Recent Publications on Asian Elephants

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If you need additional information on any of the articles, please feel free to contact me.

V. Aditya & T. Ganesh
Mammals of Papikonda Hills, northern Eastern Ghats, India
J. of Threatened Taxa 9 (2017) 10823-10830
Abstract. Papikonda National Park covering an area of 1,012 km^2 holds high conservation value as the only national park in the geographically vast northern Eastern Ghats. The tropical moist deciduous forests support species assemblages characteristic of the Eastern Ghats. We conducted the first comprehensive assessment of the mammal diversity in Papikonda National Park using camera traps, sign surveys and community interviews between October 2014 and March 2015, combined with a comprehensive literature review of research articles, field guides and IUCN species range reports. A total of 55 species from 46 genera belonging to 24 families were enumerated. There was a high diversity of carnivores (15 species), followed by chiropterans (13 species) and rodents (11 species).

D.M. Arnold, C. Gray, T.L. Roth, S. Mitchell & L.H. Graham
A simple, field-friendly technique for cryopreserving semen from Asian elephants (*Elephas maximus*)
Animal Reproduction Science 182 (2017) 84-94
Abstract. The specific objectives of the present study were to investigate the effects of manual seeding, differing freeze and thaw rates as well as storage for 24 h at 4°C prior to cryopreservation on post-thaw sperm quality in Asian elephants. Extended semen was cooled in an equitainer to 4°C, frozen in liquid nitrogen vapour at various rates with and without manual seeding or in a dry shipper and thawed at 37, 50 and 75°C. There was a significant effect of freeze rate on post-thaw motility ($P<0.0001$) and acrosomal integrity ($P<0.005$). The faster freeze rates in the dry shipper and at 1 cm or 2 cm above liquid nitrogen consistently provided better cryopreservation than slower freezing rates. Thaw temperature had no effect on post-thaw semen quality but there was an interaction between freeze and thaw rates with higher thaw rates resulting in superior post-thaw semen quality in straws frozen at fast rates. Storage of samples prior to freezing had a detrimental effect on post-thaw semen quality. In summary, our results indicate cooling extended semen in an equitainer and cryopreserving it by placing straws directly in a dry shipper is a simple technique for effectively cryopreserving Asian elephant semen in the field or zoo.

H.A. Asquith-Barnes, L. Sambrook, N.J. Masters, P. Kertesz & F.M. Molenaar
Operant conditioning facilitates safe induction and appropriate positioning for molar extraction under general anaesthetic in an Asian elephant (*Elephas maximus*)
VetRecord 5 (2017) e000455
Abstract. An Asian elephant (*Elephas maximus*) suffering from dental malocclusion was anaesthetised for dental treatment using etorphine. The main risks of the procedure were trauma, associated with falls during sedation, and malpositioning, preventing access to the oral cavity. To reduce these risks the elephant was trained, using operant conditioning, to lie down in the required position and accept hand injections. Induction was straightforward and no repositioning was required under anaesthesia. One molar was extracted and another reshaped to improve occlusion and prevent soft tissue trauma. The anaesthetic was reversed within

two hours of induction, and the elephant was manually assisted by the keepers to stand up. Operant conditioning proved invaluable during this procedure by improving staff and animal safety by enabling controlled hand injection of potent opioids instead of remote injection; allowing correct positioning prior to induction, greatly reducing anaesthetic time; and allowing a swift-assisted recovery post reversal. © British Veterinary Association.

V. K. Bhagat, D. K. Yadav & M. K. Jhariya

A comprehensive study on ecological aspect, feeding behaviour and pugmark analysis of elephants in the bordering areas of northern Chhattisgarh

Journal of Human Ecology 58 (2017) 41-47

Abstract. The study attempted to examine the ecological aspect, feeding behaviour with food preferences and pugmark analysis in four blocks viz, Kunkuri, Duldula, Bagicha and Farsabahar of northern Chhattisgarh. The field study was conducted through well structured questionnaires in the affected villages/forest areas where migrated elephants were encountered. Among the different pressing issues related to farming in the study area the major obstacle was wildlife especially the elephants (55%). The most commonly consumed species belong to family Poaceae and Fabaceae (17.65%) followed by Moraceae (14.71%). Elephants extensively feed on *Artocarpus heterophyllus*, *Syzygium cumini*, *Acacia nilotica*, *A. catechu*, *Dalbergia sissoo*, *Zizyphus mauritiana*, *Aegle marmelos* and *Ficus species*, besides various grasses and shrubs. Analysis of pugmarks revealed that the circumference varied from 51.55 cm to 165 cm. Therefore, it is needful to carry out detailed assessment of feeding behaviour, habitat suitability and dispersal corridor for elephants in the area for better understanding, planning, conservation and management of wildlife. © 2017 Kamla-Raj.

T. Bouts, J. Dodds, K. Berry, A. Arif, P. Taylor, A. Routh & F. Gasthuys

Detomidine and butorphanol for standing sedation in a range of zoo-kept ungulate species

Journal of Zoo and Wildlife Medicine 48 (2017) 616-626

Abstract. General anesthesia poses risks for larger zoo species, like cardiorespiratory depression, myopathy, and hyperthermia. In ruminants, ruminal bloat and regurgitation of rumen contents with potential aspiration pneumonia are added risks. Thus, the use of sedation to perform minor procedures is justified in zoo animals. A combination of detomidine and butorphanol has been routinely used in domestic animals. This drug combination, administered by remote intramuscular injection, can also be applied for standing sedation in a range of zoo animals, allowing a number of minor procedures. The combination was successfully administered in five species of nondomesticated equids (Przewalski horse [n = 1], onager [n = 4], kiang [n = 3], Grevy's zebra [n = 4], and Somali wild ass [n = 7]), with a mean dose range of 0.10–0.17 mg/kg detomidine and 0.07–0.13 mg/kg butorphanol; the white (n = 12) and greater one-horned rhinoceros (n = 4), with a mean dose of 0.015 mg/kg of both detomidine and butorphanol; and Asiatic elephant bulls (n = 2), with a mean dose of 0.018 mg/kg of both detomidine and butorphanol. In addition, the combination was successfully used for standing sedation in six species of artiodactylids: giraffe (n = 3), western bongo (n = 2), wisent (n = 5), yak (n = 1), water buffalo (n = 4) and Bactrian camel (n = 5). The mean dose range for artiodactylid species except bongo was 0.04–0.06 mg/kg detomidine and 0.03–0.06 mg/kg butorphanol. The dose in bongo, 0.15–0.20 mg/kg detomidine and 0.13–0.15 mg/kg butorphanol, was considerably higher. Times to first effect, approach, and recovery after antidote were short. The use of detomidine and butorphanol has been demonstrated to be a reliable, safe alternative to general anesthesia for a number of large ungulate species. © 2017 American Association of Zoo Veterinarians.

K. Buddhachat, W. Kriangwanich, I. Kumoun, J.L. Brown, S. Chailangkarn, C. Somgird, C. Thitaram, S. Prasitwattanaseree & K. Nganvongpanit

Telomeric attrition with increasing age in short- (Chihuahua dog) and long- (Asian elephant) life span animals

Kafkas Univ Vet Fak Derg 23 (2017) 643-649

Abstract. Here, we explored the rate of telomere

attrition with increasing age by real-time quantitative PCR (qPCR) in a short- (Chihuahua dog) and long- (Asian elephant) lived species. A total of 122 Asian elephants (female = 106, male = 16) ranging from 24–840 months of age, and 89 Chihuahuas (female = 65, male = 24) 1–179 months of age were used in this study. We found that young (pre- and peri-pubertal) Asian elephants had a higher relative telomere length (RTL) compared to dogs. A low, but significant negative relationship between RTL and increasing age was observed in both Chihuahuas (R^2 = 0.0490, P = 0.0017) and Asian elephants (R^2 = 0.0177, P = 0.0210). The estimated rate of telomere loss for males and females of both species ranged from -0.0023 to -0.0065, with no clear differences between gender or species. Results suggest that Asian elephants may start with longer telomeres than Chihuahuas, as RTL was higher, but then the rate of telomere attrition proceeds at a similar rate in both species. Age accounted for only a small percentage of the variation in RTL in both Chihuahua dogs and Asian elephants, however. Thus, its use as a biological tool for age estimation would appear to be limited for these species.

A. Calabrese, J.M. Calabrese, M. Songer, M. Wegmann, S. Hedges, R. Rose & P. Leimgruber

Conservation status of Asian elephants: The influence of habitat and governance

Biodiversity and Conserv. 26 (2017) 2067-2081

Abstract. Understanding the drivers of Asian elephant (*Elephas maximus*) abundance and distribution is critical for effective elephant conservation, yet no such analysis exists despite decades of assessments and planning. We explored the influence of habitat- and governance-related drivers on elephant abundance across the 13 Asian elephant range countries. We tested competing statistical models by integrating a binary index of elephant abundance (IEA) derived from expert knowledge with different predictor variables including habitat, human population, socioeconomics, and governance data. We employed logistic regression and model-averaging techniques based on Akaike's Information Criterion to identify the best-performing subset among our 12 candidate models and used the model-averaged results to predict IEA in other areas in Asia where elephant population status is currently unknown. Forest area was our strongest single predictor variable. The best performing model, however, featured a combination of habitat and governance variables including forest area, level of corruption, proportional mix of forest and agriculture, and total agricultural area. Our predictive model identified five areas with medium–high to high probability to have populations with >150 elephants, which we believe should be surveyed to assess their status. Asian elephants persist in areas that are dominated by forest but also seem to benefit from a mix of agricultural activities. A relatively low level of corruption is also important and we conclude that effective governance is essential for maintaining Asian elephant populations. Asian elephant populations cannot be maintained solely in protected areas but need well-managed, mixed-use landscapes where people and elephants coexist.

