poaching crisis. In this paper, we review poaching detection technologies that aim to save endangered species from extinction. We present requirements for effective poacher detection and identify research challenges through the survey. We describe poaching detection technologies in four domains: perimeter based, ground based, aerial based, and animal tagging based technologies. Moreover, we discuss the different types of sensor technologies that are used in intruder detection systems such as: radar, magnetic, acoustic, optic, infrared and thermal, radio frequency, motion, seismic, chemical, and animal sentinels. The ultimate long-term solution for the poaching crisis is to remove the drivers of demand by educating people in demanding countries and raising awareness of the poaching crisis. Until prevention of poaching takes effect, there will be a continuous urgent need for new (combined) approaches that take up the research challenges and provide better protection against poaching in wildlife areas.

Katlam, G., et al. (2018). "Trash on the menu: patterns of animal visitation and foraging behaviour at garbage dumps." Current Science **115**(12): 2322-2326.

Garbage accumulation around terrestrial nature reserves poses a risk to many species. We monitored animal visitation patterns and foraging behaviour at garbage dumps near a forested area in Uttarakhand Himalaya, India, to examine plastic consumption by animals. We recorded 32 species of birds and mammals visiting garbage dumps and classified them as 'peckers', 'handlers' and 'gulpers' based on their foraging behaviour. Gulpers (carnivores and ruminants) were observed feeding more frequently and spent longer durations (3.8 +/- 0.2 min) at garbage dumps. Our results highlight the importance of at-source segregation of waste to prevent wild and domestic animals from ingesting hazardous wastes, including plastics at garbage dumps.

Kido, N., et al. (2018). "Novel treatment for chronic pododermatitis in an Indian elephant (Elephas maximus indicus) with Mohs' paste." J Vet Med Sci **80**(12): 1834-1838.
Asian and African elephants are frequently afflicted by foot disorders that can be very challenging to manage even with aggressive therapy. Such conditions may have indirect life-threatening effects. Mohs' paste (zinc chloride based escharotic agent) was used to treat a female Indian elephant (Elephas maximus indicus) aged 39 years with foot disorder at Kanazawa Zoological Gardens. Degenerated hyperplastic tissue was observed inside the hoofs of digits 2 and 5. Mohs' paste was applied on the lesions, which coagulated the hyperplastic tissue and restrained its proliferation. Subsequently, the hyperplastic tissue could be trimmed with little pain, and the disorder became manageable. Mohs' paste treatment was effective and is expected to be an alternative treatment for hoof disorder.

King, L., et al. (2018). "Wild Sri Lankan elephants retreat from the sound of disturbed Asian honey bees." Curr Biol **28**(2): R64-r65.
Asian elephants (Elephas maximus) are threatened primarily by habitat loss and human-elephant conflict. In addition to establishing protected areas and corridors for wildlife, empowering farmers to protect their crops is crucial for Asian elephant conservation [1,2]. Elephants can habituate to artificial deterrents, hence natural biological alternatives are of great interest [2,3]. African elephants (Loxodonta africana) avoid African honey bees (Apis mellifera scutellata), inspiring 'beehive fences' as a successful means of small-scale crop protection [4,5]. Here, we used a recording of a disturbed hive of cavity-dwelling Asian honey bees (Apis cerana indica) and conducted sound playbacks to 120 wild elephants in 28 different groups resting under trees in Uda Walawe National Park in Sri Lanka. Elephants responded by moving significantly further away from their resting site in bee playback trials compared to controls. Elephants also increased vocalization rates, as well as investigative and reassurance behaviours in response to bee sounds, but did not display dusting or headshaking behaviour.

Kobayashi, Y., et al. (2018). "An endogenous adeno-associated virus element in elephants." Virus Res.
An endogenous viral element derived from adeno-associated virus containing a nearly intact open reading frame (ORF) of the rep gene (enAAV-rep) has been identified in the genomes of various mammals including degu and African elephant. Particularly, in degu, mRNA expression of enAAV-rep has been observed specifically in the liver. Here we newly identified enAAV-rep in Asian elephant and rock hyrax, both of which are afrotherians. The enAAV-rep of African and Asian elephants appeared to be orthologous and originated from an integration event of the entire genome of AAV into the ancestral genome of elephants more than 6 million years ago, whereas that of rock hyrax appeared to have originated independently. Negative selection operating at the amino acid sequence level was detected for the ORF of enAAV-rep in elephants. As in degu, mRNA expression of enAAV-rep was specifically observed in the liver in Asian elephant. Integrations of enAAV-rep appeared to have occurred independently on the evolutionary lineages of elephants and degu, suggesting that the AAV Rep protein has been co-opted repeatedly in the mammalian liver.

Kochagul, V., et al. (2018). "Production of antibody against elephant endotheliotropic herpesvirus (EEHV)

unveils tissue tropisms and routes of viral transmission in EEHV-infected Asian elephants." <u>Sci Rep</u> **8**(1): 4675.

> Elephant endotheliotropic herpesvirus (EEHV) is one of the most devastating viral infectious diseases in elephants worldwide. To date, it remains unclear how elephants get infected by the virus, where the virus persists, and what mechanisms drive the pathogenesis of the disease. The present study was aimed to develop an antibody against glycoprotein B (gB) of EEHV, investigate the EEHV tissue tropisms, and provide the possible routes of EEHV transmission in Asian elephants. Samples from elephant organs that had died from EEHV1A and EEHV4 infections, peripheral blood mononuclear cells (PBMC) from EEHV4- and non-EEHV-infected calves were used in this study. The results of western immunoblotting indicated that the antibody can be used for detection of gB antigens in both EEHV1A- and EEHV4-infected samples. Immunohistochemical detection indicated that the EEHV gB antigens were distributed mainly in the epithelial cells of the salivary glands, stomach and intestines. Immunofluorescence test of PBMC for EEHV gB in the EEHV4-infected calf indicated that the virus was observed predominantly in the mononuclear phagocytic cells. The findings in the present study unveil tissue tropisms in the EEHV1A- and EEHV4-infected calves and point out that saliva and intestinal content are likely sources for virus transmission in EEHV-infected Asian elephants.

Kochakul, V., et al. (2018). "Development of in situ hybridization for detection of elephant endotheliotropic herpesvirus in Asian elephants." <u>Journal of Veterinary Diagnostic Investigation</u> **30**(4): 628-632.

Lahdenpera, M., et al. (2018). "Publisher Correction: Differences in age-specific mortality between wild-caught and captive-born Asian elephants." <u>Nat Commun</u> **9**(1): 3544.

> The original version of this Article incorrectly cited as Ref. 45 the paper 'Lynch, E. C., Lahdenpera, M., Mar, K. U. & Lummaa, V. The evolutionary significance of maternal kinship in a long-lived mammal. Philos. Trans. R. Soc. Lond. B (2018, in press)' in the eighth sentence of the last paragraph of the Introduction, and the last sentence of the first paragraph of the 'Study population' section of the Methods. As this paper does not exist, this reference has been removed and all following citations have been renumbered as appropriate. This has been corrected in both the PDF and HTML versions of the Article.

Lahdenpera, M., et al. (2018). "Differences in age-specific mortality between wild-caught and captive-born Asian elephants." <u>Nat Commun</u> **9**(1): 3023.

> Wild-capture of numerous species is common for diverse purposes, including medical experiments, conservation, veterinary interventions and research, but little objective data exists on its consequences. We use exceptional demographic records on Asian elephants from timber camps in Myanmar to investigate the long-term consequences of wild-capture during 1951-2000 on their mortality (N = 5150). We show that captured elephants have increased mortality compared to captive-born elephants, regardless of their capture method. These detrimental effects of capture are similar for both sexes but differ substantially according to age. Elephants captured and tamed at older ages show a higher increase in mortality after capture than elephants captured and tamed young. Moreover, the increased mortality risk following capture and taming is still perceived several years after capture. Our results are timely given the continued capture of elephants and other wild animals to supplement captive populations despite the alarming declines of wild populations globally.

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Lamichhane, B. R., et al. (2018). "Spatio-temporal patterns of attacks on human and economic losses from wildlife in Chitwan National Park, Nepal." <u>PLoS ONE</u> **13**(4): e0195373.

> Wildlife attacks on humans and economic losses often result in reduced support of local communities for wildlife conservation. Information on spatial and temporal patterns of such losses in the highly affected areas contribute in designing and implementing effective mitigation measures. We analyzed the loss of humans, livestock and property caused by wildlife during 1998 to 2016, using victim family's reports to Chitwan National Park authorities and Buffer Zone User Committees. A total of 4,014 incidents were recorded including attacks on humans, livestock depredation, property damage and crop raiding caused by 12 wildlife species. In total >400,000 US dollar was paid to the victim families as a relief over the whole period. Most of the attacks on humans were caused by rhino, sloth bear, tiger, elephant, wild boar and leopard. A significantly higher number of conflict incidents caused by rhino and elephant were observed during full moon periods. An increase in the wildlife population did not coincide with an equal rise in conflict incidents reported. Underprivileged ethnic communities were attacked by wildlife more frequently than expected. Number of attacks on humans by carnivores and herbivores did not differ significantly. An insignificant decreasing trend of wildlife attacks on humans and livestock was observed with significant variation over the years. Tiger and leopard caused >90% of livestock depredation. Tigers killed both large (cattle and buffalo) and medium sized (goat, sheep, pig) livestock but leopard mostly killed medium sized livestock. Most (87%) of the livestock killing during 2012-2016 occurred within the stall but close (<500m) to the forest edge. Both the percentage of households with livestock and average holding has decreased over the years in buffer zone. Decreased forest dependency as well as conflict mitigation measures (electric and mesh wire fences) have contributed to keep the conflict incidents in control. Strengthening mitigation measures like construction of electric or mesh wire fences and predator-proof livestock corrals along with educating local communities about wildlife behavior and timely management of problem animals (man-eater tiger, rage elephant etc.) will contribute to reduce the conflict.

Laricchiuta, P., et al. (2018). "Histological and immunohistochemical characterization of uterine adenocarcinoma in an Asian elephant (Elephas Maximus)." <u>Folia Morphol (Warsz)</u>.

> A 56 year old nulliparous female Asian elephant (Elephas maximus) living at the zoological garden of Naples (Italy), with a clinical history of recurrent colic, was found in agonal state and humane euthanasia was elected. At necropsy the uterine body was moderately increased in size and the lumen was reduced due to a poorly demarcated and infiltrative neoplasm. Furthermore, multiple, whitish, firm nodules were present in both lungs. Histological examination of the uterine mass revealed epithelial

cells arranged in tubular or solid pattern infiltrating the endometrium and the muscular layer. Immunohistochemical examination showed immunoreactivity of neoplastic cells to estrogen receptors antibody. Pulmonary lesions were histologically and immunohistochemically superimposable to the epithelial uterine neoplasm. A definitive diagnosis of uterine adenocarcinoma with pulmonary metastases was made.

Laricchiuta, P., et al. (2018). "Histological and immunohistochemical characterisation of uterine adenocarcinoma in an Asian elephant (Elephas Maximus)." <u>Folia Morphol (Warsz)</u> **77**(4): 771-774.
  A 56-year-old nulliparous female Asian elephant (Elephas maximus) living at the zoological garden of Naples (Italy), with a clinical history of recurrent colic, was found in agonal state and humane euthanasia was elected. At necropsy the uterine body was moderately increased in size and the lumen was reduced due to a poorly demarcated and infiltrative neoplasm. Furthermore, multiple, whitish, firm nodules were present in both lungs. Histological examination of the uterine mass revealed epithelial cells arranged in tubular or solid pattern infiltrating the endometrium and the muscular layer. Immunohistochemical examination showed immunoreactivity of neoplastic cells to oestrogen receptors antibody. Pulmonary lesions were histologically and immunohistochemically superimposable to the epithelial uterine neoplasm. A definitive diagnosis of uterine adenocarcinoma with pulmonary metastases was made.

Leeuwis, T., et al. (2018). "Complexity in African savannas: Direct, indirect, and cascading effects of animal densities, rainfall and vegetation availability." <u>PLoS ONE</u> **13**(5): e0197149.
  Savanna ecosystems are popular subjects for interaction studies. Multiple studies have been done on the impact of elephants on vegetation, the impact of grass and browse availability on animal densities or on competition between herbivore species. Previous studies showed that elephant densities are frequently negatively correlated with densities of tall trees, and that browse and grass availability are correlated with browser and grazer density respectively. Additionally, a competition effect between browse and grass availability has been reported. These relationships are usually analysed by testing direct relationships between e.g., herbivore densities and food availability, without addressing competition effects or other indirect effects. In this study, multiple interactions in a savanna system have been analysed simultaneously using Partial Least Square-Path Modelling (PLS-PM) using mammal and vegetation data from three different wildlife reserves in southern KwaZulu-Natal. The results showed that the processes that three separate models for the three areas provided the best understanding of the importance of the different interactions. These models suggest that elephants had a negative impact on trees, but also on grass availability. The impact is stronger when elephants are not able to migrate during the dry season. Browsers and grazers were correlated with browse and grass availability, but competition between browse and grass was not detected. This study shows that due to the complexity of the interactions in an ecosystem and differences in environmental factors, these interactions are best studied per area. PLS-PM can be a useful tool for estimating direct, indirect, and cascading effects of changing animal densities in conservation areas.

