

## Recent Publications on Asian Elephants

Compiled by Jennifer Pastorini

*Anthropologisches Institut, Universität Zürich, Zürich, Switzerland and  
Centre for Conservation and Research, Rajagiriya, Sri Lanka*

L.A. Bates, J.H. Poole & R.W. Byrne

### **Elephant cognition**

*Current Biology 18 (2008) 544-546*

Review article, no abstract available.

B. Behr, D. Rath, T.B. Hildebrandt, F. Goeritz,  
S. Blottner, T.J. Portas, B.R. Bryant, B. Sieg, A.  
Knieriem, S.P. de Graaf, W.M.C. Maxwell & R.  
Hermes

### **Germany/Australia index of sperm sex sortability in elephants and rhinoceros**

*Reproduction in Domestic Animals 44 (2009)  
273-277*

**Abstract.** Flow cytometric sexing of spermatozoa followed by application in artificial insemination or in vitro fertilization provides a unique opportunity to predetermine the sex of offspring and might enhance the conservation management of endangered species in captivity such as the elephant and rhinoceros. To obtain an indication of the sortability of spermatozoa from these species, the relative DNA differences between X and Y chromosome bearing spermatozoa (fresh, frozen thawed, epididymal) from three rhinoceros species [white (*Ceratotherium simum*), black (*Diceros bicornis*), Indian (Rhinoceros unicornis)] and both elephant species, the Asian and the African elephant (*Elephas maximus*, *Loxodonta africana*), were determined through separation of spermatozoa into X and Y chromosome bearing populations, using a modified high speed flow cytometer. The head profile areas of spermatozoa from all five species were measured using light microscopy. By multiplying the relative DNA differences and the head profile areas, the sperm sorting indices were calculated to be 47, 48 and 51 for white, black and Indian rhinoceros respectively. The calculated sorting index for the Asian elephant was 66. In the African elephant, we determined the highest sorting index of 76. These results indicate the practicability of flow cytometric sex sorting of spermatozoa from

the tested rhinoceros species and both elephant species. The lower sorting indices in rhinos indicate that sex sorting of spermatozoa from the rhinoceros will be more challenging than in elephants. © 2008 Blackwell Verlag.

M.F. Bertelsen, M. Kjelgaard-Hansen, C.  
Grondahl, P.M.H. Heegaard & S. Jacobsen

### **Identification of acute phase proteins and assays applicable in nondomesticated mammals**

*Journal of Zoo and Wildlife Medicine 40 (2009)  
199-203*

**Abstract.** The serum concentration of acute phase proteins (APPs) increases dramatically in response to inflammation and tissue injury. APPs are clinically useful in a range of domesticated mammals; however, knowledge is limited in nondomesticated mammals. The detective ability of two assays for each of three potential APPs--serum amyloid A (SAA), C-reactive protein (CRP), and haptoglobin (Hp)--was evaluated in eight species. For SAA, a turbidimetric immunoassay (TIA) demonstrated significant detective abilities in the Asian elephant (*Elephas maximus*), impala (*Aepyceros melampus*), musk ox (*Ovibos moschatus*), and chimpanzee (*Pan troglodytes*), as did an SAA enzyme-linked immunosorbent assay (ELISA) in the impala. For CRP, both TIA and ELISA had significant detective abilities in the chimpanzee. For Hp, a colorimetric assay demonstrated significant detective abilities in impala, musk ox, sitatunga (*Tragelaphus spekeii*), and chimpanzee, as did the Hp ELISA in the impala, musk ox, and sitatunga. In conclusion, these results suggest that assays for detection of relevant APPs in several nondomesticated animals are available. © 2008 by American Association of Zoo Veterinarians.

A. Campos-Arceiz, T.Z. Lin, W. Htun, S.  
Takatsuki & P. Leimgruber

**Working with mahouts to explore the diet of work elephants in Myanmar (Burma)**

*Ecological Research* 23 (2008) 1057–1064

**Abstract.** At an elephant camp in central Myanmar (Burma), we interviewed mahouts and veterinarians to describe the diet of Asian elephants (*Elephas maximus*) in a mixed-deciduous forest. Elephants showed a broad dietary breadth (103 plant species from 42 families); consumed mostly browse (94% of plant species); and were very selective about plant parts [e.g., many trees were eaten exclusively for their bark (22%) or fruits (14%)]. The fruits from 29 plant species were recorded to be eaten by elephants. Several of these were found as fruit remains, seeds, or seedlings in elephant dung, suggesting a role of Asian elephants in seed dispersal. Work elephants and their mahouts prove to be a rich source of information to understand wild elephant ecology. © 2008 The Ecological Society of Japan.

