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- ▶ [Alternatives](#)
- ▶ [Literature Searching and Databases](#)
- ▶ [Pain and Distress](#)
- ▶ [Humane Endpoints and Euthanasia](#)

 You are here: [Home](#) / [Publications](#) / [Bibliographies and Resource Guides](#) / [Information Resources on Elephants](#)

Publications

Information Resources on Elephants

AWIC Resource Series No. 18 Revised May 2010

 Updates and Replaces Information Resources on Elephants, June 2006. For information prior to 2002 please see [Information Resources on Elephants, April 2003](#)

Table of Contents

- [About this Document](#)
- [Bibliography](#)
 - [General](#)
 - [African Elephants](#)
 - [Asian Elephants](#)

Additional AWIC Resources

- [Exhibit Animal Species - Elephants](#)
- [Legislation, Regulations and Guidelines - Exhibition Animals](#)

African Elephant


Loxodonta africana

About this Document

Although there is a considerable amount of information available on elephants in bibliographic databases it is not readily available in an organized manner to most persons. The references in this publication were obtained from multiple databases and compiled chronologically and alphabetically by author, under various general headings. Although there are a number of published papers and articles dealing with elephants in the wild, including their tracking, number estimation, feeding habits, environmental damage, and conflicts with people, only a few of these types of articles are included in this resource. Most of the references in this publication are concerned with captive animals and their care, behavior, health, and handling.

This publication is not meant to be all inclusive as there are a number of private database collections with references on elephants which are not included here. The references listed in this publication were collected and organized into general categories for ease in locating pertinent articles. The references are listed first under a [General](#) category which pertains to elephants in general and then under separate sections for [African Elephants](#) and [Asian Elephants](#). These two sections are further broken into thirteen subsections, covering topics such as anatomy, behavior, and veterinary care. Selected Web sites are found under [Additional AWIC Resources](#). It is hoped this publication will be of use to those interested in elephants and their care, treatment and conservation in captivity and in the wild.

For this document, the compiler searched for citations from multiple sources published between the years 2003 to 2010. The sources of information include peer-reviewed journals, conference proceedings, theses, annual reports, dissertations, books, monographs, and reviews. Some URLs are provided for documents available as eDocuments. Readers are cautioned as to the dynamic nature of the internet and the fact that Web addresses and content are subject to change. All sites are current as of May 2010.

The National Agricultural Library (NAL) Services web page supplies information on how to [request library materials](#) that are included in its collection.

[Acknowledgements](#)

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[Back to Top](#)

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[Back to Top](#)

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[Home](#)[About AWIC](#)[Publications](#)[Workshops](#)[Services](#)[News and Events](#)[Help](#)[Contact Us](#)

Search AWIC

Go

- Search all USDA
- Advanced Search

Browse by Subject

- ▷ Research Animals
- ▷ Farm Animals
- ▷ Zoo, Circus and Marine Animals
- ▷ Companion Animals
- ▷ Government and Professional Resources
- ▷ Alternatives
- ▷ Literature Searching and Databases
- ▷ Pain and Distress
- ▷ Humane Endpoints and Euthanasia

You are here: [Home](#) / [Publications](#) / [Bibliographies and Resource Guides](#) / [Information Resources on Elephants](#) / [Elephants - General](#)

 [Printer Friendly Page](#)

Publications

Information Resources on Elephants

[<< Table of Contents](#)
[>> Previous](#) | [Next >>](#)

General

- Baxter, P.W.J. and W.M. Getz (2005). **A model-framed evaluation of elephant effects on tree and fire dynamics in African savannas.** *Ecological Applications* 15(4): 1331-1341. ISSN: 1051-0761.
NAL Call Number: QH540.E23
Descriptors: savannas, *Loxodonta africana*, population density, herbivores, browsing, trees, woody plants, grasses, plant ecology, community ecology, wildfires, fire ecology, simulation models, Southern Africa.
- Bhima, R., J. Howard, and S. Nyanyale (2003). **The status of elephants in Kasungu National Park, Malawi, in 2003.** *Pachyderm* 35: 31-36. ISSN: 1026-2881.
Descriptors: *Loxodonta africana africana*, trade in animals, extent of illegal poaching, conservation measures, need for increased law enforcement activities, population censuses, population density, population size, site comparisons, Malawi, Kasungu National Park, abundance, level of poaching and need for better law enforcement.
Language of Text: English, with English and French summaries.
- Blake, S. and S. Hedges (2004). **Sinking the flagship: the case of forest elephants in Asia and Africa.** *Conservation Biology* 18(5): 1191-1202. ISSN: 0888-8892.
NAL Call Number: QH75.A2C5
Descriptors: forests, wild animals, wildlife conservation, *Elephas maximus*, *Loxodonta africana*, management implications.
- Blanc, J.J., R.F.W. Barnes, G.C. Craig, H.T. Dublin, C.R. Thouless, I. Douglas Hamilton and J.A. Hart (2007). **African Elephant Status Report 2007: an Update From the African Elephant Database,** Occasional Paper of the IUCN Species Survival Commission, International Union for Conservation of Nature and Natural Resources (IUCN): Gland, Switzerland, 276 p. ISBN: 978-2-8317-0970-3.
Online: <http://www.iucn.org/dbtw-wpd/edocs/SSC-OP-033.pdf>
Descriptors: African elephant, *Loxodonta africana*, databases, geographical distribution, population dynamics, wildlife conservation, wildlife management.
- Blanc, J., C. Thouless, J. Hart, H. Dublin, I. Douglas Hamilton, C. Craig, and R. Barnes (2003). **African elephant status report 2002. An update from the African elephant database.** *Occasional Papers of the IUCN Species Survival Commission* 29: i-vi, 1-301. ISSN: 1026-4965.
Descriptors: African elephant, *Loxodonta africana*, conservation, population dynamics, Africa, distribution, database.
- Boafo, Y., U.F. Dubuire, E.K. Danquah, M. Manford, A. Nandjui, E.M. Hema, R.F.W. Barnes, and B. Bailey (2004). **Long term management of crop raiding by elephants around Kakum Conservation Area in southern Ghana.** *Pachyderm* 37: 68-72. ISSN: 1026-2881.
Online: <http://www.african-elephant.org/pachy/pdfs/pachy39.pdf>
Descriptors: African elephant, *Loxodonta africana*, damage to crops, longterm

management recommendations, Ghana, Kakum conservation area, crop raiding.

Language of Text: English, Summaries in English and French.

- Borah, J., K. Thakuria, K. Baruah, N. Sarma, and K. Deka (2005). **Man-elephant conflict problem: a case study.** *Zoos' Print Journal* 20(7): 22-24. ISSN: 0971-6378.
Descriptors: Asian elephant, *Elephas maximus*, human-animal conflict, resolution.
- Bradshaw, G.A., A.N. Schore, J.L. Brown, J.H. Poole, and C.J. Moss (2005). **Elephant breakdown.** *Nature* 433(7028): 807.
NAL Call Number: 472 N21
Descriptors: aggression physiology, animal behavior physiology, elephant physiology, stress physiopathology, violence, animal disease models, fathers, maternal deprivation, mothers, social behavior, post traumatic stress disorders physiopathology.
- Bulte, E., R. Damania, G. Lindsey, and K. Lindsay (2004). **Ecology and conservation. Space--the final frontier for economists and elephants.** *Science* 306(5695): 420-421.
NAL Call Number: 470 SCI2
Descriptors: commerce, conservation of natural resources economics, ecosystem, ecology, environment, models, economic, population dynamics, population growth.
- Choudhury, A. (2004). **Human-elephant conflicts in northeast India.** *Human Dimensions of Wildlife* 9(4): 261-270. ISSN: 1087-1209.
Descriptors: Asian elephant, *Elephas maximus*, man, habitat management, India, human conflict, conservation issues, habitat loss, conflicts.
- Clubb, R. and G. Mason (2003). **The welfare of zoo elephants in Europe: mortality, morbidity and reproduction.** *Proceedings of the Fifth Annual Symposium on Zoo Research, Marwell Zoological Park, Federation of Zoological Gardens of Great Britain and Ireland, London, July 7, 2003-July 8, 2003*, p. 67-76. 342 p.
Descriptors: Asian elephant, *Elephas maximus*, African elephant, *Loxodonta africana*, zoos, wildlife parks, philosophy, ethics, care, reproduction, breeding, longevity, mortality, Europe, welfare.
- Dublin, H.T. and R.E. Hoare (2004). **Searching for solutions: the evolution of an integrated approach to understanding and mitigating human-elephant conflict in Africa.** *Human Dimensions of Wildlife* 9(4): 271-278. ISSN: 1087-1209.
Descriptors: African elephants, *Loxodonta africana*, man, research, Africa, human conflict, management, solutions, mitigating.
- Dudley, J.P. (2004). **Elephant evolution, ecology, and conservation biology.** *Quarterly Review of Biology* 79(2): 188-94.
NAL Call Number: 442.8 Q2
Descriptors: book review, Asian elephants, African elephants, evolutionary ecology, behavior, conservation.
- Dunham, K.M. (2008). **Detection of anthropogenic mortality in elephant *Loxodonta africana* populations: a long-term case study from the Sebungwe region of Zimbabwe.** *Oryx* 42(1): 36-48. ISSN: (p) 0030-6053; (E) 1365-3008.
Online: <http://dx.doi.org/10.1017/S0030605308000471>
Descriptors: African elephant, *Loxodonta africana*, causes of death, mortality of wild animals, wildlife management.
- Eggert, L.S., J.A. Eggert, and D.S. Woodruff (2003). **Estimating population sizes for elusive animals: the forest elephants of Kakum National Park, Ghana.** *Molecular Ecology* 12(6): 1389-402.
NAL Call Number: QH540.M64
Abstract: African forest elephants are difficult to observe in the dense vegetation, and previous studies have relied upon indirect methods to estimate population sizes. Using multilocus genotyping of noninvasively collected samples, we performed a genetic survey of the forest elephant population at Kakum National Park, Ghana. We estimated population size, sex ratio and genetic variability from our data, then combined this information with field observations to divide the population into age groups. Our population size estimate was very close to that obtained using dung counts, the most commonly used indirect method of estimating the population sizes of forest elephant populations. As their habitat is fragmented by expanding human populations, management will be increasingly important to the persistence of forest elephant populations. The data that can be obtained from noninvasively collected samples will help managers plan for the conservation of this keystone species.
Descriptors: genetics, physiology, trees, variation genetics, DNA primers, feces chemistry, gene frequency, Ghana, microsatellite repeats, population density, sex ratio, specimen handling.
- Endres, J., A. Hauffellner, B. Hauffellner, J. Schilfarth and M. Schilfarth (2003). **Elephants in Zoos and Safari Parks: Comprehensive Data on Elephant Husbandry With an Analysis of the Oxford Study. Documentation 2002.**, European Elephant Group: Gruenwald, 211 p.

Descriptors: Asian elephant, *Elephas maximus*, African elephant, *Loxodonta africana*, captive stock lists, care in captivity, husbandry, reproduction, breeding, Europe.

Garai, M. (2005). **Large herbivores: the elephant.** In: J.d.P. Bothma and N. van Rooyen (Editors), *Intensive Wildlife Production in Southern Africa*, Van Schaik, Pretoria, p. 2-24. ISBN: 0627025498.