Leiberich, M., et al. (2018). "Phylogenetic analysis of the cytochrome P450 (CYP450) nucleotide sequences of the horse and predicted CYP450s of the white rhinoceros (Ceratotherium simum) and other mammalian species." <u>PeerJ</u> **6**: e5718.
  Background: The plight of the white rhinoceros (Ceratotherium simum) and the increasing need of treatment options for injured poaching victims led to the necessity to expand the knowledge on applicable drugs in this endangered species. With very little information available on drug pharmacokinetics in rhino, veterinarians have to rely on information generated from other species. The horse being a closely related species, has served as the model for dose extrapolations. However, from recent research on enrofloxacin and carprofen, the white rhino showed considerable differences in the pharmacokinetic properties of these drugs in comparison to the horse. While the reason for the

differences is unknown, a likely cause may be a difference in present cytochrome P450 (CYP450), which may result in the rhino being genetically deficient in certain enzyme families. Methods: For this paper we assess the degree of similarity of the CYP genome sequences across the different species, using BLAT (BLAST-like alignment tool) for the alignment of the nucleotide sequences of the equine CYP450 with potential homologous nucleotide sequences of the published database from white rhinos and other mammalian species (cow, pig, dog, sheep, elephant, mouse and human). Results: The white rhino nucleotide sequences were 90.74% identical to the equine sequences. This was higher than the degree of similarity between any of the other evaluated species sequences. While no specific CYP family were found to be deficient in the published rhino genome, the horse genome contained additional genetic sequence for a larger number of iso-enzymes that were not present in the rhino. Discussion: In pharmacokinetic study, it is well known that absence of a metabolic enzyme will result in constraints in drug metabolism and drug elimination. While this was our speculation, comparison to the horse and other mammalian species indicate that all the described CYP genes required for metabolism are present within the rhino genome. These results leave functional differences in enzyme activity and a lack of isoenzymes as the likely reason for the constraint in drug metabolism. Despite a more than 90% similarity of the equine and rhino gene sequences, seemingly small differences can have major effects on drug metabolism. Thus, in spite of the close anatomical relationship, the rhino should not simply be treated like a big horse.

Li, F., et al. (2018). "Anti-Influenza A Viral Butenolide from Streptomyces sp. Smu03 Inhabiting the Intestine of Elephas maximus." Viruses **10**(7).
Actinobacteria are a phylum of bacteria known for their potential in producing structurally diversified natural products that are always associated with a broad range of biological activities. In this paper, using an H5N1 pseudo-typed virus drug screening system combined with a bioassay guided purification approach, an antiviral butanolide (1) was identified from the culture broth of Streptomyces sp. SMU03, a bacterium isolated from the feces of Elephas maximus in Yunnan province, China. This compound displayed broad and potent activity against a panel of influenza viruses including H1N1 and H3N2 subtypes, as well as influenza B virus and clinical isolates with half maximal inhibitory concentration values (IC50) in the range of 0.29 to 12 µg/mL. In addition, 1 was also active against oseltamivir-resistant influenza virus strain of A/PR/8/34 with NA-H274Y mutation. Studies on the detailed modes of action suggested that 1 functioned by interfering with the fusogenic process of hemagglutinin (HA) of influenza A virus (IAV), thereby blocking the entry of virus into host cells. Furthermore, the anti-IAV activity of 1 was assessed with infected BALB/c mice, of which the appearance, weight, and histopathological changes in the infected lungs were significantly alleviated compared with the no-drug-treated group. Conclusively, these results provide evidence that natural products derived from microbes residing in animal intestines might be a good source for antiviral drug discovery.

Limacher-Burrell, A., et al. (2018). "Nuclear organization of the African elephant (Loxodonta africana) amygdaloid complex: an unusual mammalian amygdala." Brain Struct Funct **223**(3): 1191-1216.
Here we describe the nuclear organization of the African elephant amygdaloid complex using Nissl, myelin, and a range of immunohistochemical stains. The African elephant is thought to exhibit many affect-laden and social-empathic behaviours; however, to date the amygdaloid complex, which is the generator of emotional states of the brain is yet to be fully explored in the elephants. For the most part, the amygdaloid complex of the African elephant is similar to that observed in other mammals in terms of the presence of nuclei and their topological relationships; however, we did observe several specific differences in amygdaloid organization. The elephant amygdala has undergone rotation in both the coronal and sagittal planes, seemingly associated with the expansion of the temporal lobe. Numerous scalloped cell clusters, termed glomeruli, forming the intermediate nuclei of the basal, accessory basal and central nuclear groups, were occupied by structures immunopositive to doublecortin. The nuclei typically associated with the accessory olfactory system (posterior cortical nucleus and medial nuclear

complex) were absent from the elephant amygdala. The anterior cortical nucleus is very large and appears to be comprised of two subdivisions. The lateral nuclear complex is expanded and has two novel subdivisions. The amygdalohippocampal area appears relatively enlarged. The numerous shared and derived characters make the elephant amygdaloid complex very unusual and unique amongst mammals, but the derived characters appear to relate to observed elephant affect-laden behaviours.

Lu, X., et al. (2018). "Effect of hydration and crack orientation on crack-tip strain, crack opening displacement and crack-tip shielding in elephant dentin." Dent Mater **34**(7): 1041-1053.
> OBJECTIVES: To quantify the extent of crack-tip plasticity, crack opening displacement (COD) and crack bridging for crack growth perpendicular (HAH) and parallel (RAR) to the tubules in elephant dentin under both hydrated and dry conditions to better understand their influence on intrinsic and extrinsic toughening during crack growth. METHODS: Compact tension test-pieces were prepared from a tusk of African elephant ivory. Crack-tip strain mapping and COD measurements by digital image correlation (DIC) technique were made under incremental loading and unloading of cracks for hydrated and dry dentin of different orientations. RESULTS: For the RAR test-piece the plastic zones were significantly larger in the hydrated condition compared to when dry. By contrast, the plastic strains in the HAH test-piece were negligible in both wet and dry conditions. In the RAR condition the crack front was broken up into overlapping longitudinal 'fingers' with crack bridging regions in between, the ligaments extending 400mum behind the crack front in the dry case. This could only be seen in 3D by X-ray CT. Extrinsic shielding reduces the crack-tip stresses by 52% and 40% for hydrated and dry RAR test-pieces respectively. No significant bridging was found in the HAH case. SIGNIFICANCE: For crack growth parallel to the tubules, collagen plasticity determines the intrinsic toughening, whereas microcracking from the tubules governs extrinsic shielding via ligament bridging, which is maintained further behind the crack in the hydrated case. For cracks grown perpendicular to the tubules, neither toughening mechanisms are significant.

Lueders, I., et al. (2018). "Prolonged luteal lifespan and pseudopregnancy in Asian elephants (Elephas maximus)." Anim Reprod Sci **197**: 58-66.
> Pseudopregnancy is a physiological occurrence in mammals which have copulation induced ovulation, but is rarely described in spontaneous ovulating species. In this study, three cases of prolonged luteal

lifespan are reported in non-pregnant Asian elephants (Elephas maximus). Case 1 was a 25-year-old female that had produced three calves previously; Case 2 was a nulliparous and 32-year-old at the start of the pseudopregnancy episode; and Case 3 occurred in a 49-year-old nulliparous elephant. Serum progesterone metabolite concentrations remained elevated for 10 months in Case 1. Urinary progestagens were high for >16 months in Case 2 and for five months in Case 3. In Case 1, multiple persistent corpora lutea were visualized monthly by ultrasonography. In all three cases, uterine leiomyoma were present and progestagen concentrations decreased spontaneously. In Case 1, the elephant became pregnant 3 years later, whilst with Case 2, the female resumed estrous cycling normally, and for the Case 3 female, there was continuation with another prolonged luteal phase before ovarian function was purposely suppressed. These examples indicate that persistently elevated progestagen concentrations may not always be indicative of pregnancy in elephants. The reasons for prolonged luteal lifespan are not understood, although serum prolactin concentrations quantified in the Case 1 female were elevated compared to values from previous reports and two other herd mates. Furthermore, all three elephants had varying degrees of uterine pathologies. It is believed that the resulting damage to the endometrium may have led to a reaction similar to implantation, which includes prolactin secretion. Prolactin may exert luteotropic properties and is thought to initiate luteal rescue during pregnancy in elephants.

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Lyashchenko, K. P., et al. (2018). "Spectrum of antibody profiles in tuberculous elephants, cervids, and cattle." Vet Microbiol **214**: 89-92.
    Using multi-antigen print immunoassay and DPP((R)) VetTB Assay approved in the United States for testing captive cervids and elephants, we analyzed antibody recognition of MPB83 and CFP10/ESAT-6 antigens in Asian elephants (Elephas maximus) infected with Mycobacterium tuberculosis and in white-tailed deer (Odocoileus virginianus), fallow deer (Dama dama), elk (Cervus elaphus), and cattle (Bos taurus) infected with Mycobacterium bovis. Serum IgG reactivity to MPB83 was found in the vast majority of tuberculous cattle and cervid species among which white-tailed deer and elk also showed significant CFP10/ESAT-6 recognition rates with added serodiagnostic value. In contrast, the infected elephants developed antibody responses mainly to CFP10/ESAT-6 with MPB83 reactivity being

relatively low. The findings demonstrate distinct patterns of predominant antigen recognition by different animal hosts in tuberculosis.

Lyras, G. A. (2018). "Brain Changes during Phyletic Dwarfing in Elephants and Hippos." <u>Brain Behav Evol</u> **92**(3-4): 167-181.

> Of all known insular mammals, hippos and elephants present the extremes of body size decrease, reducing to 4 and a mere 2% of their ancestral mainland size, respectively. Despite the numerous studies on these taxa, what happens to their relative brain size during phyletic dwarfing is not well known, and results are sometimes conflicting. For example, relative brain size increase has been noted in the Sicilian dwarf elephant, Palaeoloxodon falconeri, whereas relative brain size decrease has been postulated for Malagasy dwarf hippos. Here, I perform an analysis of brain, skull, and body size of 3 insular elephants (Palaeoloxodon "mnaidriensis," P. tiliensis, and P. falconeri) and 3 insular hippos (Hippopotamus madagascariensis, H. lemerlei, and H. minor) to address this issue and to test whether relative brain size in phyletic dwarf species can be predicted. The results presented here show that the encephalization of all insular elephants and hippos is higher than that of their continental relatives. P. falconeri in particular has an enormous encephalization increase, which has so far not been reported in any other insular mammal. Insular brain size cannot be reliably predicted using either static allometric or ontogenetic scaling models. The results of this study indicate that insular dwarf species follow brain-body allometric relationships different from the expected patterns seen for their mainland relatives.

Martins, A. F., et al. (2018). "Locally-curved geometry generates bending cracks in the African elephant skin." <u>Nat Commun</u> **9**(1): 3865.

> An intricate network of crevices adorns the skin surface of the African bush elephant, Loxodonta africana. These micrometre-wide channels enhance the effectiveness of thermal regulation (by water retention) as well as protection against parasites and intense solar radiation (by mud adherence). While the adaptive value of these structures is well established, their morphological characterisation and generative mechanism are unknown. Using microscopy, computed tomography and a custom physics-based lattice model, we show that African elephant skin channels are fractures of the animal brittle and desquamation-deficient skin outermost layer. We suggest that the progressive thickening of the hyperkeratinised stratum corneum causes its fracture due to local bending mechanical stress in the troughs of a lattice of skin millimetric elevations. The African elephant skin channels are therefore generated by thickening of a brittle material on a locally-curved substrate rather than by a canonical tensile cracking process caused by frustrated shrinkage.

Miller, L. J., et al. (2018). "Viewing African and Asian elephants at accredited zoological institutions: Conservation intent and perceptions of animal welfare." <u>Zoo Biol</u>.

> African and Asian elephants are popular within zoos, however there is currently limited information on how viewing them impacts zoo visitors. The goal of the current study was to examine the relationship between viewing elephants in zoos accredited by the Association of Zoos and Aquariums and zoo visitors' reported conservation intent and perceptions of animal welfare. Visitors were systematically selected to fill out questionnaires following elephant observation at nine facilities throughout North America. Questions included information on conservation predispositions, exhibit experience, exhibit perceptions, animal welfare perceptions, emotional experience, learning outcomes, conservation intent, and demographics. Results suggest that observing elephants engaged in a variety of species-typical behaviors and having an up-close experience was significantly correlated to visitors having a positive emotional response. The positive emotional response, combined with visitor conservation predisposition had a significant positive relationship with reported interest in getting involved in conservation. Perceptions of animal welfare were significantly related to a positive emotional experience driven by seeing animals engaged in a variety of active species-typical behaviors as well as exhibit perceptions and whether or not visitors thought it was important to have elephants in zoos. Exhibit perception was primarily correlated with exhibit size. The results provide factors that could help to increase visitor interest in conservation as well as the potential impact of viewing elephants in an accredited zoo. Facilities can use this information to help ensure their visitors have similar type experiences in order to inspire visitors' interest in conservation as well as positive perceptions of animal welfare.

Miller, M. A., et al. (2018). "OUTBREAK OF MYCOBACTERIUM TUBERCULOSIS IN A HERD OF CAPTIVE ASIAN ELEPHANTS (ELEPHAS MAXIMUS): ANTEMORTEM DIAGNOSIS, TREATMENT, AND LESSONS LEARNED." <u>J Zoo Wildl Med</u> **49**(3): 748-754.