S. Chomdej, W. Saokeaw, K. Buddhachat, W. Pradit, P. Siengdee, S. Mahasawangkul, S. Sripiboon, C. Somgrid, K. Nganvongpanit, S. Ongchai & C. Thitaram

Identification, characterization and expression analysis of biglycan in Asian elephant (*Elephas maximus*)

Kafkas Univ Vet Fak Derg 23 (2017) 997-1001

Abstract. The aims of this study were to investigate the coding sequence and the deduced amino acid sequence of Asian elephant's biglycan gene as well as its expression in different tissues and conditions using wound healing as a model. The results showed that Asian elephant biglycan coding sequence was 1,110 base pair (bp) long (accession number: JQ753329), encoding 369 amino acids. The coding and amino acid sequences between Asian and African elephants revealed 99% and 98% similarity, respectively. The conserved domains of biglycan protein were also observed. In addition, its expression was found in 15 tissues with a predominant expression in cartilage and spleen. For expression analysis in the wound healing process, it was found that the level of biglycan mRNA was influenced by many factors, including age, type of wound and stage of wound healing.

Richard T. Corlett

Frugivory and seed dispersal by vertebrates in tropical and subtropical Asia: An update

Global Ecology and Conservation 11 (2017) 1-22

Abstract. Seed dispersal is a key process in plant communities and frugivory is very important in vertebrate communities. This paper updates a review of frugivory and seed dispersal by vertebrates in the Oriental Region (tropical and subtropical Asia) published in 1998. The major conclusions remain the same. Small fruits are consumed by a wide range of potential seed dispersal agents, including species that thrive in small forest fragments and degraded landscapes. Larger and larger-seeded fruits are consumed by progressively fewer dispersers, and the largest depend on a few species of mammals and birds which are highly vulnerable to hunting, fragmentation, and habitat loss. Controlling hunting in both forest areas and the agricultural matrix must be a top priority for conservation. A lot more natural history information has been added to the literature since 1998. This reinforces previous evidence for the importance of hornbills, bulbuls, elephants, gibbons, civets, and fruit bats in seed dispersal, and suggests that the roles of green pigeons, macaques, rodents, bears, and deer were previously underestimated. The taxa for which additional natural history observations would be most valuable include fish, pheasants, pigeons, babblers, rodents, and even-toed ungulates. For other animal taxa, future frugivory and seed dispersal studies need to focus more on the fitness consequences for both the plants and the animals.

J.A.H. Crawley, H.S. Mumby, S.N. Chapman, M. Lahdenperä, K.U. Mar, W. Htut, A.T. Soe, H.H. Aung & V. Lummaa

Is bigger better? The relationship between size and reproduction in female Asian elephants

J. of Evolutionary Biology 30 (2017) 1836-1845

Abstract. The limited availability of resources is predicted to impose trade-offs between growth, reproduction and self-maintenance in animals. However, whilst some studies have shown that early reproduction suppresses growth, reproduction positively correlates with size in others. We use detailed records from a large population of semi-captive elephants in Myanmar to assess the relationships between size (height and weight), reproduction and survival in female Asian elephants, a species characterised by slow, costly life history. Although female height gain during the growth period overlapped little with reproductive onset in the population, there was large variation in age at first reproduction and only 81% of final weight had been reached by peak age of reproduction at the population level (19 yrs). Those females beginning reproduction early tended to be taller and lighter later in life, though these trends were not significant. We found that taller females were more likely to have reproduced by a given age, but such effects diminished with age, suggesting there may be a size threshold to reproduction which is especially important in young females. Because size was not linked with female survival during reproductive ages, the diminishing effect of height on reproduction with age is unlikely to be due to biased survival of larger females. We conclude that although reproduction may not always impose significant costs on growth, height may be a limiting factor to reproduction in young female Asian elephants, which could have important implications considering birth rates are low and peak reproduction is young – 19 years in this population.

G. Ghielmetti, M. Coscolla, M. Ruetten, U. Friedel, C. Loiseau, J. Feldmann, H.W. Steinmetz, D. Stucki & S. Gagneux

Tuberculosis in Swiss captive Asian elephants: Microevolution of *Mycobacterium tuberculosis* characterized by multilocus variable-number tandem-repeat analysis and whole-genome sequencing

Scientific Reports 7 (2017) e14647

Abstract. Zoonotic tuberculosis is a risk for human health, especially when animals are in close contact with humans. *Mycobacterium tuberculosis* was cultured from several organs, including lung tissue and gastric mucosa, of three captive elephants euthanized in a Swiss zoo. The elephants presented weight loss, weakness and exercise intolerance. Molecular characterization of the *M. tuberculosis* isolates by spoligotyping revealed an identical profile, suggesting a single source of infection. Multilocus variable-

number of tandem-repeat analysis (MLVA) elucidated two divergent populations of bacteria and mixed infection in one elephant, suggesting either different transmission chains or prolonged infection over time. A total of eight *M. tuberculosis* isolates were subjected to whole-genome sequence (WGS) analysis, confirming a single source of infection and indicating the route of transmission between the three animals. Our findings also show that the methods currently used for epidemiological investigations of *M. tuberculosis* infections should be carefully applied on isolates from elephants. Moreover the importance of multiple sampling and analysis of within-host mycobacterial clonal populations for investigations of transmission is demonstrated.

A. Giljov, S. de Silva & K. Karenina

Context-dependent lateralization of trunk movements in wild Asian elephants

Biological Communications 62 (2017) 82-92

Asymmetrical trunk use in elephants represents a distinctive example of motor lateralization. Previous studies have shown that trunk movements in the elephant behaviour associated with feeding is lateralized at the individual, but not the population level. The manifestation of lateralized behaviour depends on the nature of the behaviour and is usually more pronounced in social context. Therefore, we hypothesized that population-level lateralization of trunk use in elephants is manifested in social behaviour. One-sided biases in trunk movements were assessed in wild individually-identified Asian elephants during feeding (tearing off a tuft of grass) and social interactions (trunk-to-mouth contacts and trunk-to-genitals contacts between male initiator and female recipient). In feeding, lateralization at the individual and population levels was estimated based on 50 lateral trunk uses per individual. In social interactions, only the population-level bias was assessed using a single trunk contact from each individual. For trunk movements during feeding, elephants showed robust individual preferences, but no population-level lateralization. The distribution of right- and left-trunkers in the present study did not differ significantly from that obtained in previous studies of both the same elephant population and geographically distinct population. No population-level bias in trunk movements during trunk-to-mouth contacts was revealed. In trunk-to-genitals contacts, in contrast, a population-level lateralization was found. Right-sided trunk movements prevailed in males touching females. While individual preferences for feeding, combined with the absence of one-sided population bias, is obviously a species-typical characteristic of Asian elephants, social behaviour, such as male-female socio-sexual contacts, can elicit population-level lateralization of trunk use in this species. The right-sided bias in trunk-to-genitals contacts may reflect lateralization of olfactory perception. If this is the case, the revealed lateralization indicates a right-hemispheric advantage in the processing of social information which is consistent with the general tendency in mammals.

K.K. Karanth & S. Kudalkar

History, location, and species matter: Insights for human-wildlife conflict mitigation from India

Human Dimensions of Wildlife 22 (2017) 331-46

Abstract. Preventing loss of crops, threats to livestock, damage to property, and human injury and death attributed to wildlife are conservation challenges. We surveyed over 5,000 households around 11 reserves in India to examine these issues and mitigation efforts. Crops were lost by 71% of households, livestock by 17%, and human injury and death were reported by 3% of households (losses attributed to 32 species). Households deployed 12 mitigation measures with nighttime watching, scare devices, and fencing used the most. A household's conflict history (>20 years for livestock loss, 10–20 years for crop loss), proximity to reserves, and crops grown or livestock owned were associated with higher mitigation use. There were differences across reserves, with households in Rajasthan least likely to use mitigation. Crop protection (88%) was more likely than livestock protection (32%). Investments in conflict mitigation should consider the history, location, species, socioeconomic variations among households, and differences in regional policies. © 2017 Taylor & Francis Group.

W.K. Kiso, E. Wiedner, R. Isaza, W. Lindsay, J. Aria, G. Jacobson, K. Jacobson & D. Schmitt

Reproductive parameters and birth statistics for a herd of Asian elephants (*Elephas maximus*) in North America over a 20-year period

Journal of Zoo and Wildlife Medicine 48 (2017) 987-996

Abstract. We reviewed medical records documenting 28 pregnancies occurring within a herd of Asian elephants (*Elephas maximus*) over a 20-yr (1994–2014) period at a private facility in the southeastern United States. Twenty-six pregnancies resulted in live calves and two ended in stillbirths. The 26 live births represented the offspring of 11 cows and 5 bulls. Twenty-four calves survived their first year, including two critically ill calves born after dystocias. Male and female calves occurred in almost equal numbers. Mean duration of labor in this group was 36 hr although the median duration was 13 hr. Although oxytocin was administered to several cows, parturition did not always immediately ensue. Female fecundity ranged from 1–6 calves while female age at parturition ranged from 9–46 yr. Females delivered their first calves between 9 and 26 yr of age whereas bulls sired their first calves in their 20s, on average. The number of live births and the 93% calf survival rate are among the highest reported in any western hemisphere elephant-holding facility. This may reflect the intensive management of cows before, during, and after each pregnancy, the number of experienced multiparous cows, and the skill level of staff, most of whom had worked with each other and with this herd for many years. The data presented here may assist facilities planning to breed Asian elephants. © 2017 American Association of Zoo Veterinarians.

T. Kitpipit, K. Thongjued, K. Penchart, K. Ouithavon & W. Chotigeat

Mini-SNaPshot multiplex assays authenticate elephant ivory and simultaneously identify the species origin

Forensic Science International: Genetics 27 (2017) 106-115

Abstract. Illegal trading of ivory is mainly responsible for the dramatic decline in elephant populations. Thailand is one of the largest laundering hotspots for African ivory, as the domestic Asian elephant ivory can be legally traded. So, to help combat ivory poaching and smuggling, an efficient method is needed to identify the elephant species from its ivory and ivory products. In this study, a mini-SNaPshot® multiplex assay was developed and fully validated for the identification of confiscated ivory and low DNA template ivory products. Elephantid- and elephant species-specific mitochondrial single nucleotide polymorphisms (SNPs) were identified from 207 mammalian and 1705 elephant/mammoth cytochrome b sequence alignments. Seven informative SNPs were used for assay development. The assay unambiguously and accurately identified authentic elephant ivory and its species of origin on the basis of peak size and color observed in the haplotype profile. The assay was highly efficient for analysis of confiscated ivory and low-template ivory products with a 99.29% success rate (N = 140). It was highly reproducible, exhibited no cross-reaction with eight other mammalian DNA; and had 100% identification accuracy. In addition, nested and direct PCR amplification were also compatible with the developed assay. This efficient assay should benefit wildlife forensic laboratories and aid in the prosecution of elephant-related crimes. © 2016 Reprinted with permission from Elsevier.