M. Chaiklin

**Ivory in early modern Ceylon: A case study in what documents don't reveal**

*International Journal of Asian Studies* 6 (2009) 37-63

**Abstract.** In Sri Lanka elephants are endangered and ivory carving, as an art, is dead. Sri Lanka was once famous for the number and quality of its elephants, whose tusks were carved and exported since ancient times. Although Sri Lanka became, successively, a pivotal outpost for the Portuguese, Dutch and English, details about the Ceylonese ivory trade appear in trade documents only rarely. And yet, if information is not to be found there, does that mean ivory trade did not occur? Trade documents, after all, do not tell the whole story. Smugglers, illegal traders, big game hunters and plantation owners all played a part in the disappearance of elephants and its corollary, the ivory trade. When archival evidence is viewed in combination with physical evidence and the anecdotes of visitors and residents, it becomes evident that ivory remained an integral part of trade and crafts in Ceylon well into the last century. © 2009 Cambridge University Press.

R. Chandrajith, E. Kudavidanage, H.J. Tobschall & C.B. Dissanayake

**Geochemical and mineralogical characteristics**

**of elephant geophagic soils in Udawalawe National Park, Sri Lanka**

*Environmental Geochemistry Health* 31 (2009) 391–400

**Abstract.** Geophagy or deliberate ingestion of soils was observed among Asian elephants (*Elephas maximus*) in the Udawalwe National Park, Sri Lanka, for several years. The geochemical and mineralogical composition of the clayey soil layers which are purposefully selected and eaten by elephants in the park were studied, in order to identify the possible reasons for elephant geophagy. The concentrations of major and trace elements were determined by means of X-ray fluorescence spectrometry in 21 soil samples from eight geophagic sites and six soil samples collected from four non-geophagic sites. The mineralogical composition of selected soil samples was investigated using X-ray diffractometry (XRD). These geochemical analyses revealed that geophagic soils in the study areas are deeply weathered and that most of the elements are leached from the soil layers under extreme weathering conditions. The XRD data showed that the soils of the area consisted mainly quartz, feldspar, and the clay minerals kaolinite, Ferich illite, and smectite. Although no significant geochemical differences were identified between geophagic and non-geophagic soils, a clear difference was observed in their clay mineralogical content. Soils eaten by elephants are richer in kaolinite and illite than non-geophagic soils, which contain a higher amount of smectite. It is suggested that elephants in Udawalawe National Park ingest soils mainly not to supplement the mineral contents of their forage but to detoxify unpalatable compounds in their diet. © 2008 with kind permission from Springer Science+Business Media.

A. Coleing

**The application of social network theory to animal behavior**

*Bioscience Horizons* 2 (2009) 32-43

**Abstract.** Social network analysis (SNA) is a mathematical technique for analysing social relationships and the patterns and implications of these relationships (Wasserman S, Faust K (1994) *Social Network Analysis: Methods and Applications*. Cambridge: Cambridge University

Press). It has only recently been discovered by behavioural biologists as a useful tool in the study of animal behaviour (Wey T, Blumstein DT, Shen W et al. (2008) Social network analysis of animal behaviour: a promising tool for the study of sociality. *Anim Behav* 75: 333–344). Video recording over a 2 month period was used to record the behaviour of the elephant group at Chester Zoo. SNA was applied in an investigation of the group structure and interactions of the group. Observations of individual and group behaviour were based upon 40 h of playback of the social interactions were recorded and analysed using AGNA (2003) and Pajek (2005) packages. The analysis showed that the many facets of individual behaviour could be understood in terms of social structure of the group. This study has demonstrated that SNA is a powerful approach to understanding group dynamics and is particularly applicable to the study of obligate social species. In conclusion, it is suggested that SNA is potentially a useful tool in the management of captive animal populations. © 2009 The Author.