> Tuberculosis (TB) was diagnosed in four Asian elephants (Elephas maximus) in a zoo in the United States. The first case was detected by isolation of Mycobacterium tuberculosis during routine trunk wash (TW) culture testing of a herd of eight elephants. Retrospective antibody analyses revealed seroconversion 1 yr before diagnosis. Serological testing of the whole elephant herd identified two additional suspect bulls with detectable antibody, but which remained culture-negative and had no clinical signs of disease. In the following months, M. tuberculosis, identical to the isolate from the index case, was isolated from TW samples of these two elephants. A fourth elephant seroconverted nearly 4 yr after the first TB case was detected, and M. tuberculosis was isolated from a TW sample collected 1 mo later. All four infected elephants received anti-TB therapy. Two treated elephants were eventually euthanized for reasons unrelated to M. tuberculosis and found to be culture-negative on necropsy, although one of them had PCR-positive lung lesions. One infected animal had to be euthanized due to development of a drug-resistant strain of M. tuberculosis; this animal did not undergo postmortem examination due to risk of staff exposure. The fourth animal is currently on treatment. Serial serological and culture results of the other four herd mates have remained negative.

Mills, E. C., et al. (2018). "Forest elephant movement and habitat use in a tropical forest-grassland mosaic in Gabon." <u>PLoS ONE</u> **13**(7): e0199387.

> Poaching of forest elephants (Loxodonta cyclotis) for ivory has decimated their populations in Central Africa. Studying elephant movement can provide insight into habitat and resource use to reveal where, when, and why they move and guide conservation efforts. We fitted 17 forest elephants with global positioning system (GPS) collars in 2015 and 2016 in the tropical forest-grassland mosaic of the Wonga Wongue Presidential Reserve (WW), Gabon. Using the location data, we quantified movement distances, home ranges, and habitat use to examine the environmental drivers of elephant movements and predict where elephants occur spatially and temporally. Forest elephants, on average, traveled

2,840 km annually and had home ranges of 713 km2, with males covering significantly larger home ranges than females. Forest elephants demonstrated both daily and seasonal movement patterns. Daily, they moved between forest and grassland at dawn and dusk. Seasonally, they spent proportionally more time in grassland than forest during the short-wet season when grasses recruit. Forest elephants also traveled faster during the short-wet season when fruit availability was greatest, likely reflecting long, direct movements to preferred fruiting tree species. Forest elephants tended to select areas with high tree and shrub density that afford cover and browse. When villages occurred in their home ranges elephants spent a disproportionate amount of time near them, particularly in the dry season, probably for access to agricultural crops and preferred habitat. Given the importance of the grassland habitat for elephants, maintenance of the forest-grassland matrix is a conservation priority in WW. Law enforcement, outreach, and education should focus on areas of potential human-elephant conflict near villages along the borders of the reserve. GPS-tracking should be extended into multi-use areas in the peripheries of protected areas to evaluate the effects of human disturbance on elephant movements and to maintain connectivity among elephant populations in Gabon.

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Mirzapour, A., et al. (2018). "Frequency of Intestinal Parasites among Zoo Animal by Morphometric Criteria and First Report of the Bivitellobilharzia nairi from Elephant (Elephasmaximus maximus) in Iran." Iran J Parasitol **13**(4): 611-617.

Background: Intestinal parasitic infections are major causative agents of wildlife health complications among different parts of the world. This study aimed to investigate the gastro-intestinal parasites in feces of the zoo animals based on parasitological and morphometric criteria. Methods: One hundred fresh fecal samples were collected from 35 species of animal lived in Eram park zoo, Tehran, Central Iran during Oct 2015 to Jun 2015. All collected samples were examined by microscopic observation following direct wet mount preparation (normal saline and Lugol's iodine), formalin-ether concentration, and permanent staining. The morphometric aspects of the recovered eggs were surveyed with the aid of Camera Lucida (x400). Results: 65.7% (23/35) of zoo animal species were infected with intestinal

parasites. The superfamily Trichostrongyloidea (6/16) and Strongylus sp. (16/4) were the most prevalent helminthic infections, while Blastocystis sp. (6/14), Entamoeba cyst (3/14) and Eimeria sp. (3/14) were the common protozoan parasites. For the first time, Bivitellobilharzia nairi egg was identified an elephant at Iran. Intestinal parasitic infections were apparently circulating among animals of the Eram park zoo. Conclusion: Identified parasitic infections can consider as a threatening source to visitors and workers' health that have contact with animals or their feces. Therefore, the effectual preventive strategies should be addressed to determine the risk factors, mechanisms of cross-transmission of parasite, the importance of applying the hygienic practices and well adjusting deworming programs for the animals, zoo workers and visitors.

Mole, M. A., et al. (2018). "Savanna elephants maintain homeothermy under African heat." J Comp Physiol B.
To conserve body water, mammals may reduce evaporative water loss by storing heat, allowing core body temperature to rise more than usual during the day, and to fall more than usual during the cooler night, so demonstrating heterothermy. It has been proposed that elephants are heterothermic, but body temperature never has been measured in elephants over 24 h at environmental temperatures higher than body temperature, where elephants would have to rely on evaporative cooling to maintain homeothermy. We used ingested temperature data loggers to record core temperature of four partly free-ranging savanna elephants exposed to high solar radiation and environmental temperatures that exceeded core temperature (> 36 degrees C) in their natural habitat. The elephants maintained core temperature at an average 36.6 degrees C within narrow daily limits of about 1.3 degrees C. While mean 24-h core temperature increased with maximum air temperature, it did not increase with mean air temperature. Maximum and minimum daily core temperatures also did not change with maximum air temperatures. As a result, core temperature range remained constant despite large variations in daily air temperatures. Contrary to the view that elephants exhibit heterothermy to cope with heat, savanna elephants in their natural habitat with access to adequate resources of food and water, and able to use thermoregulatory behaviour, maintained homeothermy.

Mortimer, B., et al. (2018). "Classifying elephant behaviour through seismic vibrations." Curr Biol 28(9): R547-r548.
Seismic waves - vibrations within and along the Earth's surface - are ubiquitous sources of information. During propagation, physical factors can obscure information transfer via vibrations and influence propagation range [1]. Here, we explore how terrain type and background seismic noise influence the propagation of seismic vibrations generated by African elephants. In Kenya, we recorded the ground-based vibrations of different wild elephant behaviours, such as locomotion and infrasonic vocalisations [2], as well as natural and anthropogenic seismic noise. We employed techniques from seismology to transform the geophone recordings into source functions - the time-varying seismic signature generated at the source. We used computer modelling to constrain the propagation ranges of elephant seismic vibrations for different terrains and noise levels. Behaviours that generate a high force on a sandy terrain with low noise propagate the furthest, over the kilometre scale. Our modelling also predicts that specific elephant behaviours can be distinguished and monitored over a range of propagation distances and noise levels. We conclude that seismic cues have considerable potential for both behavioural classification and remote monitoring of wildlife. In particular, classifying the seismic signatures of specific behaviours of large mammals remotely in real time, such as elephant running, could inform on poaching threats.

Moyo, D. Z., et al. (2018). "Ixodid ticks of African buffalo (Syncerus caffer), impala (Aepyceros melampus) and elephant (Loxodonta africana) in five protected park estates in the Zambezi valley, Zimbabwe." Exp Appl Acarol 75(4): 409-417.
Wildlife hosts many pathogens of economic importance and is considered as a reservoir of important tick-borne diseases of livestock in southern Africa. The species composition of ticks parasitizing buffalo

(Syncerus caffer), impala (Aepyceros melampus) and elephant (Loxodonta africana) was investigated in five protected parks in the Zambezi valley, Zimbabwe. A total of 1104 adult ticks was collected from 75 adult animals comprising five buffaloes, five elephants and five impalas drawn from five protected wildlife parks. Five tick species belonging to two genera were recovered, with Rhipicephalus decoloratus being the most prevalent species in all the three animal groups. Amblyomma hebraeum was only recovered from buffaloes whereas Rhipicephalus zambeziensis was recovered from buffalos and elephants. Significant differences in mean tick species distribution and concentration were observed amongst the wildlife parks and these appeared to be influenced by the number of hosts in each park. The study revealed that buffaloes are the major host of R. decoloratus in the Zambezi valley. The presence of these ixodid ticks within the Zambezi valley may have significant ecological and economic impacts on wildlife conservation, domestic animals and human health.

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Mumby, H. S. and J. M. Plotnik (2018). "Taking the elephants' perspective: Remembering elephant behavior, cognition and ecology in human-elephant conflict mitigation." Frontiers in Ecology and Evolution **6**(AUG).
Conflict between humans and wildlife is an increasing problem worldwide due to human population growth and habitat fragmentation, with growing interest amongst scientists and conservationists in developing novel solutions toward sustainable coexistence. Current efforts to mitigate human-wildlife conflict, however, are often unbalanced; they consider immediate human-centric concerns and offer deterrents against wildlife, rather than offering solutions to the underlying problems. Recently, there has been an increase in the number of calls to action for the integration of animal behavior, cognition and knowledge of individual variation into conservation practice. However, as elephant researchers, we have seen that most human-elephant conflict mitigation strategies employed in Asia and Africa are based on conditioning fear in elephants, or general monitoring of individual or group activities aimed at altering elephant movements, rather than understanding and providing for elephant and human needs. We see an opportunity to do more by investigating elephant behavior, cognition and ecology at the level of the individual to prevent conflict from occurring in the first place. Here, we review studies on elephants to illustrate this concept and to outline avenues for the application of research on elephant ecology, life history, behavior and personality to the development of new, comprehensive conservation strategies that take both human and elephant behavior into account. © 2018 Mumby and Plotnik.

Nagel, R. M., et al. (2018). "Muscles and fascial elements of the antebrachium and manus of the African elephant (Loxodonta africana, Blumenbach 1797): starring comparative and functional considerations." Anat Histol Embryol.

The structure of the limbs of elephants is unusual among mammals. In African elephants (Loxodonta africana, Blumenbach 1797), the front limbs serve to support the greatest part of the body mass of the largest land animal. In this study, we present new and detailed anatomical data regarding muscular and specific fascial structures of the lower front limb which were examined by means of standard anatomical and histological techniques. The muscles and tendons of the forearm (antebrachium) and hand (manus) are tightly surrounded by thick, highly elastic fascial layers which fuse with the lacertus (lac.) fibrosus and the so-called ligamentum (lig.) humeroulnare. A well-developed musculus (m.) brachioradialis occupies the proximolateral aspect of the forearm and its tendon inserts together with the lac. fibrosus on the os carpi intermedium. The lac. fibrosus, the lig. humeroulnare and the m. flexor carpi radialis reveal a large proportion of elastic fibres. These three structures may play an important role in storing strain energy thus promoting energy-saving locomotion. On the palmar aspect of the carpus, metacarpus and digits, short flexor, abductor, adductor, lumbricales and interossei muscles are present, whereas supinator muscles are absent in all specimens. The short muscles of the hand together with specific dorsal tendons enable precise movements of specific toes.

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Nandini, S., et al. (2018). "Group size differences may mask underlying similarities in social structure: A comparison of female elephant societies." Behavioral Ecology **29**(1): 145-159.

> Fission-fusion dynamics allow for the costs and benefits of sociality to be regulated through changes in group size. There are different modal fission-fusion societies, and female Asian and African elephant populations examined so far have shown different social structures and average group sizes. We report on female Asian elephant social structure in Nagarahole and Bandipur National Parks (Kabini population), southern India, and examine the role of group size in affecting the outcome of social structure analysis in female elephants. Based on 5 years of data, we found the Kabini association network structured into highly modular communities that we call clans. A comparison of the Kabini dataset, modified to match sampling methods, with previously published Uda Walawe Asian elephant and Samburu African elephant data showed that measures of association and network structure were more similar among the Asian elephant populations compared to Samburu. The Samburu population formed a hierarchically-nested multilevel society whereas the Asian populations did not. However, we found hierarchical levels in all 3 populations using Louvain community detection. Moreover, the average community sizes obtained through the Louvain method were not significantly different across populations, indicating basic similarities in social structure. We examined the effect of average group size on association and network statistics. Higher average association index and degree, and lower average path length in Samburu compared to Kabini were explained by larger average group size in Samburu. Thus, underlying similarities in the social networks of species showing fission-fusion dynamics may be obscured by differences in average group size. ©The Author(s) 2017. Published by Oxford University Press on behalf of the International Society for Behavioral Ecology. All rights reserved.

Ndlovu, M., et al. (2018). "Water for African elephants (Loxodonta africana): faecal microbial loads affect use of artificial waterholes." Biol Lett **14**(8).

> In semi-arid protected areas, artificial waterholes ensure that water is locally available to animals for extended periods. However, artificial waterholes may limit animal movement, which contributes towards habitat deterioration. Challenges of artificial water provisioning worsen in the presence of ecosystem engineers like African elephants Loxodonta africana, capable of transforming environments. Camera traps were used to monitor elephant visitation at 21 artificial waterholes in the Kruger National Park, South Africa. We also assessed if water quality parameters influenced elephant preference for certain waterholes. There were no significant correlations between elephant abundance and water physicochemical properties. However, there was a strong negative correlation between elephant abundance and levels of Escherichia coli in water. Our findings suggest that elephants avoid drinking water with high levels of faecal microbial loads. Whereas most studies addressing animal management in protected areas consider waterholes as homogeneous units, we posit that water quality could also determine local landscape use and movement patterns of key species like elephants, a finding with relevant implications in reserve management practices.

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Norkaew, T., et al. (2018). "Body condition and adrenal glucocorticoid activity affects metabolic marker and lipid profiles in captive female elephants in Thailand." PLoS ONE **13**(10): e0204965.