Descriptors: African elephant, *Loxodonta africana*, care in captivity, reproductive techniques, parasites, diseases and disorders, Africa, biological characteristics.

Glickman, S.E., R.V. Short, and M.B. Renfree (2005). **Sexual differentiation in three unconventional mammals: spotted hyenas, elephants and tammar wallabies.** *Hormones and Behavior* 48(4): 403-17.

NAL Call Number: QP801.H7H64

Abstract: The present review explores sexual differentiation in three non-conventional species: the spotted hyena, the elephant and the tammar wallaby, selected because of the natural challenges they present for contemporary understanding of sexual differentiation. According to the prevailing view of mammalian sexual differentiation, originally proposed by Alfred Jost, secretion of androgen and anti-Mullerian hormone (AMH) by the fetal testes during critical stages of development accounts for the full range of sexually dimorphic urogenital traits observed at birth. Jost's concept was subsequently expanded to encompass sexual differentiation of the brain and behavior. Although the central focus of this review involves urogenital development, we assume that the novel mechanisms described in this article have potentially significant implications for sexual differentiation of brain and behavior, a transposition with precedent in the history of this field. Contrary to the "specific" requirements of Jost's formulation, female spotted hyenas and elephants initially develop male-type external genitalia prior to gonadal differentiation. In addition, the administration of anti-androgens to pregnant female spotted hyenas does not prevent the formation of a scrotum, pseudoscrotum, penis or penile clitoris in the offspring of treated females, although it is not yet clear whether the creation of masculine genitalia involves other steroids or whether there is a genetic mechanism bypassing a hormonal mediator. Wallabies, where sexual differentiation occurs in the pouch after birth, provide the most conclusive evidence for direct genetic control of sexual dimorphism, with the scrotum developing only in males and the pouch and mammary glands only in females, before differentiation of the gonads. The development of the pouch and mammary gland in females and the scrotum in males is controlled by genes on the X chromosome. In keeping with the "expanded" version of Jost's formulation, secretion of androgens by the fetal testes provides the best current account of a broad array of sex differences in reproductive morphology and endocrinology of the spotted hyena, and androgens are essential for development of the prostate and penis of the wallaby. But the essential circulating androgen in the male wallaby is 5 α androstane-3 α ,20-dione, locally converted in target tissues to DHT, while in the pregnant female hyena, androstenedione, secreted by the maternal ovary, is converted by the placenta to testosterone (and estradiol) and transferred to the developing fetus. Testicular testosterone certainly seems to be responsible for the behavioral phenomenon of musth in male elephants. Both spotted hyenas and elephants display matrilineal social organization, and, in both species, female genital morphology requires feminine cooperation for successful copulation. We conclude that not all aspects of sexual differentiation have been delegated to testicular hormones in these mammals. In addition, we suggest that research on urogenital development in these non-traditional species directs attention to processes that may well be operating during the sexual differentiation of morphology and behavior in more common laboratory mammals, albeit in less dramatic fashion.

Descriptors: androgens physiology, elephant physiology, hyaenidae physiology, macropodidae physiology, sex differentiation physiology, urogenital system physiology, elephant anatomy and histology, elephant embryology, gene expression regulation, developmental physiology, genomic imprinting physiology, hyaenidae anatomy and histology, hyaenidae embryology, macropodidae anatomy and histology, macropodidae embryology, neurosecretory systems physiology, organogenesis physiology, sex characteristics, urogenital system anatomy and histology, urogenital system embryology, urogenital system growth and development.

Graham, M.D. and T. Ochieng (2008). **Uptake and performance of farm-based measures for reducing crop raiding by elephants *Loxodonta africana* among smallholder farms in Laikipia District, Kenya.** *Oryx* 42(1): 76-82. ISSN: (p) 0030-6053; (E) 1365-3008. **Online:** <http://dx.doi.org/10.1017/S0030605308000677>

Descriptors: African elephant, *Loxodonta africana*, crop raiding, vertebrate pests, human-elephant conflict, elephant deterrents.

Hambler, C., P.A. Henderson, and M.R. Speight (2005). **Elephants, ecology, and nonequilibrium?** *Science* 307(5710): 673-674; Author Reply 673-674.

NAL Call Number: 470 SCI2

Descriptors: conservation of natural resources, ecosystem, Africa, Australia, ecology, environment, insects, population density.

Harris, G.M., G.J. Russell, R.I.v. Aarde, and S.L. Pimm (2008). **Rules of habitat use by**

elephants *Loxodonta africana* in southern Africa: insights for regional management. *Oryx* 42(1): 66-75. ISSN: (p) 0030-6053; (E) 1365-3008.

Online: <http://dx.doi.org/10.1017/S0030605308000483>

Descriptors: African elephant, *Loxodonta africana*, culling, habitat selection, population control, wildlife management.

Jackson, T.P., S. Mosojane, S.M. Ferreira, and R.J.v. Aarde (2008). **Solutions for elephant *Loxodonta africana* crop raiding in northern Botswana: moving away from symptomatic approaches.** *Oryx* 42(1): 83-91. ISSN: (p) 0030-6053; (E) 1365-3008.
Online: <http://dx.doi.org/10.1017/S0030605308001117>

Descriptors: African elephants, *Loxodonta africana*, crop damage, economic analysis, crop raiding.

Jackson, W.A. (2003). **Elephants' milk.** *Pharmaceutical Historian* 33(4): 64-5.

Descriptors: milk history, therapeutics history, Great Britain, history, 19th century.

Nissani, M. (2004). **Theory of mind and insight in chimpanzees, elephants and other animals?** In: L.J. Rogers and G. Kaplan (Editors), *Comparative Vertebrate Cognition: Are Primates Superior to Non-Primates? Developments in Primatology: Progress and Prospects*, Kluwer Academic/Plenum Publishers: New York, Boston, p. 227-261. ISBN: 0306477270.

NAL Call Number: QL785.C537 2004

Descriptors: *Pan troglodytes*, chimpanzees, *Elephas maximus*, Asian elephant, intelligence, cognition, overview and insight ability.

Nyhus, P. and R. Tilson (2004). **Agroforestry, elephants, and tigers: balancing conservation theory and practice in human-dominated landscapes of Southeast Asia.**

Agriculture, Ecosystems and Environment 104(1): 87-97. ISSN: 0167-8809.

NAL Call Number: S601.A34

Descriptors: agroforestry, Elephantidae, *Panthera tigris*, wildlife management, conservation buffers, human wildlife relations, land use, South East Asia, Indonesia.

Omondi, P., E. Bitok, and J. Kagiri (2004). **Managing human-elephant conflicts: the Kenyan experience.** *Pachyderm* 36: 80-86. ISSN: 1026-2881.

Descriptors: African elephants, *Loxodonta africana*, animals, man, conflicts with man, interactions, conservation measures, Kenya, strategies, management.

Language of Text: English, with English and French summaries.

Palombo, M., M. Mussi, P. Gioia, and G. Cavarretta (2005). **Studying Proboscideans: knowledge, problems, and perspectives. Selected papers from "The World of Elephants" congress, Rome.** *Quaternary International* 126-128: i-vi, 1-287. ISSN: 1040-6182.

Descriptors: Proboscidea, Italy, meeting papers, problems, knowledge, perspectives.

Payne, K. (2003). **Sources of social complexity in the three elephant species.** In: F.B.M. de Waal and P.L. Tyack (Editors), *Animal Social Complexity: Intelligence, Culture, and Individualized Societies*, Harvard University Press: Cambridge & London, p. 57-85. ISBN: 0674009290.

NAL Call Number: QL739.3.A56 2003

Descriptors: *Elephas maximus*, *Loxodonta africana*, *Loxodonta cyclotis*, literature review, social behavior, social complexity, review.

Pradhan, N.M.B. (2007). **An ecological study of a re-colonizing population of Asian elephants (*Elephas maximus*) in lowland Nepal.** Dissertation, Norwegian University of Life Sciences, Department of Ecology and Natural Resource Management: 31 + 26 + 20 + 27 pp. + 1 paper p.

Abstract: This thesis includes four papers studying the population size and composition, habitat use at different spatial scales, seasonal diets and impact on forest habitats of a recently recolonizing population of Asian elephant (*Elephas maximus*) in the south-western part of the Bardia National Park, Nepal. Elephants strongly preferred floodplain communities both during the cool and the hot dry season, and there was a significant shift from forest to grass-dominated subtypes between these two seasons. Along fresh elephant tracks in the sal-dominated forest, there were more trees with previous elephant impact and a higher density of important food trees, especially *Mallotus philippensis*, than at random points. Elephant impact on trees was higher in the floodplain complex than in sal-dominated forest. At the time of study, the density of the colonizing population was low. However, the population is increasing and with immigrating sub-adult males, genetic diversity may be enhanced. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, diet, floodplains, genetic diversity, genetic variation, habitat selection, habitats, national parks, population dynamics, population structure, seasonal variation, *Mallotus philippensis*, *Shorea robusta*.

Pradhan, N.M.B. and P. Wegge (2007). **Dry season habitat selection by a recolonizing population of Asian elephants *Elephas maximus* in lowland Nepal.** *Acta Theriologica* 52(2): 205-214. ISSN: 0001-7051.

Abstract: Owing to landclearing and human expansion, Asian elephant *Elephas maximus*

Linnaeus, 1758 is declining throughout its range. In lowland Nepal, the species now only occurs in small remnant populations, shared with India. In order to develop guidelines for conserving the species in the country, we studied the habitat use of a small and recently re-established population in Bardia National Park. We used the distribution of dung in fixed width transects to estimate seasonal habitat selection at a general scale of the Park. We also analysed a specific habitat selection by elephants within the sal-dominated forest, by comparing the composition of trees and frequency of previous elephant impact on them along fresh tracks with those at random points. Elephants strongly preferred floodplain communities both during the cool and the hot season, but there was a marked shift from forest to grass-dominated subtypes between these seasons. Within the sal-dominated forest, there were more trees with previous elephant impact and a higher density of important food trees, especially *Mallotus philippensis* along fresh tracks than in random points. We found little if any effect of human activity or location of available water on the spatial distribution of elephant dung. The density of the colonizing population was low (ca 0.2 animals/km²), but numbers are expected to increase in the future. With the preferred floodplain habitat being quite small (ca 60 km²), animals are then expected to spread outside the national park. A large tract of government forest adjacent to the park may then, for some time, provide needed space for the expanding population. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephants, *Elephas maximus*, dry season, feces, floodplains, habitat selection, population decrease, seasonal behavior, spatial distribution, wildlife conservation.

Pradhan, N.M.B., P. Wegge, and S.R. Moe (2007). **How does a recolonizing population of Asian elephants affect the forest habitat.** *Journal of Zoology* 273(2): 183-191. ISSN: 0952-8369; Online: 1469-7998.