L. Kroutnoi, T. Sriburi, S. Wijitkosum & K. Nuanyai

Assessment of elephant dietary biomass at the adjoining area of Kaeng Krachan Natural Park, Thailand

Applied Environmental Res. 39 (2017) 33-40

Abstract. This study investigated the dietary diversity and biomass of the elephants (*Elephas maximus*) ranging in the area adjoining Kaeng Krachan Natural Park, Pa Deng Sub-District, Kaeng Krachan District, Petchaburi Province, Thailand. The investigation was conducted by reconnaissance survey transect (Recce) combined with concentric sample plots with 3 different radii to observe vegetation and collect data on trees, saplings, seedlings, and undergrowth from 89 locations in the study area. Six transects along elephant feeding trails were surveyed at 200 m intervals within 15 m from the center of both sides of each line. The vegetation comprised in

all 57 families and 140 plant species, of which 28 families and 51 species formed part of the elephant diets. The average biomass in the study area ranged from 83.14–658.63 tons/ha, with an average of 250.00 tons/ha. Huay Rae - Hub Pla Kang trail found the greatest amount of biomass which is 658.63 tons/ha.

P. Liu, H. Wen, F.K. Harich, C. He, L. Wang, X. Guo, J. Zhao, A. Luo, H. Yang, X. Sun, Y. Yu, S. Zheng, J. Guo, L. Li & L. Zhang

Conflict between conservation and development: Cash forest encroachment in Asian elephant distributions

Scientific Reports 7 (2017) e6404

Abstract. Over the last 4 decades, China has undergone major economic development, resulting in considerable impacts on its wildlife populations and habitats. It is essential to quantify the conflict between development and conservation to assist with policy-making because forestry policies and market trends affected indirectly the distribution of Asian elephants. Here, we mapped the historical distribution of elephants versus human land use. Elephant distributions appear to occur in unbroken natural forests only. However, over the 40-year period, the distribution ranges have become smaller and fragmented, with natural forest area also declining by 16%. The monoculture of cash trees is encroaching on natural forests. Over the past 10 years, rubber plantations have become concentrated in the south, with extensive natural forests and scattered rubber farms being converted to tea plantations, due to changes in governmental policies and product prices. Through mapping the spatial changes in the distribution of rubber and tea plantations, our study is expected to help local managers to incorporate the needs of endangered elephants through creating space when planning plantations, especially in Xishuangbanna and the south part of Pu'er. In conclusion, restoring elephant habitat and establishing ecological corridors are critical for the survival of elephants in this region. © 2017 The Authors.

J. Lopez, J. Haycock, A. Mckenzie, K. Seilern-Moy & A. Dastjerdi

Assessment of a lancet-and-swab blood sampling technique for surveillance of elephant endotheliotropic herpesvirus infection

Journal of Zoo and Wildlife Medicine 48 (2017) 659-667

Abstract. Lancing a finger elicits minimal pain in humans and is applied routinely to obtain small volumes of blood for clinical diagnostics. A modified lancet bleeding method and several blood sampling matrices were evaluated in this study for the purpose of routine elephant endotheliotropic herpesvirus (EEHV) surveillance in Asian elephants (*Elephas maximus*). The procedure enabled weekly sampling from elephants as young as 9 mo of age. The blood sampling matrices were evaluated for their sensitivity measuring b-actin, tumor necrosis factor a, and/or EEHV-1 by quantitative polymerase chain reaction assays. Foam and flocked swabs produced significantly ($P<0.05$) lower quantitation cycles, ie, increased analytical sensitivity, than filter papers, Whatmant FTA cards, or conventional cotton-tipped swabs. The two swab types also demonstrated comparable analytical sensitivity to that of a similar volume of EDTA whole blood for the detection of EEHV-1 DNA. This lancet-and-swab technique proved satisfactory for the detection of EEHV-1 viremia in two Asian elephant calves, and in one instance viremia could be detected 5 days prior to the development of clinical signs. Low blood yield from the lancet application may reduce sensitivity and compromise early detection of viremia. Therefore, standard venipuncture remains the recommended blood sampling method, and training for consistent and regular vein access should continue to be the priority for collections holding elephants. However, if appropriate measures are taken to collect an optimum blood volume, this lancet-and-swab technique offers a suitable alternative for EEHV surveillance in situations where venipuncture may not be practical. © 2017 American Association of Zoo Veterinarians.

C.L. Lynsdale, H.S. Mumby, A.D. Hayward, K.U. Mar & V. Lummaa

Parasite-associated mortality in a long-lived mammal: Variation with host age, sex, and reproduction

Ecology and Evolution 7 (2017) 10904-10915

Abstract. Parasites can cause severe host

morbidity and threaten survival. As parasites are generally aggregated within certain host demographics, they are likely to affect a small proportion of the entire population, with specific hosts being at particular risk. However, little is known as to whether increased host mortality from parasitic causes is experienced by specific host demographics. Outside of theoretical studies, there is a paucity of literature concerning dynamics of parasite-associated host mortality. Empirical evidence mainly focuses on short-lived hosts or model systems, with data lacking from long-lived wild or semi-wild vertebrate populations. We investigated parasite-associated mortality utilizing a multigenerational database of mortality, health, and reproductive data for over 4,000 semi-captive timber elephants (*Elephas maximus*), with known causes of death for mortality events. We determined variation in mortality according to a number of host traits that are commonly associated with variation in parasitism within mammals: age, sex, and reproductive investment in females. We found that potentially parasite-associated mortality varied significantly across elephant ages, with individuals at extremes of lifespan (young and old) at highest risk. Mortality probability was significantly higher for males across all ages. Female reproducers experienced a lower probability of potentially parasite-associated mortality than females who did not reproduce at any investigated time frame. Our results demonstrate increased potentially parasite-associated mortality within particular demographic groups. These groups (males, juveniles, elderly adults) have been identified in other studies as susceptible to parasitism, stressing the need for further work investigating links between infection and mortality. Furthermore, we show variation between reproductive and non-reproductive females, with mothers being less at risk of potentially parasite mortality than nonreproducers.

J. Ma, Yuan Wang, C. Jin, Y. Yan, Y. Qu & Y. Hu,
Isotopic evidence of foraging ecology of Asian elephant (*Elephas maximus*) in South China during the Late Pleistocene
Quaternary International 443A (2017) 160-167
Abstract. Currently, knowledge of dietary preferences throughout the evolutionary history of the Asian elephant *Elephas maximus* is ambiguous due to the absence of quantified proxy from the Late Pleistocene. In this study, carbon and oxygen stable isotope analysis on the fossilized mammal teeth from the faunal assemblage recovered at Baxian Cave in Guangxi, South China was undertaken in order to reconstruct the dietary behavior and foraging ecology of *Elephas maximus* during the Late Pleistocene. The analyses of X-ray Diffraction (XRD) and Fourier Transform Infrared Spectroscopy (FTIR) on several samples showed that all teeth bioapatite was well-preserved. The isotopic data indicate that all the mammals relied entirely on C3-based foodstuff, revealing that C3 vegetation was dominant in this region. Two groups of the Asian elephants are observed in this study on the basis of isotopic difference. This isotopic variation among the Asian elephants evaluated in this study may suggest that they were mixed feeders. The dietary difference of the two groups observed may relate to elephant ages, seasonal variation and/or subspecies differences. In combination with previously published isotopic data, the dietary transition from substantial C4 plants to C3 plants of *Elephas* is discussed, indicating flexible dietary behavior throughout the evolution of the genus. © 2016 Elsevier Ltd and INQUA.

D. Magintan, T. Lihan, K.A. Mohamed, A. Campos-Arceiz, S. Saaban, S.M. Husin & S.M. Nor
The impact of hydroelectric development on elephant habitats in Hulu Terengganu
Malaysian Applied Biology 46(4) (2017) 23-33
Abstract. The development of a hydroelectric dam in Tembat and Petuang Forest Reserve, Hulu Terengganu has changed the natural habitat of elephants into a modified landscape. This study assesses the land-use and land-cover changes in the forest reserve from 2006 to 2016 to detect the changes that have occurred over that period and identify the habitats used by elephants therein. An unsupervised classification was conducted to identify logged-over forests, degraded forests and water bodies. The classified image from 2006 showed only 117.56 km^2 of the logged-over forest, however, in 2013, an area increases of 43.41%

of the logged-over forest was detected. In 2006, the degraded forest and water body areas were around 2.14 km^2 and 3.22 km^2 respectively, but an increase from 2006 to 2013 for degraded forests amounted to 33.94 km^2 water bodies decreased to 2.46 km^2. Due to the impoundment of the new dams in 2016, a decrease in the size of unlogged forests, logged forests and degraded forests were 2.37%, 24.35% and 41.72% respectively. The development of a hydroelectric dam has contributed to the expansion of the logged and degraded forests. Forest openings in the study area promoted the growth of palatable plants for elephants to consume. Thus, the preferred habitats of elephants were observed to be heavily influenced by the availability of resources in the logged area.

D. Magintan, S.M. Nor, T.P. Ean, A.M. Lechner & B. Azhar

The conservation value of unlogged and logged forests for native mammals on the East Coast of Peninsular Malaysia

J. for Nature Conservation 40 (2017) 113-119

Abstract. Tropical forests across the world provide important habitats for a diverse number of conservation priority species, yet are under threat from a range of anthropogenic impacts including logging. This study aims to quantify mammalian biodiversity in unlogged and logged forests in the adjoining Tembat and Petuang Forest Reserves, Terengganu, on the East Coast of Peninsular Malaysia. Data was collected over a series of surveys using direct and indirect observation methods from 2008 to 2014. A total of 30 medium and large sized mammals species were identified, with 27 of those species found in unlogged forests and 22 species in logged forests. Carnivores encompassed 11 species from 67 observations representing 15% of the total number of observations. The family Felidae had the highest number of species (six species), followed by Hylobatidae, Cercopithecidae and Suidae with three species each. A total of 17 species contributed to more than 90% of the mammal com- munity in the unlogged and logged forests, while six species were uncommon and only observed once during the entire survey. Species abundance in the unlogged forest was significantly greater than the logged forests, but the difference was not significant for species richness. This study provides critical baseline information on the impact of unlogged and logged forests and the identification of threatened species warrant the establishment of conservation measures such as anti-poaching patrol and ranger stations in the study area.