Studies in western zoo elephants have found relationships between body condition and physiological function, and identified mitigating management strategies to optimize health and welfare. A similar methodological approach was used in this study, which evaluated a body condition score (BCS; 1 = thinnest, 5 = fattest) every other month and fecal glucocorticoid metabolite (FGM) concentrations twice monthly in 33 tourist camp elephants in Thailand for a 1-year period to assess seasonal variations, and determine how lipid profiles [total cholesterol (TC), low density lipoproteins (LDL), high density lipoproteins (HDL), triglycerides (TG)] and metabolic parameters [insulin, glucose, fructosamine, glucose to insulin ratio (G:I)] related to measures of body condition and adrenal function. The most prevalent BCS was 3-3.5 (60.6%), with 27.3% at BCS = 4 (overweight) and 12.1% at BCS = 4.5-5 (very overweight); no elephants had a BCS <2. BCSs were higher in rainy and winter seasons compared to summer, with FGM, TG, HDL, LDL, and insulin also higher in the rainy and/or winter seasons (p<0.05). By contrast, TC and glucose were lowest in the rainy season. FGM measures were negatively associated with two environmental factors: temperature and rainfall, but not humidity. Positive correlations were found between BCS and TC, LDL, and HDL, and between FGM and TC, HDL, glucose, and insulin (p<0.05), whereas BCS and FGM were both negatively associated with the G:I (p<0.05). However, there was no relationship between BCS and FGM among the camp elephants. Using BCS and FGM measures as outcome variables in separate regression models, this study found high BCS and elevated FGM concentrations were associated with altered lipid profiles and metabolic status in elephants. Furthermore, more work hours/day was associated with better body condition and health measures. Thus, being overweight and exposed to factors that increase adrenal activity could adversely affect health status, requiring alterations in management for some individuals, whereas exercise appears to have a protective effect.

Osipova, L., et al. (2018). "Fencing solves human-wildlife conflict locally but shifts problems elsewhere: A case study using functional connectivity modelling of the African elephant." Journal of Applied Ecology **55**(6): 2673-2684.

Fencing is one of the most common methods of mitigating human-wildlife conflicts. At the same time, fencing is considered one of the most pressing threats emerging in conservation globally. Although fences act as barriers and can cause population isolation and fragmentation over time, it is difficult to quantitatively predict the consequences fences have for wildlife. Here, we model how fencing designed to mitigate human-elephant conflict (HEC) on the Borderlands between Kenya and Tanzania will affect functional connectivity and movement corridors for African elephants. Specifically, we (a) model functional landscape connectivity integrating natural and anthropogenic factors; (b) predict seasonal movement corridors used by elephants in non-protected areas; and (c) evaluate whether fencing in one area can potentially intensify human-wildlife conflicts elsewhere. We used GPS movement and remote sensing data to develop monthly step-selection functions to model functional connectivity. For future scenarios, we used an ongoing fencing project designed for HEC mitigation within the study area. We modelled movement corridors using least-cost path and circuit theory methods, evaluated their predictive power and quantified connectivity changes resulting from the planned fencing. Our results suggest that fencing will not cause landscape fragmentation and will not change functional landscape connectivity dramatically. However, fencing will lead to a loss of connectivity locally and will increase

the potential for HEC in new areas. We estimate that wetlands, important for movement corridors, will be more intensively used by the elephants, which may also cause problems of overgrazing. Seasonal analysis highlights an increasing usage of non-protected lands in the dry season and equal importance of the pinch point wetlands for preserving overall function connectivity. Synthesis and applications. Fencing is a solution to small-scale human-elephant conflict problems but will not solve the issue at a broader scale. Moreover, our results highlight that it may intensify the conflicts and overuse of habitat patches in other areas, thereby negating conservation benefits. If fencing is employed on a broader scale, then it is imperative that corridors are integrated within protected area networks to ensure local connectivity of affected species. © 2018 The Authors. Journal of Applied Ecology © 2018 British Ecological Society

Palkopoulou, E., et al. (2018). "A comprehensive genomic history of extinct and living elephants." Proceedings of the National Academy of Sciences of the United States of America **115**(11): E2566-E2574.
    Elephantids are the world's most iconic megafaunal family, yet there is no comprehensive genomic assessment of their relationships. We report a total of 14 genomes, including 2 from the American mastodon, which is an extinct elephantid relative, and 12 spanning all three extant and three extinct elephantid species including an ~120,000-y-old straight-tusked elephant, a Columbian mammoth, and woolly mammoths. Earlier genetic studies modeled elephantid evolution via simple bifurcating trees, but here we show that interspecies hybridization has been a recurrent feature of elephantid evolution. We found that the genetic makeup of the straight-tusked elephant, previously placed as a sister group to African forest elephants based on lower coverage data, in fact comprises three major components. Most of the straight-tusked elephant's ancestry derives from a lineage related to the ancestor of African elephants while its remaining ancestry consists of a large contribution from a lineage related to forest elephants and another related to mammoths. Columbian and woolly mammoths also showed evidence of interbreeding, likely following a latitudinal cline across North America. While hybridization events have shaped elephantid history in profound ways, isolation also appears to have played an important role. Our data reveal nearly complete isolation between the ancestors of the African forest and savanna elephants for ~500,000 y, providing compelling justification for the conservation of forest and savanna elephants as separate species. © 2018 National Academy of Sciences. All Rights Reserved.

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Elephantids are the world's most iconic megafaunal family, yet there is no comprehensive genomic assessment of their relationships. We report a total of 14 genomes, including 2 from the American mastodon, which is an extinct elephantid relative, and 12 spanning all three extant and three extinct elephantid species including an approximately 120,000-y-old straight-tusked elephant, a Columbian mammoth, and woolly mammoths. Earlier genetic studies modeled elephantid evolution via simple bifurcating trees, but here we show that interspecies hybridization has been a recurrent feature of elephantid evolution. We found that the genetic makeup of the straight-tusked elephant, previously placed as a sister group to African forest elephants based on lower coverage data, in fact comprises three major components. Most of the straight-tusked elephant's ancestry derives from a lineage related to the ancestor of African elephants while its remaining ancestry consists of a large contribution from a lineage related to forest elephants and another related to mammoths. Columbian and woolly mammoths also showed evidence of interbreeding, likely following a latitudinal cline across North America. While hybridization events have shaped elephantid history in profound ways, isolation also appears to have played an important role. Our data reveal nearly complete isolation between the ancestors of the African forest and savanna elephants for approximately 500,000 y, providing compelling justification for the conservation of forest and savanna elephants as separate species.

Palkopoulou, E., et al. (2018). "A comprehensive genomic history of extinct and living elephants." Proc Natl Acad Sci U S A **115**(11): E2566-e2574.

Elephantids are the world's most iconic megafaunal family, yet there is no comprehensive genomic assessment of their relationships. We report a total of 14 genomes, including 2 from the American mastodon, which is an extinct elephantid relative, and 12 spanning all three extant and three extinct elephantid species including an approximately 120,000-y-old straight-tusked elephant, a Columbian mammoth, and woolly mammoths. Earlier genetic studies modeled elephantid evolution via simple bifurcating trees, but here we show that interspecies hybridization has been a recurrent feature of elephantid evolution. We found that the genetic makeup of the straight-tusked elephant, previously placed as a sister group to African forest elephants based on lower coverage data, in fact comprises three major components. Most of the straight-tusked elephant's ancestry derives from a lineage related to the ancestor of African elephants while its remaining ancestry consists of a large contribution from a lineage related to forest elephants and another related to mammoths. Columbian and woolly mammoths also showed evidence of interbreeding, likely following a latitudinal cline across North America. While hybridization events have shaped elephantid history in profound ways, isolation also appears to have played an important role. Our data reveal nearly complete isolation between the ancestors of the African forest and savanna elephants for approximately 500,000 y, providing compelling justification for the conservation of forest and savanna elephants as separate species.

Pathirana, I. N., et al. (2018). "EFFECTS OF GONADOTROPIN-RELEASING HORMONE ANTAGONIST DEGARELIX ON MUSTH AND SERUM TESTOSTERONE CONCENTRATIONS IN ASIAN ELEPHANTS (ELEPHAS MAXIMUS)." J Zoo Wildl Med **49**(3): 779-783.

Two male Asian elephants (bulls 1 and 2) in musth were subcutaneously injected with a long-acting gonadotropin-releasing hormone (GnRH) antagonist, degarelix acetate (240 mug/kg; total dose of 960 mg). Musth behavior (MB) and temporal gland secretions (TGS) were monitored and serum testosterone concentrations were determined. In bull 1, MB and TGS ceased on day 1 and reappeared 5.5 mo after the treatment (day 0). During the subsequent musth cycle, MB and TGS ceased on day 1 and did not appear for 4 mo. In bull 2, MB and TGS ceased at day 7 after the treatment. Musth behavior and TGS recurred on Day 11 and continued for 1 wk, then disappeared for 8 mo. Serum testosterone concentrations decreased ($P < 0.05$) in all occasions from day 0 (29.8 +/- 15.8 ng/ml; mean +/- SEM) to day 1 (2.2 +/- 1.1 ng/ml), suggesting a sudden drop in circulating testosterone in musth elephants after the GnRH-antagonist treatment.

Paudel, S., et al. (2018). "Serodiagnosis of elephant tuberculosis: a useful tool for early identification of infected elephants at the captive-wild interface." European Journal of Wildlife Research **64**: 70.

> Tuberculosis (TB) is an emerging disease in elephants primarily caused by Mycobacterium tuberculosis (M. tb) and in some occassion by M. bovis. We performed culture and three serological tests—the Elephant TB STAT-PAK,® DPP VetTB® Assay, and MAPIA (multi-antigen print immunoassay)— prospectively on samples from eight elephants in Nepal that died of suspected or confirmed tuberculosis (TB) between 2007 and 2013. Among them, all elephants were reactive to DPP VetTB® Assay, five to Elephant TB STAT-PAK,® and two were reactive to MAPIA. Similarly, six elephants were positive on culture on samples collected antemortem or postmortem.We observed antibody responses months to years before culture confirmation of TB which shows that serological tests can be highly useful for the early diagnosis of TB in elephants. Validated point-of-care serological tests are easily performed in the field and hold promise for improved TB surveillance in other non-domestic species.

Perrin, K. L., et al. (2018). "THROMBOELASTOGRAPHY IN THE HEALTHY ASIAN ELEPHANT (ELEPHAS MAXIMUS): REFERENCE INTERVALS AND EFFECTS OF STORAGE." J Zoo Wildl Med **49**(1): 54-63.

> Hemorrhagic disease associated with elephant endotheliotropic herpesvirus infection is the most-frequent cause of mortality in captive Asian elephants (Elephas maximus). Survival relies on intensive monitoring of hemostatic status. Thromboelastography (TEG) utilizes whole blood samples containing all the blood components of hemostasis and is therefore a sensitive indicator of the clinical status in the patient. This study was performed to assess the practicability of TEG in Asian elephants in a zoo environment. Citrated stabilized whole blood samples were obtained from 44 healthy Asian elephants. Kaolin-activated TEG was performed on whole blood at 60 min and 24 hr postsampling (to replicate shipment to an external laboratory) as well as on freeze-thawed plasma samples, 12-14 mo postsampling. Reference intervals were calculated for fresh whole blood and freeze-thawed plasma samples. In the 24-hr analysis, storage artifacts, likely due to cellular degeneration, resulted in a hypercoagulable thromboelastogram and thus reduced sensitivity for detecting coagulopathies. Therefore, delayed analysis of whole blood samples is not recommended.

Pinyopummin, A., et al. (2018). "Supplemented stallion seminal plasma can improve impaired motility due to the dilution effect in chilled Asian elephant sperm." Reprod Domest Anim **53**(2): 525-533.

> The dilution effect and effect of restoring seminal plasma (SP) proportion in diluted semen were determined in chilled Asian elephant sperm. Semen was collected from eight males, and samples with >/=30% motile sperm were used in the study. Tris-glucose-egg yolk extender (TE) was used for cooled storage at 4 degrees C for 48 hr. In experiment 1 (n = 18), semen was diluted to 1:1, 1:3, 1:7 and 1:15 with TE (volume per volume). There were no significant changes in sperm viability and sperm with normal acrosome integrity among dilutions, but sperm motility and motility velocities were greater (p < .05) in the 1:1 dilution than those of the 1:7 and 1:15 dilutions at 48 hr of storage. In experiment 2, supplemented SP was derived from elephants and stallions. In experiment 2.1, diluted semen (1:7 dilution) was restored with SP to obtain a 1:2 proportion (n = 8). Sperm motility, viability and sperm with normal acrosome integrity were similar among treatments, but motility velocities were greater (p < .05) with stallion SP at 48 hr of storage. In experiment 2.2, diluted semen (1:15 dilution) was restored with SP to obtain a 1:3 proportion (n = 10). Sperm viability and sperm with normal acrosome integrity were similar among treatments at 48 hr of storage. However, sperm motility and motility velocities were greater (p < .05) with stallion SP than those of others. In conclusion, elephant sperm motility was affected by a dilution effect and restoration of SP proportion with stallion SP, but not with elephant SP, could improve motility in chilled highly diluted sperm.

Prado, N. A., et al. (2018). "Prolonged ovarian acyclicity is associated with a higher likelihood of developing hyperprolactinemia in zoo female African elephants." Zoo Biol.