Online: <http://dx.doi.org/10.1111/j.1469-7998.2007.00313.x>

NAL Call Number: QL1.J68

Abstract: The Asian elephant *Elephas maximus* is currently re-colonizing the Bardia National Park in lowland Nepal. We studied their impact on woody vegetation in the nutrient-rich floodplain and in the relatively nutrient-poor sal forest. The types and extent of tree impact were recorded along fixed-width transects (335 km). Species composition, density and size classes ≥ 8 cm diameter breast height (dbh) were recorded in 15-m radius random plots (n=95). Impact was higher in the floodplain complex than in the sal-dominated forest. Our hypothesis that elephants were more selective on species in the nutrient-poor sal forest was only partly supported; the niche breadth of impacted trees was slightly higher in the floodplain complex. Pushed-over trees accounted for the highest proportion of impact (55%), followed by killed trees (39%). Of the pushed trees, 10% were not used for food. Among food trees, elephants selectively impacted size class 12-16 cm dbh, whereas non-food trees were impacted independently of size. A large proportion of the freshly browsed trees had been felled previously, indicating that most felled trees survived, enabling elephants to feed on them again. This may reflect an evolutionary adaptation among long-lived species with high site fidelity. Owing to preferential use but low abundance, two species in sal forest, *Grewia* spp. and *Desmodium oojeinense*, were found to be particularly vulnerable to local extinction due to elephants. Although the elephants had impacted a large number of species (62, 73% of all), 56.4% of the impacted trees consisted of *Mallotus philippinensis*. A recently observed increase in the density of *M. philippinensis* and the concurrent reduction of the hardly utilized *Shorea robusta* indicates that the rapidly growing elephant population may modify the composition of the forest by increasing its preferred food species. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, Asia, Nepal, alluvial-floodplain, *Mallotus philippinensis*, megaherbivores, sal forest, tree impact.

Sitati, N.W., M.J. Walpole, and N. Leader Williams (2005). **Factors affecting susceptibility of farms to crop raiding by African elephants: using a predictive model to mitigate conflict.** *Journal of Applied Ecology* 42(6): 1175-1182. ISSN: 0021-8901.

NAL Call Number: 410 J828

Descriptors: *Loxodonta africana*, crop damage, prediction, pest control, Kenya.

Skarpe, C., P.A. Aarrestad, H.P. Andreassen, S.S. Dhillion, T. Dimakatso, J.T. du Toit, Duncan, J. Halley, H. Hytteborn, S. Makhabu, M. Mari, W. Marokane, G. Masunga, M. Ditshoswane, S.R. Moe, R. Mojaphoko, D. Mosugelo, S. Motsumi, G. Neo Mahupeleng, M. Ramotadima, L. Rutina, L. Sechele, T.B. Sejoe, S. Stokke, J.E. Swenson, C. Taolo, M. Vandewalle, and P. Wegge (2004). **The return of the giants: ecological effects of an increasing elephant population.** *Ambio* 33(6): 276-82.

NAL Call Number: QH540.A52

Abstract: Northern Botswana and adjacent areas, have the world's largest population of African elephant (*Loxodonta africana*). However, a 100 years ago elephants were rare following excessive hunting. Simultaneously, ungulate populations were severely reduced by decrease. The ecological effects of the reduction in large herbivores must have been substantial, but are little known. Today, however, ecosystem changes following the increase in elephant numbers cause considerable concern in Botswana. This was the background for the "BONIC" project, investigating the interactions between the increasing elephant population and other ecosystem components and processes. Results confirm

that the ecosystem is changing following the increase in elephant and ungulate populations, and, presumably, developing towards a situation resembling that before the reduction of large herbivores. We see no ecological reasons to artificially change elephant numbers. There are, however, economic and social reasons to control elephants, and their range in northern Botswana may have to be artificially restricted.

Descriptors: conservation of natural resources, ecosystem, antelopes, Botswana, plants growth and development, population dynamics.

Stephenson, P.J. (2004). **The future for elephants in Africa.** In : N. Burgess, J. D'Amico Hales, E. Underwood, E. Dinerstein, D. Olson, I. Itoua, J. Schipper, T. Ricketts and K. Newman *Terrestrial Ecoregions of Africa and Madagascar: a Conservation Assessment*, Island Press: Washington, DC, Covelo & London, p. 133-136. ISBN: 1559633646.

NAL Call Number: QH77.A35T47 2004

Descriptors: African elephant, *Loxodonta africana*, conservation threats, past, present, future, conservation measures, review, Africa.

Sukumar, R. (2003). **The Living Elephants: Evolutionary Ecology, Behavior, and Conservation.**, Oxford University Press: New York, 478 p. ISBN: 0195107780.

NAL Call Number: QL737.P98S956 2003

Descriptors: Asian elephant, African elephant, wildlife conservation.

Surendra Varma (2006). **Conserving a compact evergreen elephant habitat: a survey of the population status and conservation of Asian elephant in Kalakad-Mundanthurai Tiger Reserve, Southern India.** *Tigerpaper* 33(4): 12-19. ISSN: 1014-2789.

Abstract: A study was conducted to document the elephant distribution pattern, human-elephant conflicts and other conservation issues of the Asian elephant (*Elephas maximus*) in Kalakadu-Mundanthuri Tiger Reserve, southern India. The vegetation type is dominated by evergreen forest and it is the last remaining compact evergreen forest elephant habitat in southern India. The survey carried out during 1991 estimated 107 elephants and 138 in 1997. The increase could be attributed to the actual increase in the number of elephants or movement of elephants across the reserves. Combining the information of both direct sightings and indirect evidence, it is indicated that the elephants used the reserve throughout the year. It was also observed that elephant conservation problems such as human-elephant conflicts and elephant deaths due to poaching are not great. However, the habitat-related problems are severe and need to be addressed immediately. Forest exploitation for irrigation and power projects, severe cattle grazing pressure, frequent fires, timber extraction, non-wood forest products collection, road construction and uncontrolled encroachments along the foothills have caused severe damage to the reserve. Some of the conservation goals are presented. Reproduced with Permission from CAB Abstracts.

Descriptors: Asian elephant, *Elephas maximus*, broadleaved evergreen forests, conflict, deforestation, ecological disturbance, forest fires, forest management, forests, grazing, habitat destruction, habitat selection, habitats, logging, mortality, nature reserves, road construction, spatial distribution, wildlife conservation.

Surendra Varma (2008). **Spatial distribution of Asian elephant (*Elephas maximus*) and its habitat usage pattern in Kalakad-Mundanthurai Tiger Reserve, Western Ghats, southern India.** *Current Science* 94(4): 501-506. ISSN: 0011-3891.

Abstract: The study demonstrates the value of short term, but rapid surveys in understanding the spatial pattern of distribution of the Asian elephant (*Elephas maximus*) and its habitat usage pattern in the Kalakad-Mundanthurai Tiger Reserve, Western Ghats, southern India. Results indicated that the elephants use the habitat uniformly throughout the reserve, since encounter rates of elephant dung piles were found to be similar for most of the routes surveyed. However, data on fresh dung piles, indicative of presence of elephants at any given point of time and space, pointed to a clumped distribution. With respect to habitat use, 60% of elephant signs were recorded in the evergreen forests, 13% in grasslands and 12% in evergreen and reed belts. However, a comparison of dung density indicates a significant difference ($P < 0.0000$) across the habitats and the elephant densities appear to be more in the grasslands. The elevation of the reserve ranged from 40 to 1867 m; however, presence of elephants was limited to altitudes ranging from 300 to 1300 m, out of which 90% was restricted to altitudes ranging between 600 and 1200 m. Reproduced with Permission from CAB Abstracts.

Descriptors: Asian elephant, *Elephas maximus*, animal behavior, feces, forests, grasslands, habitat selection, habitats, nature reserves, population density, spatial distribution, wildlife conservation.

Surendra Varma, Nguyen Xuan Dang, Tran Van Thanh, and R. Sukumar (2008). **The Asian elephants *Elephas maximus* of Cat Tien National Park, Vietnam: status and conservation of a vanishing population.** *Oryx* 42(1): 92-99. ISSN: 0030-6053.

Online: <http://dx.doi.org/10.1017/S0030605308010090>

Abstract: This study updates the status and conservation of the Endangered Asian elephant *Elephas maximus* in Cat Tien National Park, Vietnam. Line transect indirect surveys, block surveys for elephant signs, village surveys of elephant-human conflict incidents, guard-post surveys for records of sightings, and surveys of elephant food plants were undertaken during the dry and wet seasons of 2001. A minimum of 11 elephants

and a maximum of 15-17 elephants was estimated for c. 500 km² of the Park and its vicinity. The elephants are largely confined to the southern boundary of the Park and make extensive use of the adjoining La Nga State Forest Enterprises. During the dry season the elephants depend on at least 26 species of wild and cultivated plants, chiefly the fruits of cashew. Most of the villages surveyed reported some elephant-human conflict. Two adult male elephants seem to cover a large area to raid crops, whereas the family groups restrict themselves to a few villages; overall, the conflict is not serious. Since 2001 there have been no reports of any deaths or births of elephants in the Park. We make recommendations for habitat protection and management, increasing the viability of the small population, reducing elephant-human conflicts, and improving the chances of survival of the declining elephants of this Park. The Government has now approved an Action Plan for Urgent Conservation Areas in Vietnam that calls for the establishment of three elephant conservation areas in the country, including Cat Tien National Park. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, conservation areas, endangered species, food supply, habitats, national parks, population decrease, seasonal behavior, survival, wildlife management.

Swain, D. (2004). **Asian Elephants: Past, Present & Future.**, International Book Distributors: Dehra Dun, 226 p. ISBN: 8170893100.

Descriptors: Asian elephant, *Elephas maximus*, conflicts with man, domestication, conservation measures, food plants, behavior, ecology, Asia, distribution, biology, threats, relationships with man, comprehensive review.

Van Der Merwe, N.J. and F.J. Kruger (2003). **Source location of African elephant ivory and rhinoceros horn by stable isotope ratio analysis.** *Forensic Science International* 136(Suppl. 1): 383. ISSN: 0379-0738.

Descriptors: ivory, African elephant, rhinoceros horn, analysis, stable isotope ratio, source location, illegal trade.

van Kooten, G.C. (2008). **Protecting the African elephant: A dynamic bioeconomic model of ivory trade.** *Biological Conservation* 141(8): 2012-2022. ISSN: 0006-3207.

Online: <http://dx.doi.org/10.1016/j.biocon.2008.05.016>

NAL Call Number: S900.B5

Abstract: A dynamic bioeconomic model of ivory trade is used to investigate the efficacy of conservation payments, tourism benefits, quota regimes and a trade ban on the protection of the African elephant (*Loxodonta africana*). The model consists of four ivory exporting regions and one demand region. Results indicate that a trade ban might not be successful in maintaining elephants, even if it increases the costs of marketing ivory and leads to a stigma effect that reduces demand. Indeed, trade in elephant products may offer some hope for the elephant, but only if there exist effective institutions that translate in situ protection into economic values.

Descriptors: African elephant, *Loxodonta africana*, ivory trade, bioeconomic, protecting, trade ban, protection.

Wiese, R.J. and K. Willis (2004). **Calculation of longevity and life expectancy in captive elephants.** *Zoo Biology* 23(4): 365-373. ISSN: 0733-3188.

NAL Call Number: QL77.5.Z6

Descriptors: captive elephants, longevity, life expectancy, calculation.

Wittemyer, G., I. Douglas Hamilton, and W.M. Getz (2005). **The socioecology of elephants: analysis of the processes creating multitiered social structures.** *Animal Behaviour* 69: 1357-71.

NAL Call Number: Film S-1802

Descriptors: social structures, processes, sociobiology, multitiered.