M.M. Garner, K. Helmick, J. Ochsenreiter, L.K. Richman, E. Latimer, A.G. Wise, R.K. Maes, M. Kiupel, R.W. Nordhausen, J.C. Zong & G.S. Hayward

**Clinico-pathologic features of fatal disease attributed to new variants of endotheliotropic herpesviruses in two Asian elephants (*Elephas maximus*)**

*Veterinary Pathology* 46 (2009) 97-104

**Abstract.** The first herpesviruses described in association with serious elephant disease were referred to as endotheliotropic herpesviruses (EEHV) because of their ability to infect capillary endothelial cells and cause potentially fatal disease. Two related viruses, EEHV1 and EEHV2, have been described based on genetic composition. This report describes the similarities and differences in clinicopathologic features of 2 cases of fatal endotheliotropic herpesvirus infections in Asian elephants caused by a previously unrecognized virus within the betaherpesvirus subfamily. EEHV3 is markedly divergent from the 2 previously studied fatal probosciviruses, based on polymerase chain reaction sequence analysis of 2 segments of the

viral genome. In addition to ascites, widespread visceral edema, petechiae, and capillary damage previously reported, important findings with EEHV3 infection were the presence of grossly visible renal medullary hemorrhage, a tropism for larger veins and arteries in various tissues, relatively high density of renal herpetic inclusions, and involvement of the retinal vessels. These findings indicate a less selective organ tropism, and this may confer a higher degree of virulence for EEHV3. © 2009 American College of Veterinary Pathologists.

R. Greenwald, O. Lyashchenko, J. Esfandiari, M. Miller, S. Mikota, J.H. Olsen, R. Ball, G. Dumonceaux, D. Schmitt, T. Moller, J.B. Payeur, B. Harris, D. Sofranko, W.R. Waters & K.P. Lyashchenko

**Highly accurate antibody assays for early and rapid detection of tuberculosis in African and Asian elephants**

*Clinical and Vaccine Immunology* 16 (2009) 605-612

**Abstract.** Tuberculosis (TB) in elephants is a reemerging zoonotic disease caused primarily by *Mycobacterium tuberculosis*. Current methods for screening and diagnosis rely on trunk wash culture, which has serious limitations due to low test sensitivity, slow turnaround time, and variable sample quality. Innovative and more efficient diagnostic tools are urgently needed. We describe three novel serologic techniques, the ElephantTB Stat-Pak kit, multiantigen print immunoassay, and dual-path platform VetTB test, for rapid antibody detection in elephants. The study was performed with serum samples from 236 captive African and Asian elephants from 53 different locations in the United States and Europe. The elephants were divided into three groups based on disease status and history of exposure: (i) 26 animals with culture-confirmed TB due to *M. tuberculosis* or *Mycobacterium bovis*, (ii) 63 exposed elephants from known-infected herds that had never produced a culture-positive result from trunk wash samples, and (iii) 147 elephants without clinical symptoms suggestive of TB, with consistently negative trunk wash culture results, and with no history of potential exposure to TB in the past 5 years. Elephants with culture-confirmed TB and a

proportion of exposed but trunk wash culture-negative elephants produced robust antibody responses to multiple antigens of *M. tuberculosis*, with seroconversions detectable years before TB-positive cultures were obtained from trunk wash specimens. ESAT-6 and CFP10 proteins were immunodominant antigens recognized by elephant antibodies during disease. The serologic assays demonstrated 100% sensitivity and 95 to 100% specificity. Rapid and accurate antibody tests to identify infected elephants will likely allow earlier and more efficient treatment, thus limiting transmission of infection to other susceptible animals and to humans. © 2009 American Society for Microbiology.