Hyperprolactinemia is a common disorder of the hypothalamic-pituitary axis, and a cause of ovarian dysfunction in women. Currently, over half of non-cycling African elephant females in North America also are hyperprolactinemic, suggesting a similar link between these two conditions may exist. The objective of this study was to determine the relationship between acyclicity and prolactin status by comparing mean prolactin concentrations of bi-weekly samples collected over a 1-year period in 2012 with 20 years of historical weekly progestagen data to assess cyclicity. Females were categorized as: 1) non-cycling with an average prolactin concentration of 15 ng/ml or greater (HIGH; n = 17); 2) non-cycling with an average prolactin concentration below 15 ng/ml (LOW; n = 16); and 3) typical temporal patterns of progestagen and prolactin secretion (NORMAL; n = 45), and evaluated based on length of time (in years) they had experienced ovarian inactivity. Results showed that the majority of HIGH prolactin elephants had been acyclic for at least 5 years, and in a number of cases (n = 9) for over 10 years. By contrast, most of the LOW prolactin elephants had experienced acyclicity for less than 5 years. Finally, there was a positive association between duration of acyclicity and mean prolactin concentrations, with an increase in the likelihood of having higher prolactin concentrations the longer an individual was acyclic. This study highlights the importance of longitudinal hormonal datasets to examine temporal changes in biological functioning and better understand the etiology of infertility problems.

Purdon, A., et al. (2018). "Partial migration in savanna elephant populations distributed across southern Africa." Sci Rep **8**(1): 11331.

Migration is an important, but threatened ecological process. Conserving migration requires the maintenance of functional connectivity across sufficiently large areas. Therefore, we need to know if, where and why species migrate. Elephants are highly mobile and can travel long distances but we do not know if they migrate. Here, we analysed the movement trajectories of 139 savanna elephants (Loxodonta africana) within eight clusters of protected areas across southern Africa to determine if elephants migrate, and if so, where, how and why they migrate. Only 25 of these elephants migrated. Elephants are a facultative partially migratory species, where only some individuals in a population migrate opportunistically, and not every year. Elephants migrated between distinct seasonal ranges corresponding to southern Africa's dry and wet seasons. The timing of wet season migrations was associated with the onset of rainfall and the subsequent greening up of forage. Conversely, the duration, distance, and the timing of dry season migrations varied idiosyncratically. The drivers of elephant migration are likely a complex interaction between individual traits, density, and the distribution and availability of resources. Despite most migrations crossing administrative boundaries, conservation networks provided functional space for elephants to migrate.

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conservation networks provided functional space for elephants to migrate.

Radhakrishnan, S. (2018). "A note on wildlife poisoning cases from Kerala, South India." **64**(58).
Wildlife poisoning is an important conservation threat for endangered species in India. There are no publications in the scientific literature that identify the specific poisons or chemicals involved in wildlife poisoning cases from the state of Kerala. In this report, all cases of wildlife mortality recorded between 2011 and 2013 at the office of the Assistant Forest Veterinary Officer, Periyar Tiger Reserve in Kerala were reviewed and cases where poisoning was considered as a differential diagnosis were identified. Specific poisons or chemicals were identified in three cases, while in a fourth, poisoning was determined to have occurred based on physical traces of the poison in gut contents. The poisons identified include carbofuran (a carbamate pesticide) in a bonnet macaque (Macaca radiata), warfarin (a rodenticide) in a mortality event involving four wild boars (Sus scrofa), endosulfan (an organochlorine pesticide) toxicity in a gaur (Bos gaurus) and imidacloprid (a neonicotinoid pesticide) toxicity in a wild adult Asian elephant (Elephas maximus). This communication thus reports for the first time on the specific chemical compounds identified in wildlife poisoning cases from Kerala state and argues for greater regulation of the sale and use of such toxic compounds in India.

Ranjeewa, A. D. G., et al. (2018). "Decreasing reservoir water levels improve habitat quality for Asian elephants." Mammalian Biology **88**: 130-137.
Population health and habitat quality are intimately related and seasonal changes in habitat quality are likely to be reflected in the body condition of animals. We studied seasonal variation of body condition in free ranging Asian elephants (Elephas maximus) in Udawalawe National Park, Sri Lanka based on visual scoring of individually identified elephants. We assessed the body condition of 218 adult females and 329 adult males from January 2008 to November 2012 and examined its relation to monthly rainfall and water level of the Udawalawe reservoir. Contrary to expectations, body condition of elephants was higher in the dry season, when primary productivity decreases due to lack of rainfall. However, the body condition showed both a seasonal and inter-annual negative co-relation with reservoir water level. A possible explanation for improved body condition in the dry season is the greater availability of fresh grass due to the emergence of reservoir bed grasslands with the drawdown of water. Our results underscore the importance of water management of large irrigation reservoirs in elephant conservation in Sri Lanka. © 2017 Deutsche Gesellschaft für Säugetierkunde

Rosen, L. E., et al. (2018). "Tuberculosis serosurveillance and management practices of captive African elephants (Loxodonta africana) in the Kavango-Zambezi Transfrontier Conservation Area." Transbound Emerg Dis **65**(2): e344-e354.
Transfrontier conservation areas represent an international effort to encourage conservation and sustainable development. Their success faces a number of challenges, including disease management in wildlife, livestock and humans. Tuberculosis (TB) affects humans and a multitude of non-human animal species and is of particular concern in sub-Saharan Africa. The Kavango-Zambezi Transfrontier Conservation Area encompasses five countries, including Zimbabwe, and is home to the largest contiguous population of free-ranging elephants in Africa. Elephants are known to be susceptible to TB; thus, understanding TB status, exposure and transmission risks to and from elephants in this area is of interest for both conservation and human health. To assess risk factors for TB seroprevalence, a questionnaire was used to collect data regarding elephant management at four ecotourism facilities offering elephant-back tourist rides in the Victoria Falls area of Zimbabwe. Thirty-five working African elephants were screened for Mycobacterium tuberculosis complex antibodies using the ElephantTB Stat-Pak and the DPP VetTB Assay for elephants. Six of 35 elephants (17.1%) were seropositive. The risk factor most important for seropositive status was time in captivity. This is the first study to assess TB seroprevalence and risk factors in working African elephants in their home range. Our findings will provide a foundation to develop guidelines to protect the health of captive and free-ranging elephants in

the southern African context, as well as elephant handlers through simple interventions. Minimizing exposure through shared feed with other wildlife, routine TB testing of elephant handlers and regular serological screening of elephants are recommended as preventive measures.

Safina, C. (2018). "Where Are Zoos Going-or Are They Gone?" J Appl Anim Welf Sci **21**(sup1): 4-11.
To some, zoos are prisons exploiting animals. In reality zoos range from bad to better. I make this distinction: A bad zoo makes animals work for it; a good zoo works for animals. Good zoos do effective conservation work and continually strive to improve exhibits, relevance to conservation, and inspiring public engagement for wildlife. Many zoos have improved enormously; the better ones being crucial in saving species that would have otherwise gone extinct. Nonetheless, for some people the mere word "zoo" carries impressions of old zoos, bad zoos, circuses, and theme-park shows that many find distasteful. Good zoos know they must innovate forward. As society grows increasingly estranged from nature and continues driving broad declines of wildlife, wild lands, and natural systems, the goal of zoos and every organization concerned with animal welfare should not be to separate humans from other animals, but to entangle all humans in nonhuman lives. Zoos of the next decades must become the first stage in bringing young people into life-long, engaged caring about animals. They could carry on that mission in their communities, in schools, in wild lands, as well as inside their gates. Without a strong public constituency, wild animals will not withstand continued human proliferation. Zoos and aquariums must innovate toward being a crucial force abetting the continued existence of wildness on Earth. Zoos of the future must become uplifting places of respect, rescue, enhancement, conservation, and public engagement.

Sampson, C., et al. (2018). "Effects of illegal grazing and invasive Lantana camara on Asian elephant habitat use." Biological Conservation **220**: 50-59.
Protected areas provide some of the last refuges for Asian elephants in the wild. Managing these areas for elephants will be critical for elephant conservation. Scientists know little about elephant habitat use in Asia and how invasive species or livestock grazing influence habitat use. We studied these issues in two protected areas in Sri Lanka, Udawalawe National Park and Hurulu Eco-Park. These areas contain some of Sri Lanka's largest remaining grasslands. These grasslands are threatened by the invasive and toxic shrub, Lantana camara, and are used for illegal livestock grazing. To measure habitat use by elephants and livestock, we conducted dung surveys along over 50 km of transects stratified across grassland, scrub, and forest. We surveyed 159 vegetation plots along these transects to assess plant composition, and mapped habitat types based on satellite images. We used mixed-effect models to determine the relative importance of habitats, livestock presence, and plant associations for elephant use. Elephant presence was greatest in scrub and grassland habitats, positively associated with both livestock presence and short graminoids, and unaffected by L. camara, which was widespread but at low densities. Given the importance of these areas to elephants, we recommend a precautionary management approach that focuses on curbing both illegal grazing and the spread of L. camara. © 2018 Elsevier Ltd

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Sampson, C., et al. (2018). "New elephant crisis in Asia-Early warning signs from Myanmar." PLoS ONE **13**(3): e0194113.

In the southern Bago Yoma mountain range in Myanmar, Asian elephants are being killed at a disturbing rate. This emerging crisis was identified initially through a telemetry study when 7 of 19 of collared elephants were poached within a year of being fitted with a satellite-GPS collar. Subsequent follow up of ground teams confirmed the human caused death or disappearance of at least 19 elephants, including the seven collared individuals, within a 35 km2 area in less than two years. The carcasses of 40 additional elephants were found in areas located across south-central Myanmar once systematic surveys began by our team and collaborators. In addition to the extreme rate of loss, this study documents the targeting of elephants for their skin instead of the more common ivory, an increasing trend in Myanmar. Intensive research programs focused on other conservation problems identified this issue and are now encouraging local authorities to prioritize anti-poaching efforts and improve conservation policies within the country. Myanmar represents one of the last remaining countries in Asia with substantial wildlands suitable for elephants. Increasing rates of human-elephant conflict and poaching events in this country pose a dire threat to the global population.

Santos, N., et al. (2018). "Spatial analysis of wildlife tuberculosis based on a serologic survey using dried blood spots, Portugal." Emerging Infectious Diseases **24**(12): 2169-2175.

We investigated the spatial epidemiology of bovine tuberculosis (TB) in wildlife in a multihost system. We surveyed bovine TB in Portugal by serologic analysis of elutes of dried blood spots obtained from hunted wild boar. We modeled spatial disease risk by using areal generalized linear mixed models with conditional autoregressive priors. Antibodies against Mycobaterium bovis were detected in 2.4% (95% CI 1.5%–3.8%) of 678 wild boar in 2 geographic clusters, and the predicted risk fits well with independent reports of M. bovis culture. Results show that elutes are an almost perfect substitute for serum (Cohen unweighted κ = 0.818), indicating that serologic tests coupled with dried blood spots are an effective strategy for large-scale bovine TB surveys, using wild boar as sentinel species. Results also show that bovine TB is an emerging wildlife disease and stress the need to prevent further geographic spread and prevalence increase. © 2018, Centers for Disease Control and Prevention (CDC). All rights reserved.

Sazykina, T. G. (2018). "Population sensitivities of animals to chronic ionizing radiation-model predictions from mice to elephant." J Environ Radioact **182**: 177-182.

Model predictions of population response to chronic ionizing radiation (endpoint 'morbidity') were made for 11 species of warm-blooded animals, differing in body mass and lifespan - from mice to elephant. Predictions were made also for 3 bird species (duck, pigeon, and house sparrow). Calculations were based on analytical solutions of the mathematical model, simulating a population response to low-LET ionizing radiation in an ecosystem with a limiting resource (Sazykina, Kryshev, 2016). Model parameters for different species were taken from biological and radioecological databases; allometric relationships were employed for estimating some parameter values. As a threshold of decreased health status in exposed populations ('health threshold'), a 10% reduction in self-repairing capacity of organisms was suggested, associated with a decline in ability to sustain environmental stresses. Results of the modeling demonstrate a general increase of population vulnerability to ionizing radiation

in animal species of larger size and longevity. Populations of small widespread species (mice, house sparrow; body mass 20-50 g), which are characterized by intensive metabolism and short lifespan, have calculated 'health thresholds' at dose rates about 6.5-7.5 mGy day(-1). Widespread animals with body mass 200-500 g (rat, common pigeon) - demonstrate 'health threshold' values at 4-5 mGy day(-1). For populations of animals with body mass 2-5 kg (rabbit, fox, raccoon), the indicators of 10% health decrease are in the range 2-3.4 mGy day(-1). For animals with body mass 40-100 kg (wolf, sheep, wild boar), thresholds are within 0.5-0.8 mGy day(-1); for herbivorous animals with body mass 200-300 kg (deer, horse) - 0.5-0.6 mGy day(-1). The lowest health threshold was estimated for elephant (body mass around 5000 kg) - 0.1 mGy day(-1). According to the model results, the differences in population sensitivities of warm-blooded animal species to ionizing radiation are generally depended on the metabolic rate and longevity of organisms, also on individual radiosensitivity of biological tissues. The results of 'health threshold' calculations are formulated as a graded scale of wildlife sensitivities to chronic radiation stress, ranging from potentially vulnerable to more resistant species. Further studies are needed to expand the scale of population sensitivities to radiation, including other groups of wildlife - cold-blooded species, invertebrates, and plants.