Wood, J.D., C.E. O'Connell Rodwell, and S.L. Klemperer (2005). **Using seismic sensors to detect elephants and other large mammals: a potential census technique.** *Journal of Applied Ecology* 42: 587-94.

NAL Call Number: 410 J828

Descriptors: census technique, seismic sensors, detect, large mammals.

Woolley, L.A., R.L. Mackey, B.R. Page, and R. Slotow (2008). **Modelling the effect of age specific mortality on elephant *Loxodonta africana* populations: can natural mortality provide regulation?** *Oryx* 42(1): 49-57. ISSN: (p) 0030-6053; (E) 1365-3008.

Online: <http://dx.doi.org/10.1017/S0030605308000495>

Descriptors: African elephant, *Loxodonta africana*, causes of death, drought, mortality, population dynamics, predation, wildlife management.

Yokoyama, S., N. Takenaka, D.W. Agnew, and J. Shoshani (2005). **Elephants and human color-blind deuteranopes have identical sets of visual pigments.** *Genetics* 170(1): 335-44.

NAL Call Number: QH431.A1G432

Abstract: Being the largest land mammals, elephants have very few natural enemies and are active during both day and night. Compared with those of diurnal and nocturnal animals, the eyes of elephants and other arrhythmic species, such as many ungulates and

large carnivores, must function in both the bright light of day and dim light of night. Despite their fundamental importance, the roles of photosensitive molecules, visual pigments, in arrhythmic vision are not well understood. Here we report that elephants (*Loxodonta africana* and *Elephas maximus*) use RH1, SWS1, and LWS pigments, which are maximally sensitive to 496, 419, and 552 nm, respectively. These light sensitivities are virtually identical to those of certain "color-blind" people who lack MWS pigments, which are maximally sensitive to 530 nm. During the day, therefore, elephants seem to have the dichromatic color vision of deuteranopes. During the night, however, they are likely to use RH1 and SWS1 pigments and detect light at 420-490 nm.

Descriptors: visual pigments, color blind deuteranopes, human, dichromatic, day, night, pigments, photosensitive molecules.

Zhang Li, Ma LiChao, and Feng LiMin (2006). **New challenges facing traditional nature reserves: Asian elephant (*Elephas maximus*) conservation in China.** *Integrative Zoology* 1(4): 179-187. ISSN: 1749-4869.

Online: <http://dx.doi.org/10.1111/j.1749-4877.2006.00031.x>

Abstract: Traditional conservation strategies can effectively preserve biodiversity within nature reserves, but may fail to mitigate the conflicts between rural development and wildlife conservation. This paper discusses the magnitude of the conflict and its development over time, focusing on elephant conservation and land resource management within and around nature reserves. We suggest that regulations alone can satisfy neither the demands to maintain biodiversity and ecosystem services nor the demands to achieve human welfare. More innovative tools such as informed land-use planning and integrated conservation development projects are called for to reduce the agricultural interface with elephant range, and therefore to alleviate the damage caused by the conflict. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, biodiversity, conservation, ecosystems, land resources, land use planning, nature reserves, regulations, resource management.

[Back to Top](#)

[<< Table of Contents](#)

[<< Previous](#) | [Next >>](#)

Last Modified: Jan 23, 2014

[Home](#)[About AWIC](#)[Publications](#)[Workshops](#)[Services](#)[News and Events](#)[Help](#)[Contact Us](#)

Search AWIC

Go

- Search all USDA
- Advanced Search

Browse by Subject

- ▷ Research Animals
- ▷ Farm Animals
- ▷ Zoo, Circus and Marine Animals
- ▷ Companion Animals
- ▷ Government and Professional Resources
- ▷ Alternatives
- ▷ Literature Searching and Databases
- ▷ Pain and Distress
- ▷ Humane Endpoints and Euthanasia

You are here: [Home](#) / [Publications](#) / [Bibliographies and Resource Guides](#) / [Information Resources on Elephants](#) / [African Elephants - Anatomy / Histology / Physiology](#)

[Printer Friendly Page](#)

Publications

Information Resources on Elephants

[<< Table of Contents](#)[>> Previous](#) | [Next >>](#)

African Elephants

- [Anatomy / Histology / Physiology](#)
- [Anesthesia / Analgesia](#)
- [Behavior / Care / Enrichment / Handling / Training](#)
- [Blood / Circulation / Cardiac / Hematology](#)
- [Communication / Vocal / Hearing](#)
- [Digestive / Food / Nutrition](#)
- [Diseases / Conditions](#)
- [Genetics / DNA](#)
- [Parasites](#)
- [Reproductive](#)
- [Research](#)
- [Veterinary](#)

Anatomy / Histology / Physiology

Clauss, M., H. Steinmetz, U. Eulenberger, P. Ossent, R. Zingg, J. Hummel, and J.M. Hatt (2007). **Observations on the length of the intestinal tract of African *Loxodonta africana* (Blumenbach 1797) and Asian elephants *Elephas maximus* (Linne 1735).**

European Journal of Wildlife Research 53(1): 68-72. ISSN: 1612-4642; (E) 1439-0574.

Descriptors: African elephant, *Loxodonta africana*, Asian elephant, *Elephas maximus*, intestinal tract length, digestive system, species differences, comparative study.

Hoffmann, J.N., A.G. Montag, and N.J. Dominy (2004). **Meissner corpuscles and somatosensory acuity: the prehensile appendages of primates and elephants.** *Anatomical Record. Part A, Discoveries in Molecular, Cellular, and Evolutionary Biology* 281(1): 1138-47.

NAL Call Number: QL801.A53

Descriptors: adaptation, physiological physiology, elephant anatomy and histology, mechanoreceptors physiology, primate anatomy and histology, skin innervation, touch physiology, elephant physiology, evolution, feeding behavior physiology, hand innervation, hand physiology, hand strength physiology, motor skills physiology, phylogeny, primate physiology, sensory thresholds physiology, species specificity.

Hutchinson, J.R., D. Famini, R. Lair, and R. Kram (2003). **Biomechanics: Are fast-moving elephants really running?** *Nature* 422(6931): 493-494.

NAL Call Number: 472 N21

Descriptors: elephant physiology, gait physiology, running physiology, walking physiology, biomechanics, kinetics, Thailand, time factors, video recording.

Manger, P.R., P. Pillay, B.C. Maseko, A. Bhagwandin, N. Gravett, D.J. Moon, N. Jillani, and J. Hemingway (2009). **Acquisition of brains from the African elephant (*Loxodonta***

***africana*) perfusion fixation and dissection.** *Journal of Neuroscience Methods* 179(1): 16-21. ISSN: 0165-0270.

Descriptors: African elephant, *Loxodonta africana*, brains, nervous system, neural coordination, laboratory techniques, dissection, perfusion fixation.

Ren, L. and J. Hutchinson (2007). **Three dimensional locomotor dynamics of African (*Loxodonta africana*) and Asian (*Elephas maximus*) elephants.** *Comparative Biochemistry and Physiology Part A Molecular and Integrative Physiology* 146(4, Suppl. S): S110-S111. ISSN: 1095-6433.

Descriptors: African elephant, *Loxodonta africana*, Asian elephant, *Elephas maximus*, movement and support, footfall pattern, trunk rotation, locomotor dynamics, hindlimb stance, comparative study.

Ren, L., J. Hutchinson, D. Schwerda, and M. Fischer (2006). **Basic limb kinematics of the locomotion in African elephants (*Loxodonta africana*).** *Comparative Biochemistry and Physiology Part A Molecular and Integrative Physiology* 143(4, Suppl. S): S89. ISSN: 1095-6433.

Descriptors: African elephant, *Loxodonta africana*, movement and support, limb kinematics, animal size, elephant locomotion, walking change, flexion extension angle, meeting abstract.

Sacks, O. (2003). **Early work on elephant gait not to be forgotten.** *Nature* 423(6937): 221.

NAL Call Number: 472 N21

Descriptors: physiology, gait physiology, photography history, biomechanics, 19th century history.

Weissengruber, G.E., F.K. Fuss, G. Egger, G. Stanek, K.M. Hittmair, and G. Forstenpointner (2006). **The elephant knee joint: morphological and biomechanical considerations.** *Journal of Anatomy* 208(1): 59-72.

NAL Call Number: 447.8 J826

Abstract: Elephant limbs display unique morphological features which are related mainly to supporting the enormous body weight of the animal. In elephants, the knee joint plays important roles in weight bearing and locomotion, but anatomical data are sparse and lacking in functional analyses. In addition, the knee joint is affected frequently by arthrosis. Here we examined structures of the knee joint by means of standard anatomical techniques in eight African (*Loxodonta africana*) and three Asian elephants (*Elephas maximus*). Furthermore, we performed radiography in five African and two Asian elephants and magnetic resonance imaging (MRI) in one African elephant. Macerated bones of 11 individuals (four African, seven Asian elephants) were measured with a pair of callipers to give standardized measurements of the articular parts. In one Asian and three African elephants, kinematic and functional analyses were carried out using a digitizer and according to the helical axis concept. Some peculiarities of healthy and arthrotic knee joints of elephants were compared with human knees. In contrast to those of other quadruped mammals, the knee joint of elephants displays an extended resting position. The femorotibial joint of elephants shows a high grade of congruency and the menisci are extremely narrow and thin. The four-bar mechanism of the cruciate ligaments exists also in the elephant. The main motion of the knee joint is extension-flexion with a range of motion of 142 degrees. In elephants, arthrotic alterations of the knee joint can lead to injury or loss of the cranial (anterior) cruciate ligament.

Descriptors: knee joint, anatomy, morphological, biomechanical, weight bearing, locomotion, radiography, MRI, magnetic resonance imaging, arthrosis.

West, J.B., Z. Fu, A.P. Gaeth, and R.V. Short (2003). **Fetal lung development in the elephant reflects the adaptations required for snorkeling in adult life.** *Respiratory Physiology and Neurobiology* 138(2-3): 325-33.

NAL Call Number: QP121.A1R4

Abstract: The adult elephant is unique among mammals in that the pleural membranes are thickened and the pleural cavity is obliterated by connective tissue. It has been suggested that this peculiar anatomy developed because the animal can snorkel at depth, and this behavior subjects the microvessels in the parietal pleura to a very large transmural pressure. To investigate the development of the parietal pleura, the thickness of the endothoracic fascia (ET) was measured in four fetal African elephants of approximate gestational age 111-130 days, and the appearances were compared with those in human, rabbit, rat and mouse fetuses of approximately the same stage of lung organogenesis. The mean thicknesses of ET in the elephant, human, rabbit, rat and mouse were 403, 53, 29, 27 and 37 microm, respectively. This very early development of a thick parietal pleura in the elephant fetus is consistent with the hypothesis of a long history of snorkeling in the elephant's putative aquatic ancestors.

Descriptors: adaptation, biological physiology, embryonic and fetal development, lung embryology, pleura embryology, fetus, gestational age, intercostal muscles, lung anatomy and histology, mice, pleura anatomy and histology, rabbits, rats, species specificity.