J.E. Haakonsson & S. Semple

**Lateralisation of trunk movements in captive Asian elephants (*Elephas maximus*)**

*Laterality 14 (2009) 413-422*

**Abstract.** Behavioural lateralisation has been widely investigated in vertebrates. Most studies in this area have focused on laterality in paired organs such as hands, limbs, and eyes. Fewer studies have explored side preferences in unpaired organs such as tails or trunks. We investigated laterality of trunk use among captive Asian elephants (*Elephas maximus*), quantifying side preference in four different trunk movements: feeding, sand spraying, self-touching, and swinging. We found evidence for significant side preference in all four movement categories. Variation in the occurrence and direction of side preference was seen both within and between individuals but no overall population-level side bias was seen for any of the four trunk movements. The strength of side preference in trunk use was significantly higher for feeding than for self-touching and swinging. This study adds to the very limited data on laterality in unpaired organs generally, and elephants' trunks more specifically. In addition it provides novel information about directional lateralisation in trunk use across a range of functionally distinct contexts. © 2009 Psychology Press.

A.Y. Hakeem, C.C. Sherwood, C.J. Bonar, C. Butti, P.R. Hof & J.M. Allman

**Von Economo neurons in the elephant brain**

*The Anatomical Record: Advances in Integrative*

*Anatomy and Evolutionary Biology 292 (2009) 242-248*

**Abstract.** Von Economo neurons (VENs), previously found in humans, all of the great ape species, and four cetacean species, are also present in African and Indian elephants. The VENs in the elephant are primarily found in similar locations to those in the other species. They are most abundant in the fronto-insular cortex (area FI) and are also present at lower density in the anterior cingulate cortex. Additionally, they are found in a dorsolateral prefrontal area and less abundantly in the region of the frontal pole. The VEN morphology appears to have arisen independently in hominids, cetaceans, and elephants, and may reflect a specialization for the rapid transmission of crucial social information in very large brains. Von Economo neurons (VENs), previously found in humans, all of the great ape species, and four cetacean species, are also present in African and Indian elephants. The VENs in the elephant are primarily found in similar locations to those in the other species. They are most abundant in the fronto-insular cortex (area FI) and are also present at lower density in the anterior cingulate cortex. Additionally, they are found in a dorsolateral prefrontal area and less abundantly in the region of the frontal pole. The VEN morphology appears to have arisen independently in hominids, cetaceans, and elephants, and may reflect a specialization for the rapid transmission of crucial social information in very large brains. © 2008 Wiley-Liss, Inc.

R. Hermes, B. Behr, T.B. Hildebrandt, S. Blottner, B. Sieg, A. Frenzel, A. Knieriem, J. Saragusty & D. Rath

**Sperm sex-sorting in the Asian elephant (*Elephas maximus*)**

*Animal Reproduction Science 112 (2009) 390-396*

**Abstract.** In captive Asian elephants, there is a strong need for production of female offspring to enhance reproduction, counter premature aging processes in female animals and reduce challenging management situations derived from husbandry of several bulls in one institution. Artificial insemination of flow cytometrically sex-sorted spermatozoa offers the possibility to predetermine the sex of offspring with high

accuracy. The aims of this study were to determine a suitable semen extender and basic parameters for flow cytometrical sex-sorting of Asian elephant spermatozoa. In total 18 semen samples were collected by manual rectal stimulation from one bull. Sperm quality parameters and sex sortability of spermatozoa were evaluated after dilution in three semen extenders (MES-HEPES-skim milk, MES-HEPES, TRIS–citric acid) and DNA staining. MES-HEPES-skim milk was the only semen extender found suitable to sex Asian elephant spermatozoa. From 18 ejaculates collected, 12 were successfully sorted with a purity of  $94.5 \pm 0.7\%$  at an average sort rate of  $1945.5 \pm 187.5$  spermatozoa per second. Sperm integrity, progressive and total motility were  $42.6 \pm 3.9\%$ ,  $48.1 \pm 3.3\%$ ,  $59.4 \pm 3.8\%$  after DNA labelling, and  $64.8 \pm 3.2\%$ ,  $58.0 \pm 5.0\%$ ,  $70.8 \pm 4.4\%$  after sorting, respectively. After liquid storage of sorted spermatozoa for 12 h at 4 °C, sperm integrity, progressive and total motility were  $46.4 \pm 5.2\%$ ,  $32.2 \pm 4.2\%$  and  $58.2 \pm 3.9\%$ , respectively. The obtained results provide a promising base to inseminate Asian elephants with sexed semen. © 2008 with permission from Elsevier.