R.J. Magnuson, L.M. Linke, R. Isaza & M.D. Salman

Rapid screening for *Mycobacterium tuberculosis* complex in clinical elephant trunk wash samples

Research in Veterinary Science 112 (2017) 52-58

Abstract. *Mycobacterium tuberculosis* can infect and be transmitted between elephants and humans. In elephants, the 'gold standard' reference test for detection of tuberculosis is culture, which takes a minimum of eight weeks for results and has limited sensitivity. A screening test that is rapid, easily implemented, and accurate is needed to aid in diagnosis of tuberculosis in elephants. Ninety-nine clinical trunk wash samples obtained from 33 elephants were utilized to validate three molecular extraction techniques followed by a polymerase chain reaction for detection of *M. tuberculosis*. Diagnostic sensitivity and specificity were estimated compared to culture. Kappa coefficients were determined between molecular results and various culture categories and serological test results. An internal amplification control was developed and assessed to monitor for PCR inhibition. One molecular test (the Column method) outperformed the other two, with diagnostic sensitivity and kappa agreement estimates of 100% (CI 57–100) and 0.46 (CI 0.2–0.74), respectively, compared to culture alone. The percentage of molecular-positive/ culture-negative samples was 8.4% overall. The molecular extraction technique followed by PCR provides a much-needed rapid screening tool for detection of tuberculosis in elephants. Immediate procedures can be implemented to further assess PCR-positive animals and provide personnel biosecurity. While a positive result is not a definitive test for elephant tuberculosis, the molecular test results can be used to support current diagnostic procedures applied by

veterinarians for treatment decisions to prevent the spread of tuberculosis in elephants. © 2017 Reprinted with permission from Elsevier.

G. Maurer, B.S. Rashford, V. Chanthavong, B. Mulot & O. Gimenez

Wild-captive interactions and economics drive dynamics of Asian elephants in Laos

Scientific Reports 7 (2017) e14800

Abstract. The interactions between wild and captive populations of Asian elephants (*Elephas maximus*) persist in most countries of the species distribution, notably through the reproduction between captive females and wild males. However, these complex interactions have been poorly studied, despite their relevance for conservation of this endangered species. Laos has a centuries-long tradition of raising Asian elephants. Besides being cultural icons, captive elephants are inextricably linked to economics through their work in forestry. Using an ecological-economic model, we investigated the effect of socio-economic strategies on fecundity of the Lao population whose dynamics is shaped by human practices. We demonstrated that fecundity is impacted by: i) the dynamics of the wild elephant pool through mating of captive females by wild males, and ii) the financial incentive of elephant owners to breed their animals. As a result, we expect fecundity to rise in response to increases in elephant prices. The captive population will tend towards an asymptotic limit determined by the wild pool growth rate. However, the population will tend to extinction if exports continue. Our ecological-economic approach, by accounting for economic incentives, allows us to predict new equilibria that can serve as a baseline for designing sustainable management strategies for the species. © 2017 The Authors.

K. Mizuno, N. Sharma, G. Idani & R. Sukumar

Collective behaviour of wild Asian elephants in risky situations: How do social groups cross roads?

Behaviour 154 (2017) 1215-1237

Abstract. Among group-living animals, some members may derive benefit by following the decisions of other members. Free-ranging wild Asian elephants in Mudumalai National Park, southern India, must often cross roads and can be disturbed by vehicles. We assessed if measures of road and traffic characteristics serve as indicators of risk, and compared behaviours of different age classes during road-crossing events. More individuals displayed excitable behaviour on wider roads. A larger number of adults entered the road first, which is considered the most dangerous position, compared with immature elephants. Immature individuals tended to move ahead of others on the road, suggesting that it is more important for immature individuals to follow adults at the beginning of a crossing than to follow along for the entire crossing. These findings may suggest that less experienced group members derive benefit by following the decisions of experienced ones under risky situations. © 2017 Koninklijke Brill NV.

K.A. Morfeld & J.L. Brown

Metabolic health assessment of zoo elephants: Management factors predicting leptin levels and the glucose-to-insulin ratio and their associations with health parameters

PLoS ONE 12 (2017) e0188701

Abstract. Screening for metabolic-related health problems can enhance animal welfare, so the purpose of this study was to conduct the first metabolic health assessment of zoo elephants and use epidemiological methods to determine how factors in the captive environment were associated with metabolic hormone concentrations. In addition, we examined relationships between metabolic status and several fitness parameters: foot health, musculoskeletal health, reproductive cyclicity, and body condition. Two blood samples were collected 2 weeks apart from 87 Asian (*Elephas maximus*) and 105 African (*Loxodonta africana*) elephants managed by zoos accredited by the Association of Zoos and Aquariums for analysis of serum leptin, insulin, glucose and the glucose-to-insulin ratio (G:I). In females, mean (± SD) leptin concentrations and the G:I were lower ($P < 0.05$) in Asian (3.93 ± 2.21 ng/ml and 110 ± 86 units) compared to African (4.37 ± 2.89 ng/ml and 208 ± 133 units) elephants, respectively. For males, mean leptin and the G:I were 4.99 ± 3.61 ng/ml and 253 ± 181 units for Asian, and 3.72 ± 2.00 ng/ml and 326 ± 231 units for African elephants, respectively, with

no differences between species ($P > 0.05$). As mean leptin concentration increased there was an increase in the odds of a female being non-cycling ($P = 0.0083$). The G:I was associated inversely with body condition ($P = 0.0002$); as the G:I increased there was a decreased risk of BCS = 4 or 5 as compared to the ideal, or BCS = 3. Neither leptin nor G:I were predictive of foot or musculoskeletal health scores. Factors related to walking and feeding practices were most influential in predicting metabolic status, whereas social and housing factors showed smaller, but significant effects. The metabolic health benefits of walking were detected if the time spent in staff-directed walking was 7 hours or more per week. The most protective feeding practices included implementing a random rather than predictable feeding schedule and limiting the number of methods presentation methods. Results indicate that leptin levels and G:I can be used as predictors of both ovarian cycle function and body condition, and are affected by zoo management in elephants.

S. Nandini, P. Keerthipriya & T.N.C. Vidya

Seasonal variation in female Asian elephant social structure in Nagarahole-Bandipur, southern India

Animal Behaviour 134 (2017) 135-145

Abstract. Fission–fusion dynamics allow for individuals to deal with spatiotemporally changing food resources, with groups from a community fusing together when resources are abundant and splitting away when competition for resources is high. Such fission–fusion dynamics are often modulated by seasonal changes in resources. We examined the seasonal variation in group size and social structure of female Asian elephants, which show high fission–fusion dynamics, in a population in southern India. Females in this population form many distinct communities or clans in both the dry and wet seasons. At the population level, females were sighted in larger group sizes and associated with more uncommon females in the dry season. However, when associations among common females were considered, a greater number of stronger associations were observed in the wet season. There were no consistently significant seasonal differences in group sizes or associations at the clan level. Thus, population-level results, obtained by a combination of results from different clans, may sometimes be misleading. Female associations showed some temporal stability, with association indices being moderately correlated across consecutive seasons and years. Interestingly, average group sizes were similar across clans of different sizes, indicating a restriction on group size, possibly due to resource distribution. In spite of this restriction, most clan-mates showed low, non-zero associations amongst themselves rather than very strong associations with a small set of individuals. The resulting fluid rather than fixed groups suggest a benefit to socializing with other clan-mates. Thus, unlike the pattern usually seen, fission–fusion dynamics here is a means to maintain multiple associates under conditions of relatively constant but constrained group size, rather than being a means of increasing or decreasing group size in response to ecological factors.

D. Neupane, R.L. Johnson & T.S. Risch

How do land-use practices affect human-elephant conflict in Nepal?

Wildlife Biology 2017 (2017) wlb.00313

Abstract. Asian elephants *Elephas maximus* are an endangered species and human-elephant conflict (HEC) is the major threat to their survival. HEC causes crop and property loss and occasionally results in the death of both humans and elephants in Nepal. Elephants are responsible for more than 40% of the human–wildlife conflict, 70% of the wildlife-caused human casualties, and a 25% loss in crop production in Nepal. Identification of the factors associated with elephant invasion can help mitigate conflict by allowing residents and representatives to address those factors. This study used face-to-face interviews in 1182 households in villages affected by elephants in southern Nepal using a structured questionnaire to understand how land-use practices are related to HEC regionally. Almost all (99%) of the surveyed houses had some damage from elephants within the past five years. A stepwise binary logistic regression showed that practices such as the growing of traditional crops (rice and

large maize fields), maintaining bananas, and home alcohol production increase the chances of elephant attacks. Our data also revealed that HEC is most intense in winter months, when rice is harvested. People residing near protected areas had positive attitudes towards elephants, as they received economic benefits from ecotourism and improved mitigation practices such as electric fences. Changing some land-use practices could reduce HEC in the region. Therefore, alternative crops should be explored to reduce HEC in southern Nepal. Other management recommendations include moving fruit trees away from homes or fencing community orchards. Although home alcohol production is illegal in Nepal, those engaging in the practice should not ferment alcohol in their homes. Finally, growing bamboo on the edge of settlements would engage elephants and allow for a response to repel them before severe crop or house damage occurs. © 2017 The Authors.