[Back to Top](#)

[<< Table of Contents](#)

[<< Previous](#) | [Next >>](#)

Last Modified: Jan 23, 2014

[AWIC Home](#) | [NAL Home](#) | [USDA](#) | [AgNIC](#) | [ARS](#) | [Web Policies and Important Links](#) | [RSS Feeds](#) | [Site Map](#)
[FOIA](#) | [Accessibility Statement](#) | [Privacy Policy](#) | [Non-Discrimination Statement](#) | [Information Quality](#) | [USA.gov](#) | [White House](#)

[Home](#)[About AWIC](#)[Publications](#)[Workshops](#)[Services](#)[News and Events](#)[Help](#)[Contact Us](#)**Search AWIC**

- Search all USDA
- Advanced Search

Browse by Subject

- ▷ Research Animals
- ▷ Farm Animals
- ▷ Zoo, Circus and Marine Animals
- ▷ Companion Animals
- ▷ Government and Professional Resources
- ▷ Alternatives
- ▷ Literature Searching and Databases
- ▷ Pain and Distress
- ▷ Humane Endpoints and Euthanasia

You are here: [Home](#) / [Publications](#) / [Bibliographies and Resource Guides](#) / [Information Resources on Elephants](#) / [African Elephants - Anesthesia / Analgesia](#)

 [Printer Friendly Page](#)

Publications

Information Resources on Elephants

[<< Table of Contents](#)[<< Previous](#) | [Next >>](#)

African Elephants

- Anatomy / Histology / Physiology
- Anesthesia / Analgesia
- Behavior / Care / Enrichment / Handling / Training
- Blood / Circulation / Cardiac / Hematology
- Communication / Vocal / Hearing
- Digestive / Food / Nutrition
- Diseases / Conditions
- Genetics / DNA
- Parasites
- Reproductive
- Research
- Veterinary

Anesthesia / Analgesia

Bechert, U., J.M. Christensen, C. Nguyen, R. Neelkant, and E. Bendas (2008). **Pharmacokinetics of orally administered phenylbutazone in African and Asian elephants (*Loxodonta africana* and *Elephas maximus*)**. *Journal of Zoo and Wildlife Medicine* 39(2): 188-200. ISSN: 1042-7260.

Online: <http://dx.doi.org/10.1638/2007-0139R.1>

Descriptors: African elephant, *Loxodonta africana*, Asian elephant, *Elephas maximus*, phenylbutazone, dosage effects, oral administration, species differences.

Neiffer, D.L., M. Miller, M. Weber, M. Setter, D. Fontenot, P.K. Robbins, and G.W. Pye (2005). **Standing sedation in African elephant (*Loxodonta africana*) using detomidine-butorphanol combinations**. *Journal of Zoo and Wildlife Medicine* 36(2): 250-256. ISSN: 1042-7260.

NAL Call Number: SF601.J6

Descriptors: African elephants, *Loxodonta africana*, standing sedation, detomidine-butorphanol, i.m., supplemental dosage, recovery, reversal agents, side effects, dose ranges.

[Back to Top](#)[<< Table of Contents](#)[<< Previous](#) | [Next >>](#)

Last Modified: Jan 23, 2014

Search AWIC

Go

- Search all USDA
- Advanced Search

Browse by Subject

- ▷ Research Animals
- ▷ Farm Animals
- ▷ Zoo, Circus and Marine Animals
- ▷ Companion Animals
- ▷ Government and Professional Resources
- ▷ Alternatives
- ▷ Literature Searching and Databases
- ▷ Pain and Distress
- ▷ Humane Endpoints and Euthanasia

You are here: [Home](#) / [Publications](#) / [Bibliographies and Resource Guides](#) / [Information Resources on Elephants](#) / [African Elephants - Behavior / Care / Enrichment / Handling / Training](#)

 [Printer Friendly Page](#)

Publications

Information Resources on Elephants

[<< Table of Contents](#)
[<< Previous](#) | [Next >>](#)

African Elephants

- [Anatomy / Histology / Physiology](#)
- [Anesthesia / Analgesia](#)
- [Behavior / Care / Enrichment / Handling / Training](#)
- [Blood / Circulation / Cardiac / Hematology](#)
- [Communication / Vocal / Hearing](#)
- [Digestive / Food / Nutrition](#)
- [Diseases / Conditions](#)
- [Genetics / DNA](#)
- [Parasites](#)
- [Reproductive](#)
- [Research](#)
- [Veterinary](#)

Behavior / Care / Enrichment / Handling / Training

Ayesu, S., F. Tetteh Kumah, H. Gyesi, and R. Baning Darko (2003). **Training as a critical component of elephant research and management in Ghana.** *Pachyderm* 35: 137-139. ISSN: 1026-2881.

Descriptors: African elephant, training, research, management, *Loxodonta africana*, techniques, Ghana.

Baldrian, B. and H.M. Schwammer (2004). **Chronobiologische Untersuchungen an einem neugeborenen Afrikanischen Elefantenbullen (*Loxodonta africana*).** [Chronobiological investigations of a newborn African elephant bull (*Loxodonta africana*)]. *Zoologische Garten* 74(2): 81-87. ISSN: 0044-5169.

NAL Call Number: 410 Z724

Descriptors: African elephant, newborn, chronobiological studies, control, welfare, *Loxodonta africana*, social behavior, activity patterns, nursing.

Language of Text: German, with English and German summaries.

Burks, K.D., J.D. Mellen, G.W. Miller, J. Lehnhardt, A. Weiss, A.J. Figueredo, and T.L. Maple (2004). **Comparison of two introduction methods for African elephants (*Loxodonta africana*).** *Zoo Biology* 23(2): 109-126. ISSN: 0733-3188.

NAL Call Number: QL77.5.Z6

Descriptors: African elephants, two introduction methods, comparison.

Carpenter, M. (2003). **Increasing activity levels in captive elephants: 'spread' (is) the word.** *Animal Keepers' Forum* 30(8): 328-330. ISSN: 0164-9531.

NAL Call Number: QL77.5.A54

Descriptors: Asian elephant, African elephant, *Elephas maximus*, *Loxodonta africana*,

care in captivity, spreading of food, enrichment items, enclosure, increased activity levels.

Dumonceaux, G. (2005). **Elephant behaviour**. In: *Small Animal and Exotics, Proceedings of the North American Veterinary Conference, January 8, 2005-January 12, 2005, Orlando, Florida, USA, Gainesville, USA: Eastern States Veterinary Association, Vol. 19, p. 1413.*

Descriptors: behavior, training, zoo elephants, *Elephas maximus*, *Loxodonta africana*, Asian elephants, African elephants, handling.

Evans, K.E. and S. Harris (2008). **Adolescence in male african elephants, *Loxodonta africana*, and the importance of sociality**. *Animal Behaviour* 76(Part 3): 779-787. ISSN: 0003-3472; Online: 1095-8282.

Descriptors: African elephant, *Loxodonta africana*, social learning, male behavior, young males.

Freeman, E.W., E. Weiss, and J.L. Brown (2004). **Examination of the interrelationships of behavior, dominance status, and ovarian activity in captive Asian and African elephants**. *Zoo Biology* 23(5): 431-448. ISSN: 0733-3188.

NAL Call Number: QL77.5.Z6

Descriptors: ovarian activity, Asian elephants, African elephants, dominance status, behavior, interrelationships.

Ganswindt, A., M. Heistermann, and K. Hodges (2005). **Physical, physiological, and behavioral correlates of musth in captive African elephants (*Loxodonta africana*)**. *Physiological and Biochemical Zoology* 78(4): 505-14.

NAL Call Number: QL1.P52

Abstract: Although musth in male African elephants (*Loxodonta africana*) is known to be associated with increased aggressiveness, urine dribbling (UD), temporal gland secretion (TGS), and elevated androgens, the temporal relationship between these changes has not been examined. Here, we describe the pattern of musth-related characteristics in 14 captive elephant bulls by combining long-term observations of physical and behavioral changes with physiological data on testicular and adrenal function. The length of musth periods was highly variable but according to our data set not related to age. Our data also confirm that musth is associated with elevated androgens and, in this respect, show that TGS and UD are downstream effects of this elevation, with TGS responding earlier and to lower androgen levels than UD. Because the majority of musth periods were associated with a decrease in glucocorticoid levels, our data also indicate that musth does not represent a physiological stress mediated by the hypothalamic-pituitary-adrenal axis. Furthermore, we demonstrate that the occurrence of musth is associated with increased aggression and that this is presumably androgen mediated because aggressive males had higher androgen levels. Collectively, the information generated contributes to a better understanding of what characterizes and initiates musth in captive African elephants and provides a basis for further studies designed to examine in more detail the factors regulating the intensity and duration of musth.

Descriptors: zoo animals, physiology, reproduction physiology, sex behavior, animal physiology, adrenal glands physiology, aggression physiology, analysis of variance, androgens metabolism, feces chemistry, glucocorticoids metabolism, observation, testis physiology, time factors.

Ganswindt, A., R. Palme, M. Heistermann, S. Borrigan, and J.K. Hodges (2003). **Non-invasive assessment of adrenocortical function in the male African elephant (*Loxodonta africana*) and its relation to musth**. *General and Comparative Endocrinology* 134(2): 156-66.

NAL Call Number: 444.8 G28

Abstract: Adult male elephants periodically show the phenomenon of musth, a condition associated with increased aggressiveness, restlessness, significant weight reduction and markedly elevated androgen levels. It has been suggested that musth-related behaviours are costly and that therefore musth may represent a form of physiological stress. In order to provide data on this largely unanswered question, the first aim of this study was to evaluate different assays for non-invasive assessment of adrenocortical function in the male African elephant by (i) characterizing the metabolism and excretion of [3H]cortisol (3H-C) and [14C]testosterone (14C-T) and (ii) using this information to evaluate the specificity of four antibodies for determination of excreted cortisol metabolites, particularly with respect to possible cross-reactions with androgen metabolites, and to assess their biological validity using an ACTH challenge test. Based on the methodology established, the second objective was to provide data on fecal cortisol metabolite concentrations in bulls during the musth and non-musth condition. 3H-C (1 mCi) and 14C-T (100 microCi) were injected simultaneously into a 16 year old male and all urine and feces collected for 30 and 86 h, respectively. The majority (82%) of cortisol metabolites was excreted into the urine, whereas testosterone metabolites were mainly (57%) excreted into the feces. Almost all radioactive metabolites recovered from urine were conjugated (86% 3H-C and 97% 14C-T). In contrast, 86% and >99% of the 3H-C and 14C-T metabolites recovered from feces consisted of unconjugated forms. HPLC separations indicated the presence of various metabolites of cortisol in both urine and feces, with cortisol being abundant in hydrolysed urine, but virtually absent in feces. Although all antibodies measured substantial amounts of immunoreactivity after HPLC

separation of peak radioactive samples and detected an increase in glucocorticoid output following the ACTH challenge, only two (in feces against 3 α ,11-oxo-cortisol metabolites, measured by an 11-oxo-etiocholanolone-EIA and in urine against cortisol, measured by a cortisol-EIA) did not show substantial cross-reactivity with excreted 14C-T metabolites and could provide an acceptable degree of specificity for reliable assessment of glucocorticoid output from urine and feces. Based on these findings, concentrations of immunoreactive 3 α ,11-oxo-cortisol metabolites were determined in weekly fecal samples collected from four adult bulls over periods of 11-20 months to examine whether musth is associated with increased adrenal activity. Results showed that in each male levels of these cortisol metabolites were not elevated during periods of musth, suggesting that in the African elephant musth is generally not associated with marked elevations in glucocorticoid output. Given the complex nature of musth and the variety of factors that are likely to influence its manifestation, it is clear, however, that further studies, particularly on free-ranging animals, are needed before a possible relationship between musth and adrenal function can be resolved. This study also clearly illustrates the potential problems associated with cross-reacting metabolites of gonadal steroids in EIAs measuring glucocorticoid metabolites. This has to be taken into account when selecting assays and interpreting results of glucocorticoid metabolite analysis, not only for studies in the elephant but also in other species.