N. Irie-Sugimoto, T. Kobayashi, T. Sato & T. Hasegawa

#### **Relative quantity judgment by Asian elephants (*Elephas maximus*)**

*Animal Cognition* 12 (2009) 193-199

**Abstract.** This study investigated whether Asian elephants can make relative quantity judgment (RQJ), a dichotomous judgment of unequal quantities ordered in magnitude. In Experiment 1, elephants were simultaneously shown two baskets with differing quantities of bait (up to 6 items). In Experiment 2, elephants were sequentially presented with baits, which could not be seen by elephants in their total quantities. The task of elephants was to choose the larger quantity in both experiments. Results showed that the elephants chose the larger quantity with significantly greater frequency. Interestingly, the elephants did not exhibit disparity or magnitude effects, in which performance declines with a smaller difference between quantities in a two-choice task, or the total quantity increases, respectively. These findings appear to be

inconsistent with the previous reports of RQJ in other animals, suggesting that elephants may be using a different mechanism to compare and represent quantities than previously suggested for other species. © 2008 with kind permission from Springer Science+Business Media.

M. Jaynes

#### **From war elephants to circus elephants: Humanity's abuse of elephants**

*Journal for Critical Animal Studies* 7 (2009) 74-106

**Abstract.** This paper examines the historical human use and abuse of elephants in an attempt to connect the contemporary use of performing elephants with the ancient use of war elephants and also examines two opposing opinions regarding elephant conservation. Beginning in ancient times, the now unheard of but once ubiquitous war elephants used by Julius Caesar, Alexander the Great, Hannibal and other Asian cultures is revisited and the abuse of war elephants is traced into modern warfare. Contemporary “elephant crushing” in Thailand and the use of elephants to execute human beings will be examined. The argument is posited that western acceptance of the use of performing elephants is equally as reprehensible as the ancient use of the war elephant. The ivory trade is also examined along with elephant cognition and social behaviors including death rituals. The paper suggests the alternative of elephant sanctuaries. Statistics are provided regarding the highly endangered Asian and African elephants’ declining total populations. The paper: connects contemporary western elephant abuse with the use of elephants in war; urges the reader to never attend or promote elephant circuses, buy ivory, or support the exploitation of the elephant in any way; and argues intrinsic valuing of elephants in lieu of other conservation approaches such as Sustainable Use. © 2009 Institute for Critical Animal Studies.

R. Joshi & R. Singh

#### **Feeding behaviour of wild Asian elephants (*Elephas maximus*) in the Rajaji National Park**

*Journal of American Science* 4 (2008) 34-48

**Abstract.** The Asian elephant's (*Elephas*

*maximus*) feeding behaviour with food preferences was studied in Rajaji National Park area between 1999-2006. The major objective of the present study is to document the fodder plant species and their seasonal consumption by elephants. Though elephants consume a variety of plant species in the study area, but their diet mainly consisted of fifty (50) plant species, which are available to them alternately round the year. Alteration between a predominantly browse diet throughout the year with a grass diet during the early dry season was related to the seasonally changing mineral content of grasses. Consumption of tree species (74%) was highest as compared to grasses (14%) and shrubs (8%) but their diet was mainly dependent on availability of seasonal food round the year and on their migration. Elephants extensively feed on *Mallotus philippinensis*, *Acacia catechu*, *Lagerstroemia parviflora*, *Ehretia laevis*, *Dalbergia sissoo*, *Tectona grandis*, *Zizyphus mauritiana*, *Aegle marmelos* and *Ficus bengalensis* besides, elephants also utilized various grasses and shrubs as their food, which mainly included *Dendrocalamus strictus*, *Helicteres isora*, *Saccharum munja*, *Saccharum spontaneum*, *Cynodon dactylon*, *Desmostachya bipinnata* and *Neyraudia arundinacea*. Elephants sometimes spent long time to feed on some particular plant species like *Dendrocalamus strictus*, *Mallotus philippinensis* and *Tectona grandis*. Eastern populations of elephants were subjected to feed extremely on *Tectona grandis* and *Holoptrophramitis* spp. whereas currently south-western populations of elephants were not utilizing these species as their food. Crop raiding, which was sporadic during the wet season, gradually increased with more area being cultivated with the onset of monsoon. We propose that this is the first documented study, which has developed a database about the fodder plant species for Asian elephant's survival in north-west India. © 2008 AmericanScience.org.