Schiffmann, C., et al. (2018). "Body condition scores of European zoo elephants (Elephas maximus and Loxodonta africana): Status quo and influencing factors." Journal of Zoo and Aquarium Research 6(3): 91-103.
Obesity is a common problem in captive elephants. Therefore, physical state monitoring presents a critical aspect in preventive elephant healthcare. Some institutions lack the equipment to weigh elephants regularly, so body condition scoring (BCS) is a valuable alternative tool. As yet, the BCS of both elephant species has not been assessed comprehensively for the European captive population. Using a previously validated visual BCS protocol, we assessed 192 African (Loxodonto ofricono) and 326 Asian elephants (Elephas moximus) living in European zoos (97% of the living European elephant population). The majority of elephants scored in the upper categories with 56% of adults assessed in the range 7-10 out of 10. Adult Asian elephants had significantly lower BCS (males: mean 6.2 +/- 1.0, median 6.0, range 4-8; females: mean 6.6 +/- 1.3, median 6.0, range 3-9) than African elephants (males: mean 6.7 +/- 0.7, median 6.0, range 6-8; females: mean 6.9 +/- 1.2, median 6.0, range 1-9). Comparison with samples of free-ranging populations (163 Asian elephants and 121 African elephants) revealed significantly lower scores in free-ranging elephants independent of species, age and sex category. Compared to previous reports from captive populations, the European zoo elephant population is nevertheless less obese. In adult Asian elephant females, BCS was significantly correlated to their breeding status with lower scores in current breeders; however, breeding status was also correlated to group size, enclosure size, and a diet with less vegetables. Further attention to zoo elephant weight management is recommended with regular longitudinal monitoring by body condition scoring.

Schiffmann, C., et al. (2018). "When elephants fall asleep: A literature review on elephant rest with case studies on elephant falling bouts, and practical solutions for zoo elephants." Zoo Biology 37(3): 133-145.
Little attention has been paid to the resting and sleeping behavior of zoo elephants so far. An important concern is when elephants avoid lying down, due to degenerative joint and foot disease, social structure, or stressful environmental changes. Inability or unwillingness to lie down for resting is an important welfare issue, as it may impair sleep. We emphasize the importance of satisfying rest in elephants by reviewing the literature on resting behavior in elephants (Loxodonta africana and Elephas maximus) as well as the documentation of four cases from European zoos and our own direct observations in a zoo group of four female African elephants during 12 entire days. The common denominator in the case reports is the occurrence of a falling bout out of a standing position subsequently to a cessation of lying rest for different periods of time. Although well-known in horses as "episodic collapse" or "excessive drowsiness," this syndrome has not been described in elephants before. To enable its detection, we recommend nocturnal video monitoring for elephant-keeping

institutions. The literature evaluation as well as own observational data suggest an inverse relationship between lying rest and standing rest. Preventative measures consist of enclosure modifications that facilitate lying rest (e.g., sand hills) or standing rest in a leaning position as a substitute. Anecdotal observations suggest that the provision of appropriate horizontal environmental structures may encourage safe, sleep-conducive standing rest. We provide drawings on how to install such structures. Effects of providing such structures should be evaluated in the future. © 2018 Wiley Periodicals, Inc.

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Schlossberg, S., et al. (2018). "Poaching and human encroachment reverse recovery of African savannah elephants in south-east Angola despite 14 years of peace." PLoS ONE **13**(3): e0193469.
    With populations of African savannah elephants (Loxodonta africana) declining across the continent, assessing the status of individual elephant populations is important for conservation. Angola's elephant population represents a key linkage between the larger populations of Namibia and Botswana. Elephants in Angola were decimated during the 1975-2002 Angolan civil war, but a 2005 survey showed that populations were recolonizing former habitats. Between 2005 and 2015, no research was permitted on elephants in Angola, but elsewhere in Africa many elephant populations experienced a poaching crisis. In 2015, we were able to resume elephant research in Angola. We used aerial surveys and satellite monitoring of collared elephants to determine the current status of elephant populations in Angola and to learn how human populations may be affecting elephant habitat usage. The aerial survey revealed a population of 3,395 +/- SE of 797 elephants, but populations had declined 21% from the 2005 estimate. The high number of carcasses observed on the survey suggests that populations may have increased after the 2005 survey but were declining rapidly as of 2015. Satellite-collared elephants avoided areas <6 km from human indicators but preferred areas nearer humans at scales of 6-40 km, suggesting that humans may be displacing elephants from preferred habitats near rivers. Taken together, these results suggest that Angola's elephant population is experiencing intense poaching and may be losing habitat to human settlements. Without action to conserve their populations, Angola's elephants face an uncertain future.

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Schmidberger, A., et al. (2018). "Development and application of a method for ivory dating by analyzing radioisotopes to distinguish legal from illegal ivory." Forensic Sci Int **289**: 363-367.

> The age determination of elephant ivory provides necessary and crucial information for all criminal prosecution authorities enforcing the Convention on International Trade in Endangered Species of Wild Fauna and Flora. The knowledge of the age of ivory allows to distinguish between pre-convention, hence legal material and ivory deriving from recent, illegal poaching incidents. The commonly applied method to determine the age of ivory is radiocarbon dating in the form of bomb pulse dating, which however will fade out soon. This work provides an enhancement of the radiocarbon dating method by supplementary determination of the isotope profile of 90-Sr and the two thorium isotopes 228-Th and 232-Th. This combined analysis allows for a precise and unambiguous age determination of ivory. We provided calibration curves for all involved radionuclides by analyzing ivory samples with known age and investigated a new method for the extraction of strontium from ivory.

Sekar, N., et al. (2018). "Ivory crisis: Growing no-trade consensus." Science **360**(6386): 276-277.

Seltmann, M. W., et al. (2018). "Evaluating the personality structure of semi-captive Asian elephants living in their natural habitat." R Soc Open Sci **5**(2): 172026.

> Data on personality for long-lived, highly social wild mammals with high cognitive abilities are rare. We investigated the personality structure of Asian elephants (Elephas maximus) by using a large sample of semi-captive timber elephants in Myanmar. Data were collected during 2014-2017 using questionnaires, for which elephant riders (mahouts) rated 28 behavioural adjectives of elephants. Repeated questionnaires were obtained for each elephant from several raters whenever possible, resulting in 690 ratings of 150 female and 107 male elephants. We started by performing a confirmatory factor analysis to compare the fit of our data to a previously published captive elephant personality structure. Owing to a poor fit of this model to our data, we proceeded by performing explanatory factor analysis to determine the personality structure in our study population. This model suggested that personality in these elephants was manifested as three factors that we labelled as Attentiveness, Sociability and Aggressiveness. This structure did not differ between the sexes. These results provide the basis for future research on the link between personality and reproductive success in this endangered species and more generally, help to resolve the selective pressures on personalities in long-lived, highly social species.

Seluanov, A., et al. (2018). "Mechanisms of cancer resistance in long-lived mammals." <u>Nat Rev Cancer</u>.
Cancer researchers have traditionally used the mouse and the rat as staple model organisms. These animals are very short-lived, reproduce rapidly and are highly prone to cancer. They have been very useful for modelling some human cancer types and testing experimental treatments; however, these cancer-prone species offer little for understanding the mechanisms of cancer resistance. Recent technological advances have expanded bestiary research to non-standard model organisms that possess unique traits of very high value to humans, such as cancer resistance and longevity. In recent years, several discoveries have been made in non-standard mammalian species, providing new insights on the natural mechanisms of cancer resistance. These include mechanisms of cancer resistance in the naked mole rat, blind mole rat and elephant. In each of these species, evolution took a different path, leading to novel mechanisms. Many other long-lived mammalian species display cancer resistance, including whales, grey squirrels, microbats, cows and horses. Understanding the molecular mechanisms of cancer resistance in all these species is important and timely, as, ultimately, these mechanisms could be harnessed for the development of human cancer therapies.

Seluanov, A., et al. (2018). "Mechanisms of cancer resistance in long-lived mammals." <u>Nat Rev Cancer</u> **18**(7): 433-441.
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Sharma, R., et al. (2018). "Genetic analyses favour an ancient and natural origin of elephants on Borneo." <u>Sci Rep</u> **8**(1): 880.
The origin of the elephant on the island of Borneo remains elusive. Research has suggested two alternative hypotheses: the Bornean elephant stems either from a recent introduction in the 17th century or from an ancient colonization several hundreds of thousands years ago. Lack of elephant fossils has been interpreted as evidence for a very recent introduction, whereas mtDNA divergence from other Asian elephants has been argued to favor an ancient colonization. We investigated the demographic history of Bornean elephants using full-likelihood and approximate Bayesian computation analyses. Our results are at odds with both the recent and ancient colonization hypotheses, and favour a third intermediate scenario. We find that genetic data favour a scenario in which Bornean elephants experienced a bottleneck during the last glacial period, possibly as a consequence of the colonization of Borneo, and from which it has slowly recovered since. Altogether the data support a natural colonization of Bornean elephants at a time when large terrestrial mammals could colonise from the Sunda shelf when sea levels were much lower. Our results are important not only in understanding the unique history of the colonization of Borneo by elephants, but also for their long-term conservation.

Sharma, R., et al. (2018). "Genetic analyses favour an ancient and natural origin of elephants on Borneo." <u>Scientific Reports</u> **8**.

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Sharma, V. and M. Hiller (2018). "Loss of Enzymes in the Bile Acid Synthesis Pathway Explains Differences in Bile Composition among Mammals." Genome Biol Evol **10**(12): 3211-3217.
Bile acids are important for absorbing nutrients. Most mammals produce cholic and chenodeoxycholic bile acids. Here, we investigated genes in the bile acid synthesis pathway in four mammals that deviate from the usual mammalian bile composition. First, we show that naked-mole rats, elephants, and manatees repeatedly inactivated CYP8B1, an enzyme uniquely required for cholic acid synthesis, which explains the absence of cholic acid in these species. Second, no gene-inactivating mutations were found in any pathway gene in the rhinoceros, a species that lacks bile acids, indicating an evolutionarily recent change in its bile composition. Third, elephants and/or manatees that also lack bile acids altogether have lost additional nonessential enzymes (SLC27A5, ACOX2). Apart from uncovering genomic differences explaining deviations in bile composition, our analysis of bile acid enzymes in bile acid-lacking species suggests that essentiality prevents gene loss, while loss of pleiotropic genes is permitted if their other functions are compensated by functionally related proteins.

Siengdee, P., et al. (2018). "Isolation and culture of primary adult skin fibroblasts from the Asian elephant (Elephas maximus)." PeerJ **6**: e4302.
Background: Primary cultures from Asian elephants (Elephas maximus) allow scientists to obtain representative cells that have conserved most of their original characteristics, function, physiology and biochemistry. This technique has thus gained significant importance as a foundation for further cellular, cell biology and molecular research. Therefore, the aim of this study was to describe conditions for the successful establishment of primary adult fibroblasts from Asian elephant carcasses. Methods: Ear tissue sample collection from Asian elephant carcasses and our recommendations are given. We

describe here a simple modified protocol for successful isolation and maintenance of primary adult fibroblasts from elephant ear skin. Ear samples from each individual (five 3 x 3 cm(2) pieces) were brought to the laboratory within 3 h after collection, kept in transportation medium at 0-4 degrees C. The ear tissues were prepared by a combination of 10% collagenase type II digestion procedure together with a simple explant procedure. Primary fibroblasts were cultured at 37 degrees C in Dulbecco's modified Eagle's medium (DMEM) with 20% fetal calf serum (FCS) in a humidified atmosphere containing 5% CO2. After the third passage, fibroblasts were routinely trypsinized with 0.25% trypsin/EDTA and cultured in DMEM with 10% FCS at 37 degrees C and 5% CO2. Traditional cell counting method was used to measure cell viability and growth curve. Long-term storage of cells used freezing medium consisting of 40% FCS (v/v). Results: We explored the most suitable conditions during sample collection (post-mortem storage time and sample storage temperature), which is the most important step in determining primary outgrowth. Our study successfully established and cultured primary adult skin fibroblasts obtained from post-mortem E. maximus ear skin tissues from six carcasses, with a success rate of around 83.3%. Outgrowth could be seen 4-12 days after explantation, and epithelial-like cells were found after 4-7 days of culture, while fibroblasts appeared at around day 7-10. The fibroblasts had viability and post-freezing recovery rates of around 97.3 +/- 4.3% and 95.5 +/- 7.3%, respectively, and doubling time was about 25 h (passage 6). Discussion: To our knowledge, this report is the first to describe primary cell cultures derived from adult Asian elephant skin. Future studies should benefit from the information and useful suggestions herein, which may be used as a standard method for establishing primary skin fibroblast cultures in future experiments.

Suba, R. B., et al. (2018). "Foraging ecology and diet of Bornean elephants (Elephas maximus borneensis) in the Sebuku forest area, North Kalimantan Province of Indonesia: Do the choices matter?" Integr Zool **13**(2): 219-223.

Takehana, K., et al. (2018). "Serum activities of two bone markers in captive Asian elephants (Elephas maximus) at different ages." J Vet Med Sci **80**(1): 63-67.
    The blood biochemical analysis of bone markers could have a role in the early diagnosis of metabolic bone disease in animals; however, there is limited information on bone markers in captive Asian elephants (Elephas maximus). Serum samples from ten captive Asian elephants were obtained to clarify the relationship between age and the blood bone markers tartrate-resistant acid phosphatase isoform 5b (TRAP5b) and bone specific alkaline phosphatase (BALP). Serum TRAP5b and BALP activities were negatively correlated with age. A positive correlation was observed between TRAP5b activity and BALP activity. These results may contribute to the health management of captive Asian elephants.