Descriptors: adrenal cortex metabolism, adrenal cortex function tests, metabolism, feces chemistry, hydrocortisone analysis, stress, psychological physiopathology, testosterone analysis, adrenal cortex secretion, adrenal cortex function tests methods, diagnostic use of carbon isotopes, high pressure liquid chromatography, corticotropin physiology, urine, glucocorticoids analysis, glucocorticoids in urine, diagnostic use of hydrocortisone, hydrocortisone in urine, immunoenzyme techniques and methods, reproduction physiology, sex behavior, animal physiology, psychological diagnosis of stress, diagnostic use of testosterone, testosterone in urine.

Ganswindt, A., H.B. Rasmussen, M. Heistermann, and J.K. Hodges (2005). **The sexually active states of free-ranging male African elephants (*Loxodonta africana*): defining musth and non-musth using endocrinology, physical signals, and behavior.** *Hormones and Behavior* 47(1): 83-91.

NAL Call Number: QP801.H7H64

Abstract: Musth in male African elephants, *Loxodonta africana*, is associated with increased aggressive behavior, continuous discharge of urine, copious secretions from the swollen temporal glands, and elevated androgen levels. During musth, bulls actively seek out and are preferred by estrous females although sexual activity is not restricted to the musth condition. The present study combines recently established methods of fecal hormone analysis with long-term observations on male-female associations as well as the presence and intensity of physical signals to provide a more detailed picture about the physical, physiological, and behavioral characteristics of different states of sexual activity in free-ranging African elephants. Based on quantitative shifts in individual bull association patterns, the presence of different physical signals, and significant differences in androgen levels, a total of three potential sub-categories for sexually active bulls could be established. The results demonstrate that elevations in androgen levels are only observed in sexually active animals showing temporal gland secretion and/or urine dribbling, but are not related to the age of the individual. Further, none of the sexually active states showed elevated glucocorticoid output indicating that musth does not represent an HPA-mediated stress condition. On the basis of these results, we suggest that the term "musth" should be exclusively used for the competitive state in sexually active male elephants and that the presence of urine dribbling should be the physical signal used for defining this state.

Descriptors: behavior, animal physiology, competitive behavior physiology, sex behavior, age factors, androsterone analysis, feces chemistry, hydrocortisone analysis, hydrocortisone metabolism, longitudinal studies, testosterone analysis.

Ganswindt, A., H.B. Rasmussen, M. Heistermann, and J.K. Hodges (2005). **The sexually active states of free-ranging male African elephants (*Loxodonta africana*): defining musth and non-musth endocrinology, physical signals, and behavior.** *Hormones and Behavior* 47(1): 83-91. ISSN: 0018-506X.

NAL Call Number: QP801.H7H64

Descriptors: African elephant, *Loxodonta africana*, reproductive behavior, musth, characteristics, free ranging males, Kenya, temporal glands, secretions, glucocorticoid, urine dribbling, androgen levels, aggressive behavior.

Gray, C., H. Loizi, M. Correll, T. Goodwin, L.E.L. Rasmussen, and B. Schulte (2004). **Social group association patterns by young male and female African elephants.** *Integrative and Comparative Biology* 43(6): 864. ISSN: 1540-7063.

NAL Call Number: QL1.167

Descriptors: African elephants, behavior, social group, association patterns, male, female, young.

Hollister Smith, J.A., S.C. Alberts, and L.E.L. Rasmussen (2008). **Do male African elephants, *Loxodonta africana*, signal musth via urine dribbling?** *Animal Behaviour* 76(Part 6): 1829-1841. ISSN: 0003-3472; Online: 1095-8282.

Descriptors: African elephant, *Loxodonta africana*, reproductive success, social relationships, social grouping, dominance status, urine dribbling, signaling musth.

Hollister Smith, J.A., J.H. Poole, E.A. Archie, E.A. Vance, N.J. Georgiadis, C.J. Moss, and S.C. Alberts (2007). **Age, musth and paternity success in wild male African elephants, *Loxodonta africana*.** *Animal Behaviour* 74(Part 2): 287-296. ISSN: 0003-3472; Online: 1095-8282.

Descriptors: African elephant, sexual activity, intrasexual selection, age-related paternity success, musth.

Leggett, K. (2004). **Coprophagy and unusual thermoregulatory behaviour in desert-dwelling elephants of north-western Namibia.** *Pachyderm* 36: 113-115. ISSN: 1026-2881.

Descriptors: African elephant, *Loxodonta africana*, body temperature, diet, coprophagy, behavior, thermoregulatory behavior, Namibia, unusual thermoregulatory behavior, desert dwelling.

Leighty, K.A., J. Soltis, C.M. Wesolek, A. Savage, J. Mellen, and J. Lehnhardt (2009). **GPS determination of walking rates in captive African elephants (*Loxodonta africana*).** *Zoo Biology* 28(1): 16-28. ISSN: 0733-3188.

Online: <http://dx.doi.org/10.1002/zoo.20199>

NAL Call Number: QL77.5.Z6

Abstract: The movements of elephants in captivity have been an issue of concern for animal welfare activists and zoological professionals alike in recent years. In order to fully understand how movement rates reflect animal welfare, we must first determine the exact distances these animals move in the captive environment. We outfitted seven adult female African elephants (*Loxodonta africana*) at Disney's Animal Kingdom with collar-mounted global positioning recording systems to document their movement rates while housed in outdoor guest viewing habitats. Further, we conducted preliminary analyses to address potential factors impacting movement rates including body size, temperature, enclosure size, and social grouping complexity. We found that our elephants moved at an average rate of 0.409±0.007 km/hr during the 9-hr data collection periods. This rate translates to an average of 3.68 km traveled during the observation periods, at a rate comparable to that observed in the wild. Although movement rate did not have a significant relationship with an individual's body size in this herd, the movements of four females demonstrated a significant positive correlation with temperature. Further, females in our largest social group demonstrated a significant increase in movement rates when residing in larger enclosures. We also present preliminary evidence suggesting that increased social group complexity, including the presence of infants in the herd, may be associated with increased walking rates, whereas factors such as reproductive and social status may constrain movements.

Descriptors: African elephant, *Loxodonta africana*, captive animals, zoo animals, physical activity, walking, radio frequency identification, global positioning systems, collars, body size, ambient temperature, animal housing, group effect, animal welfare, animal movements, GPS tracking collars, enclosure size.

Loizi, H., T.E. Goodwin, L.E.L. Rasmussen, A.M. Whitehouse, and B.A. Schulte (2009). **Sexual dimorphism in the performance of chemosensory investigatory behaviours by African elephants (*Loxodonta africana*).** *Behaviour* 146(Part 3): 373-392. ISSN: 0005-7959; Online: 1568-539X.

Descriptors: African elephants, *Loxodonta africana*, investigatory behavior, sexual dimorphism, chemosensory behavior.

McKinney, G.C. (2003). **The ambassadorship of the captive African elephant in North America: a demographic comparison of African elephant management strategies.** *Animal Keepers' Forum* 30(9): 376-384. ISSN: 0164-9531.

NAL Call Number: QL77.5.A54

Descriptors: African elephant, *Loxodonta africana*, housing techniques, housing conditions, management strategies, comparison of wild vs captivity, influence of housing conditions.

Meyer, J.M., T.E. Goodwin, and B.A. Schulte (2008). **Intrasexual chemical communication and social responses of captive female African elephants, *Loxodonta africana*.** *Animal Behaviour* 76(1): 163-174. ISSN: 0003-3472.

Online: <http://dx.doi.org/10.1016/j.anbehav.2007.12.019>

Descriptors: African elephant, *Loxodonta africana*, social behavior, communication, ovulation, zoo animals.

Ortolani, A., K. Leong, L. Graham, and A. Savage (2005). **Behavioral indices of estrus in a group of captive African elephants (*Loxodonta africana*).** *Zoo Biology* 24(4): 311-329. ISSN: 0733-3188.

NAL Call Number: QL77.5.Z6

Descriptors: estrous cycle, sexual behavior, flehmen, estrus detection, males, females.

Pinter Wollman, N., L.A. Isbell, and L.A. Hart (2009). **The relationship between social behaviour and habitat familiarity in African elephants (*Loxodonta africana*).**

Proceedings of the Royal Society of London Series B, Biological Sciences 276(1659): 1009-1014. ISSN: 0962-8452.

Online: <http://dx.doi.org/10.1098/rspb.2008.1538>

Descriptors: African elephant, *Loxodonta africana*, social behavior, acclimation to novel environments, translocated animals, body condition, social relationships, habitat familiarity.

Pinter Wollman, N., L.A. Isbell, and L.A. Hart (2009). **Assessing translocation outcome: comparing behavioral and physiological aspects of translocated and resident African elephants (*Loxodonta africana*)**. *Biological Conservation* 142(5): 1116-1124. ISSN: 0006-3207.

Online: <http://dx.doi.org/10.1016/j.biocon.2009.01.027>

NAL Call Number: S900.B5

Abstract: Evaluating translocation outcomes is important for improving wildlife management and conservation actions. Often, when quick decisions need to be made and long-lived animals with slow reproduction rates are translocated, traditional assessment methods such as long-term survival and reproductive success cannot be used for assessing translocation outcomes. Thus, alternative, seldom used, measures such as comparing the behavior and physiology of translocated animals to those of local residents should be employed to assess the translocated animals' acclimation to their new home. Here we monitored the survival, physiology, and behavior of translocated African elephants (*Loxodonta africana*) and compared these measures to the local resident population at the release site. Adult male and female translocated elephants' death rates were higher than those of the local population. Furthermore, the mortality rate of translocated adult males and calves was greater than expected based on their proportion in the translocated elephant population. No difference was found in stress hormone levels between the two populations, but the body condition of the translocated elephants was significantly poorer than that of the local population throughout the study period. The behavioral time budgets of the translocated elephants converged with those of the local population over time. Finally, translocated elephants utilized habitat that was similar to their source site (hills and permanent rivers) more than did the local population. Based on these findings we recommend careful consideration of timing, release location, and individuals targeted in future elephant translocations. More broadly, we introduce and explore seldom used translocation assessment techniques.

Descriptors: wildlife management, African elephant, *Loxodonta africana*, mortality, animal behavior, males, females, animal stress, wildlife habitats, rivers, Kenya.

Poole, J.H., P.L. Tyack, A.S. Stoeger Horwath, and S. Watwood (2005). **Animal behaviour: elephants are capable of vocal learning**. *Nature* 434(7032): 455-6.

NAL Call Number: 472 N21

Abstract: There are a few mammalian species that can modify their vocalizations in response to auditory experience--for example, some marine mammals use vocal imitation for reproductive advertisement, as birds sometimes do. Here we describe two examples of vocal imitation by African savannah elephants, *Loxodonta africana*, a terrestrial mammal that lives in a complex fission-fusion society. Our findings favour a role for vocal imitation that has already been proposed for primates, birds, bats and marine mammals: it is a useful form of acoustic communication that helps to maintain individual-specific bonds within changing social groupings.