C. Kilgallon, E. Flach, W. Boardman, A. Routh, T. Strike & B. Jackson

**Analysis of biochemical markers of bone metabolism in Asian elephants (*Elephas maximus*)**

*Journal of Zoo and Wildlife Medicine* 39 (2008) 527-536

**Abstract.** Two human enzyme immunoassays (EIA) and one radioimmunoassay (RIA) were validated and used to measure osteocalcin (OC), bone alkaline phosphatase (BAP), and the cross-linked telopeptide domain of type I collagen (ICTP), in serum from Asian elephants (*Elephas maximus*). Sera from four adult females sampled on 7 consecutive days were also analyzed to assess the existence and magnitude of intraindividual day-to-day variability of the serum concentration of these markers. Sample dilution curves were parallel with assay standard curves, which demonstrated that excellent cross reactivity existed between assay antibodies and elephants marker antigens. Statistically significant inverse correlations were found between age and concentrations of all three markers: BAP,  $r=-0.862$  ( $P<0.01$ ); OC,  $r=-0.788$  ( $P<0.002$ ); and ICTP,  $r=-0.848$  ( $P<0.01$ ). Strong positive correlations were found between BAP and OC ( $r=0.797$ ,  $P<0.01$ ), OC and ICTP ( $r=0.860$ ,  $P<0.01$ ), and between BAP and ICTP ( $r=0.958$ ,  $P<0.01$ ). No statistically significant intraindividual variability was found over 7 days in the four adult females for any of the markers assessed (OC:  $P = 0.089$ ; ICTP:  $P=0.642$ ; BAP:  $P=0.146$ ;  $n = 4$  in each case). The overall coefficient of variability observed in this group of animals was 10.3%, 7.4%, and 5.5% for OC, BAP, and ICTP, respectively. These results suggest a potential role for biochemical markers of bone turnover in monitoring skeletal health and bone disease in Asian elephants. © 2008 by American Association of Zoo Veterinarians.

J.C. Lee, H.M. Hsieh, L.H. Huang, Y.C. Kuo, J.H. Wu, S.C. Chin, A.H. Lee, A. Linacre & L.C. Tsai

**Ivory identification by DNA profiling of cytochrome b gene**

*International Journal of Legal Medicine* 123 (2009) 117-121

**Abstract.** Ivory can be visually identified in its native form as coming from an elephant species; however, determining from which of the three extant elephant species a section of ivory originates is more problematic. We report on a method that will identify and distinguish the protected and endangered elephant species, *Elephas maximus* or *Loxodonta* sp. To identify the species of elephant from ivory products, we developed three

groups of nested PCR amplifications within the cytochrome b gene that generate amplification products using highly degraded DNA isolated from confiscated ivory samples dating from 1995. DNA from a total of 382 out of 453 ivory samples were successfully isolated and amplified leading to species identification. All sequences were searched against GenBank and found to match with *E. maximus* and *Loxodonta* sp. with at least 99% similarity. The samples that were tested came from eight Asian elephants, 14 African forest elephants (*Loxodonta cyclotis*), and 360 African savannah elephants (*Loxodonta africana*). This study demonstrates a high success rate in species identification of ivory by a nested PCR approach within the cytochrome b gene which provides the necessary information for the protection of endangered species conservation. © 2008 with kind permission from Springer Science+Business Media.

M. Ogra

**Attitudes toward resolution of human-wildlife conflict among Forest-Dependent agriculturalists Near Rajaji National Park, India**

*Human Ecology* 37 (2009) 161-177

**Abstract.** Understanding local attitudes towards human-wildlife conflict (HWC) is key to developing successful conflict mitigation strategies. In this paper, in-depth interview and questionnaire data about resolution of HWC in Uttarakhand, India are examined from both qualitative and quantitative approaches (n=70). Responses are differentiated between and within three subgroups: gender, literacy status, and relative wealth. Overall, the plurality of respondents said that fencing is the best solution, that the Forest Department should take leadership, and that villagers would be willing to participate in a cooperative management institution. However, cooperative action was only actively supported by 27.4% of respondents, suggesting that comanagement of this protected area will require significant capacity building and trust building activities. Intragroup differences show that all three factors are significant, and underscore the importance of addressing gender differences in attitudes about HWC in particular. Women were less likely than men to support compensation,

more likely to prefer that the village take leadership, and less willing to participate in a cooperative management institution. The study illustrates the value of mixed-method research, and suggests a number of specific entry points for action. © 2008 with kind permission from Springer Science+Business Media.