Tejada-Lara, J. V., et al. (2018). "Body mass predicts isotope enrichment in herbivorous mammals." Proc Biol Sci **285**(1881).
    Carbon isotopic signatures recorded in vertebrate tissues derive from ingested food and thus reflect ecologies and ecosystems. For almost two decades, most carbon isotope-based ecological interpretations of extant and extinct herbivorous mammals have used a single diet-bioapatite enrichment value (14 per thousand). Assuming this single value applies to all herbivorous mammals, from tiny monkeys to giant elephants, it overlooks potential effects of distinct physiological and metabolic processes on carbon fractionation. By analysing a never before assessed herbivorous group spanning a broad range of body masses-sloths-we discovered considerable variation in diet-bioapatite delta(13)C enrichment among mammals. Statistical tests (ordinary least squares, quantile, robust

regressions, Akaike information criterion model tests) document independence from phylogeny, and a previously unrecognized strong and significant correlation of delta(13)C enrichment with body mass for all mammalian herbivores. A single-factor body mass model outperforms all other single-factor or more complex combinatorial models evaluated, including for physiological variables (metabolic rate and body temperature proxies), and indicates that body mass alone predicts delta(13)C enrichment. These analyses, spanning more than 5 orders of magnitude of body sizes, yield a size-dependent prediction of isotopic enrichment across Mammalia and for distinct digestive physiologies, permitting reconstruction of foregut versus hindgut fermentation for fossils and refined mean annual palaeoprecipitation estimates based on delta(13)C of mammalian bioapatite.

Thammarat, P., et al. (2018). "Identification of Volatile Compounds and Selection of Discriminant Markers for Elephant Dung Coffee Using Static Headspace Gas Chromatography-Mass Spectrometry and Chemometrics." Molecules **23**(8).
> Elephant dung coffee (Black Ivory Coffee) is a unique Thai coffee produced from Arabica coffee cherries consumed by Asian elephants and collected from their feces. In this work, elephant dung coffee and controls were analyzed using static headspace gas chromatography hyphenated with mass spectrometry (SHS GC-MS), and chemometric approaches were applied for multivariate analysis and the selection of marker compounds that are characteristic of the coffee. Seventy-eight volatile compounds belonging to 13 chemical classes were tentatively identified, including six alcohols, five aldehydes, one carboxylic acid, three esters, 17 furans, one furanone, 13 ketones, two oxazoles, four phenolic compounds, 14 pyrazines, one pyridine, eight pyrroles and three sulfur-containing compounds. Moreover, four potential discriminant markers of elephant dung coffee, including 3-methyl-1-butanol, 2-methyl-1-butanol, 2-furfurylfuran and 3-penten-2-one were established. The proposed method may be useful for elephant dung coffee authentication and quality control.

Thitaram, C. and J. L. Brown (2018). "Monitoring and controlling ovarian activity in elephants." Theriogenology **109**: 42-47.
> Both Asian (Elephas maximus) and African (Loxodonta africana) elephants are important keystone, umbrella and flagship species. Paradoxically, world population numbers of both species are declining in many of their natural ranges due mainly to poaching, while over population of elephants in some areas is resulting in serious human-elephant conflict, and modifications of natural habitats that impact biodiversity. Understanding mechanisms of reproductive control is vital to effective population management, and for that reason significant advances have been made in endocrine and ultrasonographic monitoring techniques, particularly in studies of elephants ex situ. However, there remains a need to develop new methods to control ovarian activity, both for enhancing and inhibiting

reproduction, to maintain population numbers at levels that ensure species survival and their ability to safely cohabitate with humans and other species. We present an overview of reproductive monitoring methods and how they have contributed to our knowledge of elephant reproductive biology, as well as their application for in situ and ex situ conservation purposes.

Thitaram, C., et al. (2018). "Histology of 24 organs from Asian elephant calves (Elephas maximus)." PeerJ **2018**(6).

Background: Elephants are the largest and heaviest living terrestrial animals, but information on their histology is still lacking. This study provides a unique insight into the elephant's organs and also provides a comparison between juvenile Asian elephants and adult Asian elephants or other species. Here we report on the histological structure of 24 organs, including the skin, brain (cerebrum, cerebellar hemisphere, vermis, thalamus, midbrain), spinal cord, sciatic nerve, striated skeletal muscle, cardiac muscle, bone (flat bone and long bone), cartilage (hyaline cartilage and fibrocartilage), heart (right atrium, right ventricle), blood vessels (aorta, pulmonary artery and caudal vena cava), trunk, trachea, lung, tongue, esophagus, stomach, small intestine (duodenum, jejunum, ileum), large intestine (cecum, colon, rectum), liver and pancreas, kidney, ovary, uterus (body and horn) and spleen of two juvenile Asian elephants. Methods: Tissue sections were stained with Harris's hematoxylin and eosin Y. Results: While almost all structures were similar to those of other species or adult elephants, some structures were different from other mammalian species, such as: plexiform bone was found in flat bone only; a thin trachealismuscle was observed in the trachea; and no serous or mucinous glands were found in the submucosa of the trachea. Discussion: Histological information from various organs can serve as an important foundation of basal data for future microanatomical studies, and help in the diagnosis and pathogenesis in sick elephants or those with an unknown cause of death. © 2018 Thitaram et al.

Torres, C. R. and J. A. Clarke (2018). "Nocturnal giants: evolution of the sensory ecology in elephant birds and other palaeognaths inferred from digital brain reconstructions." Proc Biol Sci **285**(1890).

The recently extinct Malagasy elephant birds (Palaeognathae, Aepyornithiformes) included the largest birds that ever lived. Elephant bird neuroanatomy is understudied but can shed light on the lifestyle of these enigmatic birds. Palaeoneurological studies can provide clues to the ecologies and behaviours of extinct birds because avian brain shape is correlated with neurological function. We digitally reconstruct endocasts of two elephant bird species, Aepyornis maximus and A. hildebrandti, and compare them with representatives of all major extant and recently extinct palaeognath lineages. Among palaeognaths, we find large olfactory bulbs in taxa generally occupying forested environments where visual cues used in foraging are likely to be limited. We detected variation in olfactory bulb size among elephant bird species, possibly indicating interspecific variation in habitat. Elephant birds exhibited extremely reduced optic lobes, a condition also observed in the nocturnal kiwi. Kiwi, the sister taxon of elephant birds, have effectively replaced their visual systems with hyperdeveloped olfactory, somatosensory and auditory systems useful for foraging. We interpret these results as evidence for nocturnality among elephant birds. Vision was likely deemphasized in the ancestor of elephant birds and kiwi. These results show a previously unreported trend towards decreased visual capacity apparently exclusive to flightless, nocturnal taxa endemic to predator-depauperate islands.

Tucker, M. A., et al. (2018). "Moving in the Anthropocene: Global reductions in terrestrial mammalian movements." Science **359**(6374): 466-469.

Animal movement is fundamental for ecosystem functioning and species survival, yet the effects of the anthropogenic footprint on animal movements have not been estimated across species. Using a unique GPS-tracking database of 803 individuals across 57 species, we found that movements of mammals in areas with a comparatively high human footprint were on average one-half to one-third the extent of their movements in areas with a low human footprint. We attribute this reduction to behavioral changes

of individual animals and to the exclusion of species with long-range movements from areas with higher human impact. Global loss of vagility alters a key ecological trait of animals that affects not only population persistence but also ecosystem processes such as predator-prey interactions, nutrient cycling, and disease transmission.

Turkalo, A. K., et al. (2018). "Demography of a forest elephant population." PLoS ONE **13**(2): e0192777. African forest elephants face severe threats from illegal killing for ivory and bushmeat and habitat conversion. Due to their cryptic nature and inaccessible range, little information on the biology of this species has been collected despite its iconic status. Compiling individual based monitoring data collected over 20 years from the Dzanga Bai population in Central African Republic, we summarize sex and age specific survivorship and female age specific fecundity for a cohort of 1625 individually identified elephants. Annual mortality (average = 3.5%) and natality (average = 5.3%) were lower and markedly less variable relative to rates reported for savanna elephant populations. New individuals consistently entered the study system, leading to a 2.5% average annual increase in the registered population. Calf sex ratios among known birth did not differ from parity. A weak seasonal signal in births was detected suggesting increased conceptions during the wet season. Inter-calf intervals and age of primiparity were longer relative to savanna elephant populations. Within the population, females between the ages of 25-39 demonstrated the shortest inter-calf intervals and highest fecundity, and previous calf sex had no influence on the interval. Calf survivorship was high (97%) the first two years after birth and did not differ by sex. Male and female survival began to differ by the age of 13 years, and males demonstrated significantly lower survival relative to females by the age of 20. It is suspected these differences are driven by human selection for ivory. Forest elephants were found to have one of the longest generation times recorded for any species at 31 years. These data provide fundamental understanding of forest elephant demography, providing baseline data for projecting population status and trends.

van de Water, A. and K. Matteson (2018). "Human-elephant conflict in western Thailand: Socio-economic drivers and potential mitigation strategies." PLoS ONE **13**(6): e0194736. Understanding human-wildlife conflict is an important first step in the conservation of highly endangered

species that can have adverse effects on human communities, such as elephants. To gain insights into variables that shape attitudes toward elephant conservation in Asia, we surveyed 410 households and 46 plantation owners in seven villages around the Salakpra Wildlife Sanctuary in western Thailand, an area of high human-elephant conflict. We sought to evaluate how past experiences with elephants (positive or negative), as well as socio-economic variables (age, income level, gender, and employment type) affect attitudes toward elephant conservation and coexistence in this area. In addition, we quantified deterrence methods currently used and identify potential mitigation strategies supported by community members. In general, less supportive attitudes toward elephant conservation and coexistence were held by individuals older than 35 years of age, those who had previously had experienced negative interactions with elephants, those with lower incomes, and those working in the agricultural sector. Conversely, those who had received benefits from living near elephants (e.g., supplemental income or feelings of pride from hosting volunteers or participating in conservation work) had more supportive views of elephant coexistence. Plantation owners reported using a variety of deterrence methods with varying success, with firecrackers being the most commonly utilized method. Community members identified several potentially beneficial mitigation strategies including forest restorations and patrol teams, adding water sources to wild elephant habitat, and education of local school and community groups. Overall, our results highlight the value of community members receiving benefits from living near elephants and suggest that special incentives may be needed for demographic groups disproportionately affected by elephants (e.g. those at lower income levels, those working in agriculture). A combination of these and other approaches will be required if human-elephant coexistence in western Thailand is to be realized.

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Vazquez, J. M., et al. (2018). "A Zombie LIF Gene in Elephants Is Upregulated by TP53 to Induce Apoptosis in Response to DNA Damage." <u>Cell Rep</u> **24**(7): 1765-1776.

> Large-bodied organisms have more cells that can potentially turn cancerous than small-bodied organisms, imposing an increased risk of developing cancer. This expectation predicts a positive correlation between body size and cancer risk; however, there is no correlation between body size and cancer risk across species ("Peto's paradox"). Here, we show that elephants and their extinct relatives (proboscideans) may have resolved Peto's paradox in part through refunctionalizing a leukemia inhibitory factor pseudogene (LIF6) with pro-apoptotic functions. LIF6 is transcriptionally upregulated by TP53 in response to DNA damage and translocates to the mitochondria where it induces apoptosis. Phylogenetic analyses of living and extinct proboscidean LIF6 genes indicates that its TP53 response element evolved coincident with the evolution of large body sizes in the proboscidean stem lineage. These results suggest that refunctionalizing of a pro-apoptotic LIF pseudogene may have been permissive (although not sufficient) for the evolution of large body sizes in proboscideans.

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Veerasami, M., et al. (2018). "Point of Care Tuberculosis Sero-Diagnosis Kit for Wild Animals: Combination of Proteins for Improving the Diagnostic Sensitivity and Specificity." <u>Indian J Microbiol</u> **58**(1): 81-92.

> Tuberculosis is a significant problem globally for domestic animals as well as captive and free ranging wild life. Rapid point of care (POC) serology kits are well suited for the diagnosis of TB in wild animals. However, wild animals are invariably exposed to environmental non-pathogenic mycobacterium species with the development of cross reacting antibodies. In the present study, POC TB diagnosis kit was developed using a combination of pathogenic Mycobacteria specific recombinant antigens and purified protein derivatives of pathogenic and non-pathogenic Mycobacteria. To benchmark the TB antibody detection kit, particularly in respect to specificity which could not be determined in wildlife due to the lack of samples from confirmed uninfected animals, we first tested well-characterized sera from 100 M. bovis infected and 100 uninfected cattle. Then we investigated the kit's performance using sera samples from wildlife, namely Sloth Bears (n = 74), Elephants (n = 9), Cervidae (n = 14), Felidae (n = 21), Cape buffalo (n = 2), Wild bear (n = 1) and Wild dog (n = 1).In cattle, a sensitivity of 81% and a specificity of 90% were obtained. The diagnostic sensitivity of the kit was 94% when the kit was tested using known TB positive sloth bear sera samples. 47.4% of the in-contact sloth bears turned seropositive using the rapid POC TB diagnostic kit. Seropositivity in other wild animals was 25% when the sera samples were tested using the kit. A point of care TB sero-diagnostic kit with the combination of proteins was developed and the kit was validated using the sera samples of wild animals.