K. Nganvongpanit, P. Siengdee, K. Buddhachat, J.L. Brown, S. Klinhom, T. Pitakarnnop, T. Angkawanish & C. Thitaram

Anatomy, histology and elemental profile of long bones and ribs of the Asian elephant (*Elephas maximus*)

Anatomical Science Internat. 92 (2017) 554-568

Abstract. This study evaluated the morphology and elemental composition of Asian elephant (*Elephas maximus*) bones (humerus, radius, ulna, femur, tibia, fibula and rib). Computerized tomography was used to image the intraosseous structure, compact bones were processed using histological techniques, and elemental profiling of compact bone was conducted using X-ray fluorescence. There was no clear evidence of an open marrow cavity in any of the bones; rather, dense trabecular bone was found in the bone interior. Compact bone contained double osteons in the radius, tibia and fibula. The osteon structure was comparatively large and similar in all bones, although the lacuna area was greater ($P < 0.05$) in the femur and ulna. Another finding was that nutrient foramina were clearly present in the humerus, ulna, femur, tibia and rib. Twenty elements were identified in elephant compact bone. Of these, ten differed significantly across the seven bones: Ca, Ti, V, Mn, Fe, Zr, Ag, Cd, Sn and Sb. Of particular interest was the finding of a significantly larger proportion of Fe in the humerus, radius, fibula and ribs, all bones without an open medullary cavity, which is traditionally associated with bone marrow for blood cell production. In conclusion, elephant bones present special characteristics, some of which may be important to hematopoiesis and bone strength for supporting a heavy body weight. © 2016 Japanese Association of Anatomists.

K. Nganvongpanit, R. Soponteerakul, P. Kaewkumpai, V. Punyapornwithaya, K. Buddhachat, R. Nomsiri, P. Kaewmong, K. Kittiwatanawong, R. Chawangwongsanukun, T. Angkawanish, C. Thitaram & P. Mahakkanukrauh

Osteoarthritis in two marine mammals and 22 land mammals: Learning from skeletal remains

Journal of Anatomy 231 (2017) 140-155

Abstract. The occurrence of osteoarthritis (OA) in marine mammals is still questionable. Here we investigated the prevalence of OA in marine (dolphin and dugong) and terrestrial mammals (Asian elephant, Asiatic buffalo, camel, cat, cattle, deer, dog, domestic goat, horse, human, hyena, impala, lion, Malayan tapir, Assam macaque, mule, pig, rabbit, red kangaroo, sheep, tiger and waterbuck). Skeletal remains obtained from five institutes were used as subjects; a total of 45 different parts (locations) of bones were observed for OA lesions. The prevalence of OA was reported as number of OA lesions/total number of bones. Our results revealed that the presence of OA in marine species (dolphin and dugong) was 2.44% and 3.33%, respectively. In dolphins, the highest OA occurrence was on the left and right humeral trochlea, with 13.68% and 12.63%, respectively, while the highest number of OA lesions in dugongs was on the lumbar vertebrae (8.79%). No significant difference ($P > 0.05$) in the prevalence of OA between sexes in dolphins and dugongs was observed, but we found a significant difference ($P < 0.05$) in 24 bone locations of human bones, which had the highest OA prevalence (48.93%), followed by dogs (3.94%). In conclusion, OA can occur in marine mammals, similar to terrestrial mammals, even though their natural habitat is the ocean. © 2017 Anatomical Society.

V. Nijman & C.R. Shepherd

Ethnozoological assessment of animals used by Mon traditional medicine vendors at Kyaiktiyo, Myanmar

J. of Ethnopharmacology 206 (2017) 101-106

Abstract. Wild animals are widely used in traditional Asian medicine but information from Myanmar is lacking. We show that a wide range of animals are used at a pilgrimage site, mostly for their rendered fats and oils to be used in mixed concoctions. The majority of species were sold to be used to treat aching joints, muscle ache and skin diseases. The aim was to assess wildlife for sale for medicinal purposes, and document their medicinal use at Kyaiktiyo, a pilgrimage site at a 1100 m tall mountain, with many of the pilgrims climbing to the top. In addition we address legal issues relating to the production and sale of traditional medicine that contain legally protected animals. Four visits were made to Kyaiktiyo, Myanmar, between 2000 and 2017 to quantify animal parts on display and through discussions with vendors to obtain information on medicinal use of these parts. Twenty-three species, mostly mammals, were recorded to be used for traditional medicine. The most common were Chinese serow *Capricornis milneedwardsii*, Asian elephant *Elephas maximus*, and Asiatic black bear *Ursus thibetanus*. Over 600 bodies or body parts were present. Combined, these parts purportedly provided cures or relief for at least 15 ailments or diseases. The most commonly mentioned treatment was that of using rendered animal fats/oils externally to relieve/cure aching joints or muscles. This treatment allegedly provides instant relief to pilgrims after an arduous climb up the mountain. Purported cures for various skin diseases was the next common use for the animal species on offer. Ten of the species observed for sale at Kyaiktiyo are listed as globally threatened, and 15 are protected and cannot be legally traded. Ambiguities in Myanmar's legislation mean that protected animals or their body parts cannot be traded, however traditional medicines can be made out of them provided rules relating to the manufacturing of traditional medicines are adhered to. This study indicated that animals and their parts continue to be openly offered for sale at Kyaiktiyo to treat various illnesses. Despite these products potential medical, traditional or cultural importance, solutions have to be found on how to ensure that, in line with Myanmar's laws, use of traditional local medicine does not impede the conservation of imperilled species.

Michael R. Pasenko

Quantitative and qualitative data of footprints produced by Asian (*Elephas maximus*) and African (*Loxodonta africana*) elephants and with a discussion of significance towards fossilized proboscidean footprints

Quaternary International 443A (2017) 221-227

Abstract. Qualitative and quantitative data from elephant footprints made by Asian and African elephants at the Reid Park Zoo and Phoenix Zoo were collected. Measurements of footprints, elephant feet, and stride were collected and permitted calculations for speed. The sediments the footprints were impressed in represent four different types; dry sand, moist sand, a semi-compacted silty-sand, and mud. My data suggest that the size and depth of footprints are not always good indicators of age, size, or sex of a proboscidean, and that the presence or absence of digits in a proboscidean's footprint should only be cautiously used for ichnotaxonomic assignment. Also, data provided here for speed of elephants can be applied to those of fossil proboscidean tracks.

W. Paungpin, W. Wiriyarat, K. Chaichoun, E. Tiyanun, N. Sangkachai, D. Changsom, K. Poltep, P. Ratanakorn & P. Puthavathana

Serosurveillance for pandemic influenza A (H1N1) 2009 virus infection in domestic elephants, Thailand

PLoS ONE 12 e0186962

Abstract. The present study conducted serosurveillance for the presence of antibody to pandemic influenza A (H1N1) 2009 virus (H1N1pdm virus) in archival serum samples collected between 2009 and 2013 from 317 domestic elephants living in 19 provinces situated in various parts of Thailand. To obtain the most accurate data, hemagglutination-inhibition (HI) assay was employed as the screening test; and sera with HI antibody titers ≥20 were further confirmed by other methods, including cytopathic effect/hemagglutination based-

microneutralization (microNT) and Western blot (WB) assays using H1N1pdm matrix 1 (M1) or hemagglutinin (HA) recombinant protein as the test antigen. Conclusively, the appropriate assays using HI in conjunction with WB assays for HA antibody revealed an overall seropositive rate of 8.5% (27 of 317). The prevalence of antibody to H1N1pdm virus was 2% (4/172) in 2009, 32% (17/53) in 2010, 9% (2/22) in 2011, 12% (1/8) in 2012, and 5% (3/62) in 2013. Notably, these positive serum samples were collected from elephants living in 7 tourist provinces of Thailand. The highest seropositive rate was obtained from elephants in Phuket, a popular tourist beach city. Young elephants had higher seropositive rate than older elephants. The source of H1N1pdm viral infection in these elephants was not explored, but most likely came from close contact with the infected mahouts or from the infected tourists who engaged in activities such as elephant riding and feeding. Nevertheless, it could not be excluded that elephant-to-elephant transmission did occur. © 2017 The Authors.

K. Pawlowski & G. McCann

Recent records of Asian elephant *Elephas maximus* in Virachey National Park, northeastern Cambodia

Cambodian Journal of Natural History 2017 (2017) 153-156

Abstract. none.

A. Pinyopummin, S. Mahasawangkul, K. Kornkaewrat, S. Rattanapirom, W. Leartsang & S. Kitkha

The presence of seminal plasma, especially derived from stallion semen, helps preserve chilled Asian elephant (E*lephas maximus*) sperm motility

Andrologia 49 (2017) e12690

Abstract. The effects of seminal plasma (SP), derived from autologous, homologous and heterologous species (stallion, boar and dog) on chilled Asian elephant sperm quality, were determined. Semen was collected from eight males and samples with ≥30% motile spermatozoa were used in the study. Semen was diluted with Tris–glucose–egg yolk extender, supplemented with different SP types and preserved at 4°C for 48 hr. Experiment 1 (n = 31), showed that the presence of SP (autologous) helped to preserve sperm quality in terms of sperm motility and acrosome integrity ($p < .05$). Homologous SP did not result in better sperm quality than autologous SP. Heterologous SP from stallion provided higher sperm motility and velocities compared to autologous SP ($p < .05$). Experiment 2 (n = 14) determined the effect of different SP from four stallions. All stallion SP gave higher ($p < .05$) results for motile spermatozoa and sperm velocities than autologous SP. In conclusion, the presence of SP helps preserve Asian elephant sperm quality and stallion SP supports the motility of Asian elephant spermatozoa during cold storage. © 2016 Blackwell.

J.P. Puyravaud, P. Davidar, R.K. Srivastava & B. Wright

Modelling harvest of Asian elephants *Elephas maximus* on the basis of faulty assumptions promotes inappropriate management solutions

Oryx 51 (2017) 506-512

Abstract. A ratio-based logistic model developed to assess elephant harvest rates, based on a study at Nagarhole Tiger Reserve in India, was recommended as a management tool to control human–elephant conflict through culling. Considering this reserve among others violates an assumption of the logistic model: isolation. Nevertheless, assuming this violation was irrelevant, we re-evaluated the model, with minor modifications, for the neighbouring Mudumalai Tiger Reserve, where we used data from 13 elephant *Elephas maximus* population surveys to derive bootstrapped sets of population ratios, and mortality records. We generated arrays of harvest regimes and examined which ratio outputs were closest to the bootstrapped ratios. Our results indicated that (1) model outputs corresponded best with the Mudumalai population structure when harvest regimes were extreme and unlikely, (2) there were significant differences in population structure and harvest regimes between Nagarhole and Mudumalai, and (3) only 49% of adult male deaths predicted by model outputs were recorded in official governmental records. The model provides significantly different results among reserves, which invalidates it as a tool to predict change across the entire elephant population.