P.A. Rees

**The sizes of elephant groups in zoos: Implications for elephant welfare**

*Journal of Applied Animal Welfare Science* 12 (2009) 44-60

**Abstract.** This study examined the distribution of 495 Asian elephants (*Elephas maximus*) and 336 African elephants (*Loxodonta africana*) in 194 zoos, most of which were located in Europe (49.1%) and North America (32.6%). Cows outnumbered bulls 4 to 1 (*Loxodonta*) and 3 to 1 (*Elephas*). Groups contained 7 or fewer: mean, 4.28 (s = 5.73). One fifth of elephants lived alone or with one conspecific. Forty-six elephants (5.5%) had no conspecific. Many zoos ignore minimum group sizes of regional zoo association guidelines. The American Zoo and Aquarium Association recommends that breeding facilities keep herds of 6 to 12 elephants. The British and Irish Association of Zoos and Aquariums recommends keeping together at least 4 cows over 2 years old. Over 69% Asian and 80% African cow groups—including those under 2 years—consisted of fewer than 4 individuals. Recently, Europe and North America have made progress with some zoos no longer keeping elephants and with others investing in improved facilities and forming larger herds. The welfare of individual elephants should outweigh all other considerations; zoos should urgently seek to integrate small groups into larger herds. © Taylor & Francis Group, LLC

N. Thongtip, J. Saikhun, S. Mahasawangkul, K. Kornkaewrat, P. Suthanmapinanh & A. Pinyopummin

**Effect of pentoxifylline on the motility characteristics and viability of spermatozoa in Asian elephants (*Elephas maximus*) with low semen quality**

*Thai Journal of Veterinary Medicine* 38 #3 (2008) 37-45

**Abstract.** To investigate the effects of pentoxifylline (PTX) to enhance the motility and fertilization capacity of semen samples with the low-motile sperm in Asian elephants, fourteen semen collection attempts in 9 elephant bulls by manual stimulation were undertaken and eleven ejaculates fitted the criteria of investigation (0-30% motility). They were divided into two groups: poor-motile (0-9% motility) and low-motile (10-30% motility) sperm groups. Fresh semen samples were divided as a control group and 3 experimental groups that were supplemented with PTX at a final concentration of 0.5, 1.0 and 2.0 mg/ml, respectively. The semen samples were incubated at 37°C for 15 and 30 mins and stained with VIADENT media for viability assessment. Sperm motility and viability were tested using computer-assisted semen analysis. PTX added to the semen did not significantly improve the percentage of the total and progressive motility, motility characteristics and viability of sperm in either the poor-or low-motile groups. However, at 30 min, in the low-motile sperm group, PTX treatment could maintain the percentage of total and progressive motility, path velocity and progressive velocity at a higher level than the control group. The present study indicated that PTX added to low motility semen did not increase elephant semen quality. However, it may partially have a tendency to maintain sperm motility and sperm movement characteristics. © 2008 Thai Journal of Veterinary Medicine.

T.N.C. Vidya, R. Sukumar & D.J. Melnick

**Range-wide mtDNA phylogeography yields insights into the origins of Asian elephants**

*Proceedings of the Royal Society B* 276 (2009) 893–902

**Abstract.** Recent phylogeographic studies of the endangered Asian elephant (*Elephas maximus*) reveal two highly divergent mitochondrial DNA (mtDNA) lineages, an elucidation of which is central to understanding the species's evolution. Previous explanations for the divergent clades include introgression of mtDNA haplotypes between ancestral species, allopatric divergence of the clades between Sri Lanka or the Sunda region and the mainland, historical trade of elephants, and retention of divergent lineages due to large population sizes. However, these