Descriptors: physiology, learning physiology, sound, vocalization, acoustic stimulation, Africa, aging physiology, automobiles.

Roocroft, A. (2005). **Indoors natural substrates for elephants & medical issues associated with hard surfaces**. *Animal Keepers' Forum* 32(10): 480-492. ISSN: 0164-9531.

NAL Call Number: QL77.5.A54

Descriptors: Elephantidae, housing techniques, indoor natural substrates, medical issues associated with hard surfaces, treatment techniques, injuries.

Shannon, G., B.R. Page, R.L. Mackey, K.J. Duffy, and R. Slotow (2008). **Activity budgets and sexual segregation in African elephants (*Loxodonta africana*)**. *Journal of Mammalogy* 89(2): 467-476. ISSN: 0022-2372; Online: 1545-1542.

Descriptors: African elephant, *Loxodonta africana*, body size, energy demands, sexual segregation, feeding time, activity budget, behavioral synchrony.

Vidya, T.N.C. and R. Sukumar (2005). **Social and reproductive behaviour in elephants**. *Current Science (Bangalore)* 89(7): 1200-1207. ISSN: 0011-3891.

NAL Call Number: 475 SCI23

Descriptors: African elephant, savannah, social behavior, reproductive behavior, forest elephant, Asian elephant, social organization, matriarchal leadership.

Weissenböck, N.M., H.M. Schwammer, and T. Ruf (2009). **Estrous synchrony in a group of African elephants (*Loxodonta africana*) under human care**. *Animal Reproduction Science* 113(1/4): 322-327. ISSN: 0378-4320.

Online: <http://dx.doi.org/10.1016/j.anireprosci.2008.07.003>

Descriptors: African elephant, *Loxodonta africana*, estrous synchrony, captive zoo animals, dominance hierarchy.

- Wells, D.L. and R.M. Irwin (2008). **Auditory stimulation as enrichment for zoo-housed Asian elephants (*Elephas maximus*)**. *Animal Welfare* 17(4): 335-340. ISSN: 0962-7286.
Online: <http://www.ufaw.org.uk/animal.php>
NAL Call Number: HV4701.A557
Descriptors: Asian elephant, *Elephas maximus*, environmental enrichment, animal welfare, zoo animals, animal behavior, Northern Ireland.
- Wilson, M.L., M.A. Bloomsmith, and T.L. Maple (2004). **Stereotypic swaying and serum cortisol concentrations in three captive African elephants (*Loxodonta africana*)**. *Animal Welfare* 13(1): 39-43. ISSN: 0962-7286.
NAL Call Number: HV4701.A557
Descriptors: zoo animals, stereotyped behavior, cortisol, animal welfare.
- Wittemyer, G. and W.M. Getz (2007). **Hierarchical dominance structure and social organization in African elephants, *Loxodonta africana***. *Animal Behaviour* 73(4): 671-681. ISSN: 0003-3472.
Online: <http://dx.doi.org/10.1016/j.anbehav.2006.10.008>
Descriptors: African elephant, *Loxodonta africana*, agonistic behavior, intraspecific competition, learning, social behavior, social dominance, dominance relationships.

[Back to Top](#)

[<< Table of Contents](#)

[<< Previous](#) | [Next >>](#)

Last Modified: Jan 23, 2014

[AWIC Home](#) | [NAL Home](#) | [USDA](#) | [AgNIC](#) | [ARS](#) | [Web Policies and Important Links](#) | [RSS Feeds](#) | [Site Map](#)
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- ▷ Alternatives
- ▷ Literature Searching and Databases
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 Printer Friendly Page

Publications

Information Resources on Elephants

[<< Table of Contents](#)
[<< Previous](#) | [Next >>](#)

African Elephants

- [Anatomy / Histology / Physiology](#)
- [Anesthesia / Analgesia](#)
- [Behavior / Care / Enrichment / Handling / Training](#)
- [Blood / Circulation / Cardiac / Hematology](#)
- [Communication / Vocal / Hearing](#)
- [Digestive / Food / Nutrition](#)
- [Diseases / Conditions](#)
- [Genetics / DNA](#)
- [Parasites](#)
- [Reproductive](#)
- [Research](#)
- [Veterinary](#)

Blood / Circulation / Cardiac / Hematology

Gakuya, F., E. Wambwa, D. Ndeereh, and T. Manyibe (2003). **Physiological and hematological findings in immobilized free-ranging African elephants.** *Pachyderm* 35: 77-81. ISSN: 1026-2881.

Online: <http://www.african-elephant.org/pachy/pdfs/pachy39.pdf>

Descriptors: African elephant, *Loxodonta africana*, physiology, blood, hematological parameters, immobilized, Kenya.

Language of Text: English, Summaries in English and French.

Knauf, S., J. Blad Stahl, A. Lawrenz, U. Schuerer, and A. Wehrend (2009). **Plasma preparation and storage for African elephants (*Loxodonta africana*).** *Journal of Zoo and Wildlife Medicine* 40(1): 71-75. ISSN: 1042-7260.

Online: <http://dx.doi.org/10.1638/2007-0146.1>

Descriptors: African elephant, *Loxodonta africana*, blood sampling, plasma storage, central plasma bank, zoo animals.

Knauf, S., J. Blad Stahl, A. Lawrenz, U. Schurer, and A. Wehrend (2007). **Methodology of plasma preparation and storage as a possible live saving tool for new born African elephants (*Loxodonta africana*) at Wuppertal Zoo.** *Proceedings of the Institute for Zoo and Wildlife Research, Berlin*(7): 264-268. ISSN: 1431-7338.

Descriptors: African elephant, *Loxodonta africana*, blood collection, blood sampling, quality and composition of elephant plasma, storage of blood plasma, zoo animals.

Windberger, U., R. Plasenzotti, and T. Voracek (2005). **The fluidity of blood in African elephants (*Loxodonta africana*).** *Clinical Hemorheology and Microcirculation* 33(4): 321-6.

Abstract: The large cellular volume of erythrocytes and the increased plasma

concentration of proteins in elephants are factors which potentially affect blood rheology adversely. To verify blood rheology, routine hemorheologic variables were analyzed in four African elephants (*Loxodonta africana*), housed in the zoo of Vienna. Whole blood viscosity at three different shear rates (WBV at low shear rate: WBV 0.7 s(-1) and WBV 2.4 s(-1); WBV at high shear rate: WBV 94 s(-1) done by LS30, Contraves) and erythrocyte aggregation (aggregation indices AI by LS30; aggregation indices M0, M1 by Myrenne aggregometer) were high (WBV 94 s(-1): 5.368 (5.246/5.648); WBV 2.4 s(-1): 16.291 (15.605/17.629); WBV 0.7 s(-1): 28.28 (25.537/32.173) mPa s; AI 2.4 s(-1): 0.25 (0.23/0.30); AI 0.7 s(-1): 0.24 (0.23/0.28); M0: 7.8 (6.4/8.4); M1: 30.2 (25/31)). Plasma viscosity (PV) was increased as well (1.865 (1.857/1.912) mPa s) compared to other mammalian species. These parameters would indicate a decrease in blood fluidity in elephants. However, erythrocyte rigidity (LORCA, Mechatronics) was decreased, which in contrast, has a promotive effect on peripheral perfusion. Blood rheology of the elephants was determined by a high whole blood and plasma viscosity as the result of pronounced erythrocyte aggregation and high plasma protein concentration. Thus, in the terminal vessels the resistance to flow will be increased. The large erythrocytes, which might impede blood flow further due to geometrical reasons, however, had a pronounced flexibility. We conclude that the effect of the increased inner resistance to peripheral blood flow was counteracted by the decreased rigidity of the erythrocytes to enable an adequate blood flow in African elephants.

Descriptors: blood proteins analysis, blood viscosity physiology, elephant blood, erythrocyte volume physiology, hemorheology methods, horse blood.

[Back to Top](#)

[<< Table of Contents](#)

[<< Previous](#) | [Next >>](#)

Last Modified: Jan 23, 2014

[AWIC Home](#) | [NAL Home](#) | [USDA](#) | [AgNIC](#) | [ARS](#) | [Web Policies and Important Links](#) | [RSS Feeds](#) | [Site Map](#)
[FOIA](#) | [Accessibility Statement](#) | [Privacy Policy](#) | [Non-Discrimination Statement](#) | [Information Quality](#) | [USA.gov](#) | [White House](#)

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- ▷ Zoo, Circus and Marine Animals
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- ▷ Government and Professional Resources
- ▷ Alternatives
- ▷ Literature Searching and Databases
- ▷ Pain and Distress
- ▷ Humane Endpoints and Euthanasia

You are here: [Home](#) / [Publications](#) / [Bibliographies and Resource Guides](#) / [Information Resources on Elephants](#) / [African Elephants - Communication / Vocal / Hearing](#)

 [Printer Friendly Page](#)

Publications

Information Resources on Elephants

[<< Table of Contents](#)[>> Previous](#) | [Next >>](#)

African Elephants

- [Anatomy / Histology / Physiology](#)
- [Anesthesia / Analgesia](#)
- [Behavior / Care / Enrichment / Handling / Training](#)
- [Blood / Circulation / Cardiac / Hematology](#)
- [Communication / Vocal / Hearing](#)
- [Digestive / Food / Nutrition](#)
- [Diseases / Conditions](#)
- [Genetics / DNA](#)
- [Parasites](#)
- [Reproductive](#)
- [Research](#)
- [Veterinary](#)

Communication / Vocal / Hearing

Clemins, P.J., M.T. Johnson, K.M. Leong, and A. Savage (2005). **Automatic classification and speaker identification of African elephant (*Loxodonta africana*) vocalizations.** *Journal of the Acoustical Society of America* 117(2): 956-63.

NAL Call Number: QC221.A27

Abstract: A hidden Markov model (HMM) system is presented for automatically classifying African elephant vocalizations. The development of the system is motivated by successful models from human speech analysis and recognition. Classification features include frequency-shifted Mel-frequency cepstral coefficients (MFCCs) and log energy, spectrally motivated features which are commonly used in human speech processing. Experiments, including vocalization type classification and speaker identification, are performed on vocalizations collected from captive elephants in a naturalistic environment. The system classified vocalizations with accuracies of 94.3% and 82.5% for type classification and speaker identification classification experiments, respectively. Classification accuracy, statistical significance tests on the model parameters, and qualitative analysis support the effectiveness and robustness of this approach for vocalization analysis in nonhuman species.

Descriptors: phonetics, signal processing, computer assisted, sound spectrography classification, speech acoustics, vocalization, animal classification, acoustics, animal identification systems classification, fourier analysis, Markov chains, reproducibility of results, sound spectrography statistics and numerical data.

Garstang, M. (2004). **Long-distance, low-frequency elephant communication.** *Journal of Comparative Physiology. A, Neuroethology, Sensory, Neural, and Behavioral Physiology* 190(10): 791-805.

NAL Call Number: QP33.68**Descriptors:** communication, physiology, auditory threshold, hearing physiology, sex

behavior, social behavior, sound, sound localization, vocalization, weather.