Variability in survey data and inaccuracies in transition probabilities are sufficiently large to warrant caution when using them as a basis for deterministic modelling. Official mortality databases provide a weak means of validation because poaching incidents are poorly recorded. We conclude that the model should be based on validated transition probabilities and encompass the entire regional population. © 2016 Fauna & Flora International.

S. Rattanayuvakorn, A. Tanomtong, S. Phimphan, W. Sangpakdee, S. Pinmongkhonkul & K. Phintong

Karyological Study of Tusker and Tuskless Male Asian Elephant (Elephas maximus) by Conventional, GTG-, and Ag-NOR Banding Techniques

Cytologia 82 (2017) 349-354

Abstract. The present study was undertaken to identify whether any difference exists in karyotype between the tusker (chang Phai) and tuskless (chang Sridor) male Asian elephants (*Elephas maximus*, Linn. 1758). The elephant using in the present work are owned of some local people who lived in the elephant village, Surin Province, Thailand. Peripheral bloods were collected from the ear-vein of healthy elephants. The lymphocyte culture and harvesting method was employed follow standard protocols. Conventional, GTG-, and Ag-NORs banding techniques were applied to find out the different of both elephant karyotypes. The results showed that the standardized karyotype of both elephants were consisted of one pair of large acrocentric, four pairs of large telocentric, one pair of medium submetacentric, one pair of medium acrocentric, six pairs of medium telocentric, two pairs of small metacentric, two pairs of small submetacentric, and ten pairs of small telocentric homologous chromosomes. The X sex-chromosome was a medium metacentric and the Y sex-chromosome was a small acrocentric chromosome. Here, the NORs bearing chromosome were found on one pair of small submetacentric and two pairs of small telocentric chromosomes similar in both of male elephants. However, those classical cytogenetic techniques could not be distinguished the karyotype of tusker and tuskless male elephants. At least, we present the standardized karyotype, idiogram and the basic cytogenetic data that could be served as a basis for future chromosome analyses of Asian elephant populations and for comparative cytogenetic studies with other related species. The karyotype formula could be deduced as: $2n$(diploid) = $L_2^{a}+L_8^{t}+M_2^{sm}+M_2^{a}+M_{12}^{t}+S_4^{sm}+S_{20}^{t}+XY$. © 2017 Japan Mendel Society.

C.K. Rohini, T. Aravindan, K.S. Anoop Das & P.A. Vinayan

Status of conflict mitigation measures in Nilambur, Western Ghats of Kerala, India

Journal of Threatened Taxa 9 (2017) 11025-32

Abstract. Mitigation measures are one of the best strategies for the management of human-elephant conflict. An assessment of the effectiveness of existing crop protection methods in 17 forest fringe villages of Karulai and Vazhikadavu ranges of Nilambur South and North Forest Divisions was carried out during June 2015 to May 2016. Mitigation methods found in the study area include electric fences (EF), combined electric fence and trench (EPT+EF), and elephant-proof stone wall (EPSW). Barriers were surveyed by foot and mapped with the help of global positioning systems (GPS). Number of elephant crossing points per kilometre along the length of the barrier was highest for EPT+EF and least for EF. About 86% of the barrier surveyed was located at an average distance of 14.47 m from the villages and 13.63% of the barrier located at an average distance of 55.33 m from the village. Damage caused by elephants to EF was primarily due to lack of maintenance of the fences. In EPT+EF, natural weak spots and gateways created for the passage of people and cattle were the main locations of elephant crossing points. Damage to the EPSW was caused by elephants by breaking the top portion of the wall. Areas outside damaged spots primarily contained agricultural land, water bodies and forests, with human habitations being least likely. Crossing points were located primarily in moderate vegetation zones. Encouraging local communities to take a primary role in the maintenance of barriers is essential in this context. Information on the current status of mitigation measures will help to improve the efficiency of barriers and facilitate better management of human-elephant conflicts. © 2017 The Authors.

C.K. Rohini, T. Aravindan, K.S. Anoop Das & P.A. Vinayan

Peoples' attitude towards wildlife conservation in Kerala part of the Western Ghats, India

International Journal of Conservation Science 8 (2017) 269-280

Abstract. High population densities around conservation areas demand strategies for balancing conservation goals and livelihood needs. Management of conservation issues and conflicting interests among stakeholders in such areas can be achieved by exploring the attitude of residents towards wildlife and its conservation. Although a substantial body of research analyses local resident's attitude towards conservation challenges around protected areas, very scanty information is available on the attitude towards areas with less categories of protection status. Hence, an attempt was made to understand people's attitude towards conservation issues, in the fringe villages of North and South Forest Divisions of Nilambur, Kerala, India. A questionnaire survey was administered to 158 residents in five villages during the year 2014 to 2015. Responses were differentiated under different categories of gender, literacy status, age, occupation, and landholding size. The majority of respondents supported wildlife conservation, provided that there is no associated cost. The attitude towards forest protection staffs were largely positive. An improved system of participatory level conservation programs will probably reduce antagonistic ambience between forest protection staffs and villagers to a great extent thereby enhance people's tolerance towards conflict-causing wildlife, and thus facilitate conservation. Socioeconomic characteristics of residents provided some sort of explanation for the distribution of conservation attitude. These differences should be taken into consideration while designing and implementing any policies. People will support conservation of wildlife and natural systems if their problems are effectively addressed.

A. Rosencranz & D. Sehgal,

Elephants, ivory and CITES

Environmental Policy and Law 47 (2017) 2-5

Abstract. none.

Z.T. Rossman, B.L. Hart, B.J. Greco, D. Young, C. Padfield, L. Weidner, J. Gates & L.A. Hart

When yawning occurs in elephants

Frontiers in Veterinary Science 4 (2017) 22

Abstract. Yawning is a widely recognized behavior in mammalian species. One would expect that elephants yawn, although to our knowledge, no one has reported observations of yawning in any species of elephant. After confirming a behavioral pattern matching the criteria of yawning in two Asian elephants (*Elephas maximu*s) in a zoological setting, this study was pursued with nine captive African elephants (*Loxodonta africana*) at a private reserve in the Western Cape, South Africa, the Knysna Elephant Park. Observations were made in June–September and in December. In the daytime, handlers managed seven of the elephants for guided interactions with visitors. At night, all elephants were maintained in a large enclosure with six having limited outdoor access. With infrared illumination, the elephants were continuously recorded by video cameras. During the nights, the elephants typically had 1–3 recumbent sleeping/resting bouts, each lasting 1–2 h. Yawning was a regular occurrence upon arousal from a recumbency, especially in the final recumbency of the night. Yawning was significantly more frequent in some elephants. Yawning was rare during the daytime and during periods of standing around in the enclosure at night. In six occurrences of likely contagious yawning, one elephant yawned upon seeing another elephant yawning upon arousal from a final recumbency; we recorded the sex and age category of the participants. The generality of yawning in both African and Asian elephants in other environments was documented in video recordings from 39 zoological facilities. In summary, the study provides evidence that yawning does occur in both African and Asian elephants, and in African elephants, yawning was particularly associated with arousal from nighttime recumbencies. © 2017 The Authors.

Mukti Roy

A spatial and temporal analysis of elephant-human conflict at Gorumara and Jalpaiguri Forest Divisions of Northern West Bengal

Journal of Wildlife Research 5 (2017) 41-49

The elephant-human conflicts at Gorumara and Jalpaiguri Forest Divisions were evaluated during 2009-2013. Data were gathered from various sources like Elephant Depredation Records from Forest Divisions, Ranges and Tea Gardens Association offices. Overall, 117 human deaths and injuries were reported during the period. Such cases were observed on the higher side during maize or paddy cultivation harvesting season. Kernel density map shows that greater concentration of the conflict is on the eastern side of the landscape, where there are more fragmented and scattered forests in all directions. To overcome this problem, landscape- level planning is needed consolidating the habitation of Jalpaiguri and Gorumara Forest Divisions by barricading the old railway track fence to separate human habitation and wildlife habitat without disconnectivity to the main corridor. Another option is to develop only the forest along the southern Bhutan boundary and shift all villages and tea gardens towards its southern side. Alternate crops can be considered on large scale with habitation formation to reduce the level of conflict the region. © 2017 Jakraya.

Jonathan Saha

Colonizing elephants: Animal agency, undead capital and imperial science in British Burma

BJHS Themes Volume (2017) 169-189

Abstract. Elephants were vital agents of empire. In British Burma their unique abilities made them essential workers in the colony's booming teak industry. Their labour was integral to the commercial exploitation of the country's vast forests. They helped to fell the trees, transport the logs and load the timber onto ships. As a result of their utility, capturing and caring for them was of utmost importance to timber firms. Elephants became a peculiar form of capital that required particular expertise. To address this need for knowledge, imperial researchers deepened their scientific understanding of the Asian elephant by studying working elephants in Burma's jungle camps and timber yards. The resulting knowledge was contingent upon the conscripted and constrained agency of working elephants, and was conditioned by the asymmetrical power relationships of colonial rule. © 2017 British Society for the History of Science.

S. Satitmanwiwat, K. Promthep, K. Buranaamnuay, S. Mahasawangkul & K. Saikhun

Lipid and protein oxidation levels in spermatozoa and seminal plasma of Asian elephants (*Elephas maximus*) and their relationship with semen parameters

Reproduction in Domestic Animals 52 (2017) 283-288

Abstract. Peroxidation damage to spermatozoa and seminal plasma has an important role in sperm quality. Thus, the objective of this study was to determine the levels of lipid and protein oxidation in spermatozoa and seminal plasma of Asian elephants (*Elephas maximus*) with varying percentage of progressive motility. Lipid and protein oxidation was measured by the thiobarbituric acid-reactive species (TBARS) assay and the 2, 4-dinitrophenylhydrazine (DNPH) carbonyl groups assay, respectively. Fresh semen samples were collected from Asian elephants and classified according to the percentage of motile spermatozoa into good (>60%) and poor (≤20%) motility. Results revealed that seminal plasma malondialdehyde (MDA) and seminal plasma protein carbonyls (PCs) were significantly higher in poor motility than in good motility ($p < .05$). The MDA and PC levels in seminal plasma were negatively correlated with the percentages of progressive motility ($p < .05$). In addition, the negative correlation between sperm concentration and seminal plasma MDA level was investigated ($p < .05$). The sperm viability was also negatively correlated with sperm PC level ($p < .05$). This study indicated that lipid and protein oxidation has deleterious effect on semen quality of Asian elephants. © 2017 Blackwell Verlag GmbH.