Vijayakrishnan, S., et al. (2018). "Physiological stress responses in wild Asian elephants Elephas maximus in a human-dominated landscape in the Western Ghats, southern India." <u>Gen Comp Endocrinol</u> **266**: 150-156.

> Increasing anthropogenic pressures on forests, especially in the tropical regions of the world, have

restricted several large mammalian species such as the Asian elephant to fragmented habitats within human-dominated landscapes. In this study, we assessed the effects of an anthropogenic landscape and its associated conflict with humans on the physiological stress responses displayed by Asian elephants in the Anamalai Hills of the Western Ghats mountains in south India. We have quantified faecal glucocorticoid metabolite (FGM) concentrations in focal individual elephants within and across herds, inhabiting both anthropogenic and natural habitats, and evaluated their physiological responses to different socio-ecological situations between November 2013 and April 2014. Physiological stress responses varied significantly among the tested elephant age- and sex categories but not across different types of social organisation. Adults generally showed higher FGM concentrations, even in the absence of stressors, than did any other age category. Males also appeared to have higher stress responses than did females. Although there was no significant variation in mean stress levels between elephants on the plateau in the absence of human interactions and those in adjacent, relatively undisturbed forest habitats, FGM concentrations increased significantly for adult and subadult individuals as well as for calves following drives, during which elephants were driven off aggressively by people. Our study emphasises the general importance of understanding individual variation in physiology and behaviour within a population of a seriously threatened mammalian species, the Asian elephant, and specifically highlights the need for long-term monitoring of the stress physiology and behavioural responses of individual elephants across both human-dominated and natural landscapes. Such studies would not only provide comprehensive insights into the adaptive biology of elephants in changing ecological regimes but also aid in the development of effective management and conservation strategies for endangered populations of the species.

Walker, J. G., et al. (2018). "Prediction and attenuation of seasonal spillover of parasites between wild and domestic ungulates in an arid mixed-use system." J Appl Ecol **55**(4): 1976-1986.
Transmission of parasites between host species affects host population dynamics, interspecific competition, and ecosystem structure and function. In areas where wild and domestic herbivores share grazing land, management of parasites in livestock may affect or be affected by sympatric wildlife due to cross-species transmission. We develop a novel method for simulating transmission potential based on both biotic and abiotic factors in a semi-arid system in Botswana. Optimal timing of antiparasitic treatment in livestock is then compared under a variety of alternative host scenarios, including seasonally migrating wild hosts. In this region, rainfall is the primary driver of seasonality of transmission, but wildlife migration leads to spatial differences in the effectiveness of treatment in domestic animals. Additionally, competent migratory wildlife hosts move parasites across the landscape. Simulated transmission potential matches observed patterns of clinical disease in livestock in the study area. Increased wildlife contact is correlated with a decrease in disease, suggesting that non-competent wild hosts may attenuate transmission by removing infective parasite larvae from livestock pasture. Optimising the timing of treatment according to within-year rainfall patterns was considerably more effective than treating at a standard time of year. By targeting treatment in this way, efficient control can be achieved, mitigating parasite spillover from wildlife where it does occur. Synthesis and applications. This model of parasite transmission potential enables evidence-based management of parasite spillover between wild and domestic species in a spatio-temporally dynamic system. It can be applied in other mixed-use systems to mitigate parasite transmission under altered climate scenarios or changes in host ranges.

Wang, Z., et al. (2018). "Exploring the value of overseas biodiversity to Chinese netizens based on willingness to pay for the African elephants' protection." Sci Total Environ **637-638**: 600-608.
For a long time, Chinese people have been considered to be concerned only with commercial interests but not ecological systems and biodiversity conservation, even though their trade and investment footprints are globalizing rapidly. This study intended to reveal the non-market valuation on the non-use value of African elephant to Chinese people. Taking the ban of ivory trade as the background, in this

study, Chinese netizens' willingness to pay for African elephant conservation was investigated using the contingent valuation method. Four versions of questionnaires were designed and distinguished by offering different background information and payment vehicles (tax and donation). It was demonstrated that the differences in both given information and payment vehicles had no significant impacts on the estimated mean willingness to pay value. 53.36% of the respondents gave positive responses for the hypothetical projects of African elephant protection. The mean willingness to pay was 83.62 RMB (12.59 USD) and 158.58 RMB (23.88 USD) per year per household and the aggregated willingness to pay or benefits for the protection of African elephants from Chinese netizens were estimated to be 16.31 billion RMB (2.45 billion USD) and 30.92 billion RMB (4.65 billion USD) per year after grouping regression and benefit transfer adjustments, respectively. The current research shows that Chinese people, living thousands kilometers away from Africa, have a high public awareness for and valuation to the endangered elephants.

Wasser, S. K., et al. (2018). "Combating transnational organized crime by linking multiple large ivory seizures to the same dealer." <u>Sci Adv</u> **4**(9): eaat0625.

Rapid growth in world trade has enabled transnational criminal networks to conceal their contraband among the 1 billion containers shipped worldwide annually. Forensic methods are needed to identify the major cartels moving the contraband into transit. We combine DNA-based sample matching and geographic assignment of tusks to show that the two tusks from the same elephant are often shipped by the same trafficker in separate large consignments of ivory. The paired shipments occur close in time from the same initial place of export and have high overlap in the geographic origins of their tusks. Collectively, these paired shipments form a linked chain that reflects the sizes, interconnectedness, and places of operation of Africa's largest ivory smuggling cartels.

Williams, E., et al. (2018). "A review of current indicators of welfare in captive elephants (Loxodonta africana and Elephas maximus)." <u>Animal Welfare</u> **27**(3): 235-249.

Concerns over elephant welfare in UK zoos have implications for their future in captivity. To monitor improvements made to elephant welfare in UK zoos, non-invasive, valid and reliable indicators of welfare are needed. Using a rapid review strategy and critical appraisal tool, we aimed to appraise evidence from peer-reviewed literature on potential welfare indicators for captive elephants. Scopus, Web of Knowledge and Ovid were searched in January 2014 using terms relevant to captive elephants and welfare assessment. Inclusion and exclusion criteria were applied and remaining articles were critically appraised against a specially designed welfare indicator appraisal tool. Thirty-seven unique indicators of welfare were extracted from 30 peer-reviewed papers which met the inclusion criteria. Behavioural measures of welfare (n = 21) were more common than either physical (n = 11) or physiological (n = 5) measures. Stereotypies were the most frequently used behavioural measure, glucocorticoids were the most frequently used physiological measure and body condition scores were the most frequently used physical measure. There was most support for the following indicators of improved welfare state: reduced stereotypies, reduced glucocorticoids and improved body condition scores. Additional measures which require further validation but had strong associations with the most supported measures, and thus have potential use in welfare assessment, were: increased lying rest and positive social interactions. Further validation of the described measures is needed, but this information forms a crucial part of the knowledge required to efficiently monitor and improve the welfare of elephants in captivity. © 2018 Universities Federation for Animal Welfare.

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Winters, M., et al. (2018). "Isolation of DNA from small amounts of elephant ivory: Sampling the cementum with total demineralization extraction." Forensic Sci Int **288**: 131-139.

Genotyping ivory samples can determine the geographic origin of poached ivory as well as the legality of ivory being sold in ivory markets. We conducted a series of experiments to determine where the DNA is most concentrated in ivory samples and how best to increase DNA yield from groups of samples likely to vary in DNA concentration. We examined variation in DNA amplification success from: the layer(s) of the tusk (cementum and/or dentine) being extracted, demineralization temperature and time, and the concentration of eluates. Since demineralization of the pulverized sample produces a pellet and supernatant, we also assessed DNA amplification success from the pellet, the supernatant, their combination, as well as variation in the respective amounts used for extraction. Our results show that the outer cementum layer of the tusk contains the highest concentration of DNA and should be separated and used exclusively as the source material of ivory processed for extraction, when available. Utilizing the combined demineralized lysate improves extraction efficiency, as does increasing demineralization time to 3 or more days, conducted at 4 degrees C. The most significant improvements occurred for low template DNA ivory samples followed by medium quality samples. Amplification success of high quality samples was not affected by these changes. Application of this optimized method to 3068 ivory samples resulted in 81.2% of samples being confirmed for both alleles at a minimum of 10 out of 16 microsatellite loci, which is our threshold for inclusion in DNA assignment analyses.

Wright, M. G., et al. (2018). "African bush elephants respond to a honeybee alarm pheromone blend." Curr Biol **28**(14): R778-r780.

We here report the responses of African bush elephants (Loxodonta africana) to a crude approximation of the honeybee alarm pheromone blend. We show that the elephants had an avoidance response to the semiochemical blend. The use of honeybee alarm pheromones to manage elephant movements in a non-invasive manner, using natural cues to which elephants may have an evolved response, holds potential for development of new options for an integrated system for elephant movement management and protection.

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Wu, Y., et al. (2018). "A grazing Gomphotherium in Middle Miocene Central Asia, 10 million years prior to the origin of the Elephantidae." Sci Rep **8**(1): 7640.
> Feeding preference of fossil herbivorous mammals, concerning the coevolution of mammalian and floral ecosystems, has become of key research interest. In this paper, phytoliths in dental calculus from two gomphotheriid proboscideans of the middle Miocene Junggar Basin, Central Asia, have been identified, suggesting that Gomphotherium connexum was a mixed feeder, while the phytoliths from G. steinheimense indicates grazing preference. This is the earliest-known proboscidean with a predominantly grazing habit. These results are further confirmed by microwear and isotope analyses. Pollen record reveals an open steppic environment with few trees, indicating an early aridity phase in the Asian interior during the Mid-Miocene Climate Optimum, which might urge a diet remodeling of G. steinheimense. Morphological and cladistic analyses show that G. steinheimense comprises the sister taxon of tetralophodont gomphotheres, which were believed to be the general ancestral stock of derived "true elephantids"; whereas G. connexum represents a more conservative lineage in both feeding behavior and tooth morphology, which subsequently became completely extinct. Therefore, grazing by G. steinheimense may have acted as a behavior preadaptive for aridity, and allowing its lineage evolving new morphological features for surviving later in time. This study displays an interesting example of behavioral adaptation prior to morphological modification.

Yano, T., et al. (2018). "The Effectiveness of a Foot and Mouth Disease Outbreak Control Programme in Thailand 2008-2015: Case Studies and Lessons Learned." Vet Sci **5**(4).
> Three Foot and Mouth Disease (FMD) outbreaks in northern Thailand that occurred during the implementation of the national FMD strategic plan in 2008(-)2015 are described to illustrate the lessons learned and to improve the prevention and control of future outbreaks. In 2008, during a FMD outbreak on a dairy farm, milk delivery was banned for 30 days. This was a part of movement management, a key strategy for FMD control in dairy farms in the area. In 2009, more than half the animals on a pig farm were affected by FMD. Animal quarantine and restricted animal movement played a key role in preventing the spread of FMD. In 2010, FMD infection was reported in a captive elephant. The suspected source of virus was a FMD-infected cow on the same premises. The infected elephant was moved to an elephant hospital that was located in a different province before the diagnosis was confirmed. FMD education was given to elephant veterinarians to promote FMD prevention and control strategies in this unique species. These three cases illustrate how differences in outbreak circumstances and species require the implementation of a variety of different FMD control and prevention measures. Control measures and responses should be customized in different outbreak situations.

Yoshida, S., et al. (2018). "Mycobacterium caprae Infection in Captive Borneo Elephant, Japan." Emerg Infect Dis **24**(10): 1937-1940.
> In 2016, disseminated tuberculosis caused by Mycobacterium caprae was diagnosed in a captive Borneo elephant in Japan. The bacterium was initially identified from clinical isolates. An isolate collected during a relapse showed isoniazid monoresistance and a codon 315 katG mutation.

Zachariah, A., et al. (2018). "Extended genotypic evaluation and comparison of twenty-two cases of lethal EEHV1 hemorrhagic disease in wild and captive Asian elephants in India." PLoS ONE **13**(8): e0202438.
> Thirteen new lethal cases of acute hemorrhagic disease (HD) with typical histopathogical features were identified in young Asian elephants (Elephas maximus indicus) in India between 2013 and 2017. Eight occurred amongst free-ranging wild herds, with three more in camp-raised orphans and two in captive-

born calves. All were confirmed to have high levels of Elephant Endotheliotropic Herpesvirus type 1A (EEHV1A) DNA detected within gross pathological lesions from necropsy tissue by multi-locus PCR DNA sequencing. The strains involved were all significantly different from one another and from nine previously described cases from Southern India (which included one example of EEHV1B). Overall, eight selected dispersed PCR loci totaling up to 6.1-kb in size were analyzed for most of the 22 cases, with extensive subtype clustering data being obtained at four hypervariable gene loci. In addition to the previously identified U48(gH-TK) and U51(vGPCR1) gene loci, these included two newly identified E5(vGPCR5) and E54(vOX2-1) loci mapping far outside of the classic EEHV1A versus EEHV1B subtype chimeric domains and towards the novel end segments of the genome that had not been evaluated previously. The high levels of genetic divergence and mosaic scrambling observed between adjacent loci match closely to the overall range of divergence found within 45 analyzed North American and European cases, but include some common relatively unique polymorphic features and preferred subtypes that appear to distinguish most but not all Indian strains from both those in Thailand and those outside range countries. Furthermore, more than half of the Indian cases studied here involved calves living within wild herds, whereas nearly all other cases identified in Asia so far represent rescued camp orphans or captive-born calves.