studies lacked data from India and Myanmar, which host approximately 70 per cent of all extant Asian elephants. In this paper, we analyse mtDNA sequence data from 534 Asian elephants across the species's range to explain the current distribution of the two divergent clades. Based on phylogenetic reconstructions, estimates of times of origin of clades, probable ancestral areas of origin inferred from dispersal-vicariance analyses and the available fossil record, we believe both clades originated from *Elephas hysudricus*. This probably occurred allopatrically in different glacial refugia, the alpha clade in the Myanmar region and the beta clade possibly in southern India-Sri Lanka, 1.6-2.1 Myr ago. Results from nested clade and dispersal-vicariance analyses indicate a subsequent isolation and independent diversification of the beta clade in both Sri Lanka and the Sunda region, followed by northward expansion of the clade. We also find more recent population expansions in both clades based on mismatch distributions. We therefore suggest a contraction-expansion scenario during severe climatic oscillations of the Quaternary, with range expansions from different refugia during warmer interglacials leading to the varying geographical overlaps of the two mtDNA clades. We also demonstrate that trade in Asian elephants has not substantially altered the species's mtDNA population genetic structure. © 2008 The Royal Society.

J.F.X. Wellehan, A.J. Johnson, A.L. Childress, K.E. Harr & R. Isaza

**Six novel gammaherpesviruses of Afrotheria provide insight into the early divergence of the Gammaherpesvirinae**

*Veterinary Microbiology* 127 (2008) 249-257

**Abstract.** The Afrotheria represent an early branching of placental mammals. Only two herpesviruses from Afrotheria have been previously identified, and the genus Proboscivirus in the subfamily Betaherpesvirinae has been proposed for them. Six novel gammaherpesviruses were identified in four species in the superorder Afrotheria by detection and analysis of their DNA polymerase genes. Elephantid herpesvirus 3 (EIHV3) and Elephantid herpesvirus 4 (EIHV4) were identified from conjunctival swabs from Asian elephants (*Elephas maximus*). EIHV3 was

also found in a vaginal swab from one elephant with vaginitis. Elephantid herpesvirus 5 (ElHV5) was identified from vaginal swabs of two Asian elephants with vaginal plaques. Elephantid herpesvirus 6 was discovered in a conjunctival swab from an African elephant (*Loxodonta africana*). Procavid herpesvirus 1 (PrHV1) was found in spleen and conjunctival swabs of rock hyrax (*Procavia capensis*). Trichechid herpesvirus 1 (TrHV1) was identified from skin and buffy coats of Florida manatees (*Trichechus manatus latirostris*). ElHV3 and ElHV4 form a distinct cluster, and ElHV5, ElHV6, TrHV1, and PrHV1 form a second cluster. These viruses may have codiverged with their host species. Phylogenetic analysis of these novel herpesviruses suggests that two separate groups of gammaherpesviruses may have codiverged with the Afrotheria. © 2007 with permission from Elsevier.

D.L. Wells & R.M. Irwin

**Auditory stimulation as enrichment for zoo-housed Asian elephants (*Elephas maximus*)**

*Animal Welfare* 17 (2008) 335-340

**Abstract.** This study explored the effect of auditory stimulation on the behaviour and welfare of four zoo-housed, female Asian elephants (*Elephas maximus*). All animals were exposed, in an ABA design, to two conditions of auditory stimulation: a 'control' (no auditory stimulation), and an 'experimental' condition, during which the animals were presented with a commercially-

available CD of classical music. Each condition lasted for five days, with an interim period of two days between each condition (Study 1). The elephants' behaviour was recorded every minute for four hours a day for the full five days of each condition using instantaneous scan-sampling. The procedure was repeated four months later (Study 2), for a shorter period of time (one day per condition, again using an ABA design) to assess whether the results are generalisable. Analysis of both studies revealed that the elephants spent significantly less of their time stereotyping during the experimental conditions than the control. None of the other behaviours recorded were influenced significantly by auditory stimulation. Overall, the findings from this study suggest that auditory stimulation, in the form of classical music, may be a useful method of reducing stereotypic behaviour in zoo-housed Asian elephants, although more long-term work with a larger number of animals is needed before firm conclusions can be drawn. © 2008 with permission from Universities Federation for Animal Welfare.

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*E-mail: jenny@aim.uzh.ch*



Collared elephant in southern Sri Lanka. Her movements can be followed on the internet via "facebook" in the group "Sapumali the Elephant".

Photo by Jennifer Pastorini