N. Sekar, C.-L. Lee & R. Sukumar

Functional nonredundancy of elephants in a disturbed tropical forest

Conservation Biology 31 (2017) 1152-1162

Abstract. Conservation efforts are often motivated by the threat of global extinction. Yet if conservationists had more information suggesting that extirpation of individual species could lead to undesirable ecological effects, they might more frequently attempt to protect or restore such species across their ranges even if they were not globally endangered. Scientists

have seldom measured or quantitatively predicted the functional consequences of species loss, even for large, extinction-prone species that theory suggests should be functionally unique. We measured the contribution of Asian elephants (*Elephas maximus*) to the dispersal of 3 large-fruited species in a disturbed tropical moist forest and predicted the extent to which alternative dispersers could compensate for elephants in their absence. We created an empirical probability model with data on frugivory and seed dispersal from Buxa Tiger Reserve, India. These data were used to estimate the proportion of seeds consumed by elephants and other frugivores that survive handling and density-dependent processes (Janzen-Connell effects and conspecific intradung competition) and germinate. Without compensation, the number of seeds dispersed and surviving density-dependent effects decreased 26% (*Artocarpus chaplasha*), 42% (*Careya arborea*), and 72% (*Dillenia indica*) when elephants were absent from the ecosystem. Compensatory fruit removal by other animals substantially ameliorated these losses. For instance, reductions in successful dispersal of *D. indica* were as low as 23% when gaur (*Bos gaurus*) persisted, but median dispersal distance still declined from 30% (*C. arborea*) to 90% (*A. chaplasha*) without elephants. Our results support the theory that the largest animal species in an ecosystem have nonredundant ecological functionality and that their extirpation is likely to lead to the deterioration of ecosystem processes such as seed dispersal. This effect is likely accentuated by the overall defaunation of many tropical systems.

A. Senthilkumar, M.G. Jayathangaraj, A. Valli, A. Thangavelu, S. Gomathinayagam & N. Sribalaji

Probiotics supplementation on nutrient digestibility in captive Asiatic elephants (*Elephas maximus*) of Tamil Nadu State in India

Research Journal of Chemical and Environmental Sciences 5 (2017) 18-22

Abstract. Probiotics are live microorganisms which have been found to confer a health on the host when administered in adequate amounts. This study was performed with the purpose of investigating effect of combinations of probiotic preparation containing genus *Lactobacillus* and genus *Bifidobacterium* supplemented in temple elephants of Tamil Nadu. Before and after supplementation of probiotics, feed and dung samples were collected in 10 elephants, the dry matter digestability was estimated by lignin as a internal marker. The same way the dry matter digestibility were calculated study elephants were supplemented with (n=10) 1 gram of probiotic preparation which contained $1x10^9$ CFU of Genus Lactobacillus and $1x10^9$ CFU of *Bifidobacterium* was given, orally per 50 kg body weight, through the food materials (concentrate feed), on a daily basis continuously for a period of ten days. On eleventh day the dung samples were collected from these ten elephants the dry matter digestibility calculated by lignin. The study elephants were divided in to two groups, elephants less than 14 years of age (n=4) were grouped as young elephants and elephants more than 14 years of age (n=5) were grouped as adult elephants, to reveal the per cent improvement of dry matter digestibility pertaining to the probiotics supplementation. The dry matter digestibility before and after administration of probiotics was determined and differences in dry matter digestibility were calculated. The results data were statistically analyzed by using Students' T test. Over all mean ± S.E. of dry matter digestibility in temple elephants before and after probiotics administration were 31.89 ± 2.87% and 42.65 ± 2.55% respectively. Dry matter digestibility values in per cent before and after the supplementation of probiotic preparations were statistically highly significant variations ($P<0.01$). Mean ± S.E. of dry matter digestibility in young and adult temple elephants groups before and after probiotics administration were 18.49 ± 4.18% and 6.82 ± 1.40% respectively. Subsequent to the supplementation of probiotics preparations, the dry matter digestibility between young elephant (n=4) group and adult elephant (n=5) group revealed statistically significant variations ($P<0.05$). © 2017 AELS, India.

T. Silwal, J. Kolejka, B.P. Bhatta, S. Rayamajhi, R.P. Sharma & B.S. Poudel

When, where and whom: Assessing wildlife attacks on people in Chitwan National Park, Nepal

Oryx 51 (2017) 370-377

Abstract. Wildlife attacks on people in and around protected areas have become one of the main challenges for wildlife management authorities. We assessed all correlates of wildlife attacks during 2003–2013 in the vicinity of Chitwan National Park, Nepal. We used data from various sources (discussion with stakeholders, field observations, questionnaire surveys). Wildlife attacks were significantly correlated to factors such as site, season and time, activity, gender and awareness. Moreover, 89% of recorded attacks occurred outside the Park. The number of attacks fluctuated widely and patterns of attacks were significantly uneven across seasons and months. Of the 87% of attacks that occurred during the day, 63% occurred in the morning. Most victims were male and c. 45% of attacks occurred when people were collecting forest resources or working on croplands. Attacks were carried out predominantly by rhinoceros *Rhinoceros unicornis* (38%), tigers *Panthera tigris* (21%), sloth bears *Melursus ursinus* (18%), elephants *Elephas maximus* (9%) and wild boar *Sus scrofa* (8%). The people attacked lived close to the Park, depended on farming for their livelihoods, and had little knowledge of animal behaviour. Attacks can be mitigated through proper management of habitats inside the Park and raising awareness of wildlife behaviour among local people. We recommend establishing a participatory emergency rescue team to deal with problematic animals in high-risk areas. © 2016 Fauna & Flora International.

R.R. Sim, E. Stringer, D. Donovan, R. Chappell, P. Flora, J. Hall, S. Pillay, B.G. Willis & S. McCain

Use of composite materials as a component of tusk fracture management in an Asian elephant (*Elephas maximus*) and an African elephant (*Loxodonta africana*)

Journal of Zoo and Wildlife Medicine 48 (2017) 891-896

Abstract. Tusk fractures in Asian (*Elephas maximus*) and African elephants (*Loxodonta africana*) can result in damage to the distal end or to longitudinal cracks, potentially progressing to pulpitis. With pulp exposure, endodontic therapy is the treatment of choice, but conservative therapy has sufficed for some elephants. This manuscript describes the use of composite materials as a component of tusk fracture management. A 7-yr-old male Asian elephant fractured the distal end of both tusks with pulp exposure in one. Capping of each tusk with a Kevlar/fiberglass composite prevented further damage, and a modification allowed care of the exposed pulp tissue. A 34-yr-old male African elephant with a longitudinal crack received a carbon fiber/fiberglass composite circumferential wrap to potentially stabilize the crack. Compression of the crack was achieved, but follow-up was truncated due to bacterial pulpitis. Both cases show that composite material allows for lightweight, durable management of tusk fractures with continued radiographic monitoring. © 2017 American Association of Zoo Veterinarians.

S. Sripiboon, T. Angkawanish, K. Boonprasert, P. Sombutputorn, W. Langkaphin, W. Ditcham & K. Warren

Successful treatment of a clinical elephant endotheliotropic herpesvirus infection: The dynamics of viral load, genotype analysis, and treatment with acyclovir

Journal of Zoo and Wildlife Medicine 48 (2017) 1254-1259

Abstract. This article describes the treatment of clinical elephant endotheliotropic herpesvirus (EEHV) infection in a male Asian elephant (*Elephas maximus*; approximately 3 yr old), the dynamics of viral load during the active infection, and genetic analysis of the virus. Treatment included injectable acyclovir (12 mg/kg iv, bid), antibiotic, vitamin, and fluids. Quantitative polymerase chain reaction was used to measure the viral levels in blood, which decreased continuously after initiation of intravenous acyclovir. Low levels of virus were detected in the blood for 2 wk, and the virus was undetectable after 1 mo. No complication was observed during the treatment period. This case report suggests that acyclovir, given parenterally, could potentially enhance survival of clinical EEHV-infected individuals. © 2017 American Association of Zoo Veterinarians.

N.I. Stacy, R. Isaza & E. Wiedner

First report of changes in leukocyte

morphology in response to inflammatory conditions in Asian and African elephants (*Elephas maximus* and *Loxodonta africana*)
PLoS ONE 12 (2017) e0185277
Abstract. Although the hematology of healthy elephants has been well-described, published information on hematological changes during disease is limited. The objective of this study was to describe qualitative morphological changes in the leukocytes of Asian and African elephants (*Elephas maximus* and *Loxodonta africana*) diagnosed with a variety of inflammatory conditions. Twenty-five of 27 elephants had morphological changes in their leukocytes, although only 16 of these had a concurrent inflammatory leukogram. Morphological changes included heterophil left-shifting with or without concurrent dysgranulopoiesis, toxicity, or hypersegmentation, reactive lymphocytes, plasma cells, and/or vacuolated monocytes. Although the observed leukocyte morphological changes are non-specific, their early recognition upon blood film evaluation may provide important, clinically-relevant information, particularly if the leukogram is normal. This case series is the first description of qualitative morphological changes in the leukocytes of elephants in association with inflammation. © 2017 The Authors.

H. Stokes, V. Perera, N. Jayasena & A. Silva-Fletcher
Nocturnal behavior of orphaned Asian elephant (*Elephas maximus*) calves in Sri Lanka
Zoo Biology 36 (2017) 261-272
Abstract. Many animals exhibit circadian variation in behavior; thus, studying nocturnal behavior is important to fully understand species activity patterns. The nocturnal behavior of Asian elephants, and specifically calves, has received little previous study. We carried out observational study of the nocturnal behavior of orphaned Asian elephant calves at three age groups: "infant" (0–24 months), "young juvenile" (25–36 months) and "old juveniles" (over 36 months). Project aims were to build a nocturnal activity budget, to investigate key age differences, and whether calves exhibited synchronous behavior patterns. We carried out focal animal sampling and instantaneous group scan sampling on 34 calves for 18 nights using an infra-red camera. Focal results indicated that calves spent the highest percentage of scans in lying rest (46.2%) and feeding (28.4%). There was no significant difference between lying rest in the three age groups. Calves spent the majority of time within 5 m of their nearest neighbor, with infants remaining in closest proximity to conspecifics compared to older calves. Synchronous behavior could not be proved statistically but two distinct lying rest periods between 23:00 and 1:00, and 3:30 and 5:30, were noted. We found that calves spent more time in lying rest than previously observed in adult elephants. Activity patterns observed suggest that the orphaned group behavior is similar to that reported in the wild and captive zoological collections, and appears to be in concordance with "natural" behavior patterns, a defining feature of animal welfare. This research provides valuable data as a preliminary study. © 2017 Wiley Periodicals.

B.S. Sulistyawan, B.A. Eichelberger, P. Verweij, R.G.A. Boot, O. Hardian, G. Adzan & W. Sukmantoro
Connecting the fragmented habitat of endangered mammals in the landscape of Riau–Jambi–Sumatera Barat (RIMBA), central Sumatra, Indonesia (connecting the fragmented habitat due to road development)
Global Ecology and Conserv. 9 (2017) 116-130
Abstract. The trend of wildlife habitat fragmentation worldwide continues as a result of anthropogenic activities on development of a linear infrastructure and land use changes, which is often implemented as part of spatial planning policies. In this paper we expand upon an existing approach to design wildlife corridors through habitat quality assessment. We used models of Habitat Quality of Integrated Valuation of Ecosystem Services and Trade-offs (InVEST) and Corridor Design tools. The habitat quality model of InVEST provides a rapid approach to assess status and change of biodiversity, and can contribute to enhanced corridor design of fragmented wildlife habitat. We conducted an assessment of habitat quality of the RIMBA corridor landscape, which is part of Riau, Jambi and West Sumatra provinces of central Sumatra Island. The result of the habitat quality model was used as the main input to evaluate habitat

connectivity and assess the target segment of roads that cross the modelled corridor. We found 20 wildland blocks, the total area of the corridor modelled including wildland blocks was calculated as about 0.77 million ha. We have obtained accurate quantitative measurement of the length of roads crossing the corridor, with a total of 417.78 km (artery 10.31 km; collector 19.52 km; and local 1987.9 km roads). This method can be replicated as an approach in valuing the quality of habitat as part of the implementation of the presidential decree of Sumatra Island Spatial Planning. This may also be applied to the spatial planning of other major islands in Indonesia and elsewhere. © 2017 The Authors.

A. Thapa, K.B. Shah, C.P. Pokheral, R. Paudel, D. Adhikari, P. Bhattarai, N.J. Cruz & A. Aryal
Combined land cover changes and habitat occupancy to understand corridor status of Laljhadi-Mohana wildlife corridor, Nepal
European J. of Wildlife Research 63 (2017) e83
Abstract. Corridor design is a centripetal conservation tool to facilitate movement between fragmented patches. Increases in anthropogenic activity have caused degradation in forest connectivity, influencing animal movement to a small degree. Laljhadi-Mohana wildlife corridor (LMWC), a corridor between Shuklaphanta National Park (Nepal) and Dudhwa National Park (India) created to be used by *Panthera tigris* and *Elephas maximus* in western Nepal, is under pressure of anthropogenic change. Using current knowledge, we analyzed land cover changes (LCC) of LMWC between 2002 and 2012. We used ERDAS IMAGINE 9.2 and Arc GIS 9.2 to process satellite images, and occupancy survey to assess status of corridor. We classified land cover into dense forest, sparse forest, cultivation, water bodies, grassland, expose surfaces, and sand bank as structural attributes of the corridor. Our analysis found dense forest area was reduced by 18.35% in a decade while cultivation and sparse forest increased by 10.15% and 8.89%, respectively. Illegal forest encroachment, resource extraction, grazing pressure, invasive species, and flood were major drivers of forest change. The null occupancy model estimated the highest detection probability of *Elephas maximus* (0.48 ± 0.08) and the lowest of *Axis axis* (0.20 ± 0.08). Incorporating site covariates improved occupancy estimates of *Sus scrofa* (0.82), *Axis axis* (0.76), *Elephas maximus* (0.76), *Boselaphus tragocamelu*s (0.66), and *Panthera pardus* (0.55). Distance to cultivation was the most influential covariate, supported by the expansion of cultivated land in the corridor. LMWC is a functional wildlife corridor despite a decline in forest cover. This decline influenced the number and detection rates of large mammals, instigating crop raiding and conflict. Mitigation measures on LCC drivers, particularly forest encroachment, can improve the functional status of LMWC and raise detection rates of large mammals in future studies. © 2017 Reprinted by permission from Springer-Verlag.

M. Ushio, H. Fukuda, T. Inoue, K. Makoto, O. Kishida, K. Sato, K. Murata, M. Nikaido, T. Sado, Y. Sato, M. Takeshita, W. Iwasaki, H. Yamanaka, M. Kondoh & M. Miya
Environmental DNA enables detection of terrestrial mammals from forest pond water
Molecular Ecology Resources 17 (2017) e63–e75
Abstract. Terrestrial animals must have frequent contact with water to survive, implying that environmental DNA (eDNA) originating from those animals should be detectable from places containing water in terrestrial ecosystems. Aiming to detect the presence of terrestrial mammals using forest water samples, we applied a set of universal PCR primers (MiMammal, a modified version of fish universal primers) for metabarcoding mammalian eDNA. The versatility of MiMammal primers was tested in silico and by amplifying DNAs extracted from tissues. The results suggested that MiMammal primers are capable of amplifying and distinguishing a diverse group of mammalian species. In addition, analyses of water samples from zoo cages of mammals with known species composition suggested that MiMammal primers could successfully detect mammalian species from water samples in the field. Then, we performed an experiment to detect mammals from natural ecosystems by collecting five 500-ml water samples from ponds in two cool-temperate forests in Hokkaido, northern Japan. MiMammal amplicon libraries were constructed using eDNA extracted from water samples, and

sequences generated by Illumina MiSeq were subjected to data processing and taxonomic assignment. We thereby detected multiple species of mammals common to the sampling areas, including deer, mouse, vole, raccoon, rat and shrew. Many previous applications of the eDNA metabarcoding approach have been limited to aquatic/semiaquatic systems, but the results presented here show that the approach is also promising even for forest mammal biodiversity surveys. © 2017 John Wiley & Sons Ltd.

E. Wiedner, W.K. Kiso, J. Aria, R. Isaza, W. Lindsay, G. Jacobson, K. Jacobson & D. Schmitt

Vital signs and first occurrences in normal and abnormal newborn Asian elephant (*Elephas maximus*) calves

Journal of Zoo and Wildlife Medicine 48 (2017) 997-1015

Abstract. Sixteen years of medical records documenting 19 births within a herd of Asian elephants (*Elephas maximus*) at a private facility in the southeastern United States were reviewed. Of the 19 calves, 11 were normal at birth, requiring no additional veterinary care, and eight were abnormal, requiring veterinary care immediately or within the first week of birth. Descriptive statistics were used to evaluate morphometrics, vital signs, and behavioral milestones in newborn calves both normal and abnormal. Blood work and urinalysis results from all calves were compared to values for adult elephants. Medical management of abnormal calves is described. All calves had faster heart rates and respiratory rates than did adult elephants, but rectal temperatures were the same. Calves were precocious with regard to sitting and standing but could be very slow to nurse. The most-common medical conditions of newborn calves were umbilical abnormalities and problems associated with nursing. Two calves required cardiopulmonary resuscitation after birth but made full recoveries. Some conditions were not apparent at birth but were recognized a few hours or days later. Following veterinary intervention, six of the eight calves made full recoveries, suggesting that early identification and treatment of problems can greatly decrease mortality. This is the first report of multiple veterinary and behavioral parameters in normal and abnormal neonatal Asian elephants from a facility with a calf survival rate above 90%. This information may be helpful to other elephant-holding facilities in providing care to their newborn elephant calves. © 2017 American Association of Zoo Veterinarians.

K. Yeshi, P. Morisco & P. Wangchuk

Animal-derived natural products of Sowa Rigpa medicine: Their pharmacopoeial description, current utilization and zoological identification

J. of Ethnopharmacology 207 (2017) 192-202

Abstract. The Bhutanese Sowa Rigpa medicine (BSM) uses animal parts in the preparation of numerous polyingredient traditional remedies. Our study reports the taxonomical identification of medicinal animals and the description of traditional uses in English medical terminologies. Aim of the study: To taxonomically identify the medicinal animals and their derived natural products used as a zootherapeutic agents in BSM. First, the traditional textbooks were reviewed to generate a list of animal products described as ingredients. Second, animal parts that are currently used in Bhutan were identified. Third, the ethnopharmacological uses of each animal ingredients were translated into English medical terminologies by consulting Traditional Physicians, clinical assistants, pharmacognosists, and pharmacists in Bhutan. Fourth, the animal parts were taxonomically identified and their Latin names were confirmed by crosschecking them with online animal databases and relevant scientific literature. The study found 73 natural products belonging to 29 categories derived from 45 medicinal animals (36 vertebrates and 9 invertebrates), comprising of 9 taxonomic categories and 30 zoological families. Out of 116 formulations currently produced, 87 of them contain one or more extracts and products obtained from 13 medicinal animals to treat more than 124 traditionally classified illnesses. Only five animal ingredients were found available in Bhutan and rest of the animal parts are being imported from India. Out of 73 natural products described in the traditional textbooks, only 13 of them (some omitted and few substituted by plants) are currently included in 87 formulations of BSM. © 2017 Reprinted with permission from Elsevier.