Garstang, M. (2005). **Long-distance, low-frequency elephant communication (vol 190, pg 791, 2004)**. *Journal of Comparative Physiology A Neuroethology Sensory Neural and Behavioral Physiology* 191(3): 299. ISSN: 0340-7594.

NAL Call Number: QP33.68

Descriptors: long distance communication, low frequency communication.

Leighty, K.A., J. Soltis, K. Leong, and A. Savage (2008). **Antiphonal exchanges in African elephants (*Loxodonta africana*): collective response to a shared stimulus, social facilitation, or true communicative event?** *Behaviour* 145(Part 3): 297-312. ISSN: 0005-7959; Online: 1568-539X.

Descriptors: African elephant, *Loxodonta africana*, communication, social relationship, vocal response, rumble vocalization, shared stimulus, antiphonal exchange, true communicative event.

Leighty, K.A., J. Soltis, C.M. Wesolek, and A. Savage (2008). **Rumble vocalizations mediate interpartner distance in African elephants, *Loxodonta africana***. *Animal Behaviour* 76(Part 5): 1601-1608. ISSN: 0003-3472; Online: 1095-8282.

Descriptors: African elephant, *Loxodonta africana*, communication, social organization, rumble vocalization, antiphonal exchange, spatial cohesion, interpartner distance, close distance social interaction.

Leong, K.M., K. Burks, C.E. Rizkalla, and A. Savage (2005). **Effects of reproductive and social context on vocal communication in captive female African elephants (*Loxodonta africana*)**. *Zoo Biology* 24(4): 331-347. ISSN: 0733-3188.

NAL Call Number: QL77.5.Z6

Descriptors: zoo animals, vocalization, social dominance, estrous cycle, hormone secretion, females, males, social behavior.

Leong, K.M., A. Ortolani, L.H. Graham, and A. Savage (2003). **The use of low-frequency vocalizations in African elephant (*Loxodonta africana*) reproductive strategies**. *Hormones and Behavior* 43(4): 433-43.

NAL Call Number: QP801.H7H64

Abstract: Fertility-advertisement calls in females are predicted to occur in nonmonogamous species where males and females are widely separated in space. In African elephants, low-frequency vocalizations have thus been suggested as a reproductive strategy used by fertile females to attract mates. This study examined the use of low-frequency vocalizations with respect to different phases of the estrous cycle in African elephants by simultaneously monitoring vocalizations, behavior, and hormonal profiles. Subjects were one male and six female African elephants housed at Disney's Animal Kingdom. No acoustically distinct vocalizations were restricted to the ovulatory follicular phase. However, overall rate of low-frequency vocalization as well as the rate of one acoustically distinct vocalization changed over the estrous cycle, with highest rates of calling related to the first period of follicular growth, or anovulatory follicular phase. Elevated rates of vocalization thus were not restricted to behavioral estrus and occurred much earlier in the estrous cycle than in most species that produce fertility-advertisement calls. Both herd composition and elephant identity also affected rates of vocalization. Vocalizations therefore may not be reliable signals of actual fertility. However, the increase in vocalizations in advance of estrus may attract males to the herd prior to ovulation, facilitating both male-male competition and female choice. Once present in the herd, males may then switch strategies to use more reliable chemical and visual cues to detect ovulating females.

Descriptors: physiology, sex behavior, animal physiology, vocalization, estrous cycle physiology, luteinizing hormone blood, ovulation physiology, reproduction physiology, social behavior.

Leong, K., A. Ortolani, K. Burks, J. Mellen, and A. Savage (2003). **Quantifying acoustic and temporal characteristics of vocalizations for a group of captive African elephants *Loxodonta africana***. *Bioacoustics* 13(3): 213-231. ISSN: 0952-4622.

Descriptors: African elephant, *Loxodonta africana*, communication, acoustic signals, vocalizations, acoustic and temporal characteristics, low frequency, rumbles, complex repertoire.

McComb, K., D. Reby, and L. Baker (2003). **Long-distance communication of acoustic cues to social identity in African elephants**. *Animal Behaviour* 65: 317-29.

NAL Call Number: Film S-1802

Descriptors: communication, acoustic cues, long distance, social identity, infrasonic calls, low frequencies.

Meyer, J.M., T.E. Goodwin, and B.A. Schulte (2008). **Intrasexual chemical communication and social responses of captive female African elephants, *Loxodonta africana***. *Animal Behaviour* 76(1): 163-174. ISSN: 0003-3472.

Online: <http://dx.doi.org/10.1016/j.anbehav.2007.12.019>

Descriptors: African elephant, *Loxodonta africana*, social behavior, communication, ovulation, zoo animals.

- O'Connell Rodwell, C.E., J.D. Wood, T.C. Rodwell, S. Puria, S.R. Partan, R. Keefe, D. Shriver, B.T. Arnason, and L.A. Hart (2006). **Wild elephant (*Loxodonta africana*) breeding herds respond to artificially transmitted seismic stimuli.** *Behavioral Ecology and Sociobiology* 59(6): 842-850. ISSN: 0340-5443.
Online: <http://dx.doi.org/10.1007/s00265-005-0136-2>
NAL Call Number: QL751.B4
Abstract: Seismic communication is known to be utilized in insects, amphibians, reptiles, and small mammals, but its use has not yet been documented in large mammals. Elephants produce low-frequency vocalizations, and these vocalizations have seismic components that propagate in the ground, but it has not yet been demonstrated that elephants can detect or interpret these seismic signals. In this study, we played back seismic replicates of elephant alarm vocalizations to herds of wild African elephants in their natural environment and observed significant behavioral changes indicating that they had detected these signals. Seismic communication may provide an important complement to existing communication modes used by elephants. Seismic sensitivity may also provide elephants with an additional modality for sensing important environmental cues such as changes in weather patterns or seismic disturbances.
Descriptors: African elephant, *Loxodonta africana*, Elephant seismic communication, seismic stimuli, replicas, elephant alarm vocalizations.
- O'Connell Rodwell, C.E., J.D. Wood, C. Kinzley, T.C. Rodwell, J.H. Poole, and S. Puria (2007). **Wild african elephants (*Loxodonta africana*) discriminate between familiar and unfamiliar conspecific seismic alarm calls.** *Journal of the Acoustical Society of America* 122(2): 823-830. ISSN: 0001-4966.
Descriptors: African elephant, *Loxodonta africana*, communication, call discrimination, vibration communication, conspecific seismic alarm call.
- Payne, K.B., M. Thompson, and L. Kramer (2003). **Elephant calling patterns as indicators of group size and composition: The basis for an acoustic monitoring system.** *African Journal of Ecology* 41(1): 99-107. ISSN: 0141-6707.
NAL Call Number: 409.6 EA7
Descriptors: African elephants, *Loxodonta africana*, behavior, acoustic activity analysis, acoustic monitoring, acoustic signals, calling patterns, variation, group size, composition, Namibia, vocal activity, remote monitoring, calls, low frequency, high frequency.
Language of Text: English, with English and French summaries.
- Soltis, J., K.A. Leighty, C.M. Wesolek, and A. Savage (2009). **The expression of affect in African elephant (*Loxodonta africana*) rumble vocalizations.** *Journal of Comparative Psychology* 123(2): 222-225. ISSN: 0735-7036.
Descriptors: African elephant, *Loxodonta africana*, communication, social interaction, dominance interaction, rumble vocalization.
- Soltis, J., K. Leong, and A. Savage (2005). **African elephant vocal communication. I. antiphonal calling behaviour among affiliated females.** *Animal Behaviour* 70(3): 579-87.
NAL Call Number: Film S-1802
Descriptors: vocal communication, calling behavior, females, antiphonal.
- Soltis, J., K. Leong, and A. Savage (2005). **African elephant vocal communication. II. rumble variation reflects the individual identity and emotional state of callers.** *Animal Behaviour* 70(3): 589-99.
NAL Call Number: Film S-1802
Descriptors: vocal communication, rumble variation, individual identity.
- Wesolek, C.M., J. Soltis, K.A. Leighty, and A. Savage (2009). **Infant african elephant rumble vocalizations vary according to social interactions with adult females.** *Bioacoustics* 18(3): 227-239. ISSN: 0952-4622.
Descriptors: African elephant, *Loxodonta africana*, communication, custom designed audio recording collar, maternal responsiveness, rumble vocalization, affiliative social interaction.
- Wood, J.D., B. Mccowan, W.R. Langbauer Jr., J.J. Viljoen, and L. Hart (2005). **Classification of African elephant, *Loxodonta africana*, rumbles using acoustic parameters and cluster analysis.** *Bioacoustics* 15(2): 143-161. ISSN: 0952-4622.
Descriptors: African elephant, rumbles, acoustic parameters, cluster analysis, calls, types, vocalizations, feeding, resting, categorized.

[Back to Top](#)

[<< Table of Contents](#)

[<< Previous](#) | [Next >>](#)

Last Modified: Jan 23, 2014

[AWIC Home](#) | [NAL Home](#) | [USDA](#) | [AgNIC](#) | [ARS](#) | [Web Policies and Important Links](#) | [RSS Feeds](#) | [Site Map](#)
[FOIA](#) | [Accessibility Statement](#) | [Privacy Policy](#) | [Non-Discrimination Statement](#) | [Information Quality](#) | [USA.gov](#) | [White House](#)

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Go

- Search all USDA
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Browse by Subject

- ▷ Research Animals
- ▷ Farm Animals
- ▷ Zoo, Circus and Marine Animals
- ▷ Companion Animals
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- ▷ Alternatives
- ▷ Literature Searching and Databases
- ▷ Pain and Distress
- ▷ Humane Endpoints and Euthanasia

You are here: [Home](#) / [Publications](#) / [Bibliographies and Resource Guides](#) / [Information Resources on Elephants](#) / [African Elephants - Digestive / Food / Nutrition](#)

 [Printer Friendly Page](#)

Publications

Information Resources on Elephants

[<< Table of Contents](#)
[<< Previous](#) | [Next >>](#)

African Elephants

- [Anatomy / Histology / Physiology](#)
- [Anesthesia / Analgesia](#)
- [Behavior / Care / Enrichment / Handling / Training](#)
- [Blood / Circulation / Cardiac / Hematology](#)
- [Communication / Vocal / Hearing](#)
- [Digestive / Food / Nutrition](#)
- [Diseases / Conditions](#)
- [Genetics / DNA](#)
- [Parasites](#)
- [Reproductive](#)
- [Research](#)
- [Veterinary](#)

Digestive / Food / Nutrition

Andrews, J., A. Mecklenborg, and F.B. Bercovitch (2005). **Milk intake and development in a newborn captive African elephant (*Loxodonta africana*)**. *Zoo Biology* 24(3): 275-281. ISSN: 0733-3188.

NAL Call Number: QL77.5.Z6

Descriptors: zoo animals, maternal milk, feeding behavior, parity reproduction, maternal behavior, physical activity.

Cerling, T.E., G. Wittemyer, H.B. Rasmussen, F. Vollrath, C.E. Cerling, T.J. Robinson, and I. Douglas Hamilton (2006). **Stable isotopes in elephant hair document migration patterns and diet changes**. *Proceedings of the National Academy of Sciences of the United States of America* 103(2): 371-3.

NAL Call Number: 500 N31P

Abstract: We use chronologies of stable isotopes measured from elephant (*Loxodonta africana*) hair to determine migration patterns and seasonal diet changes in elephants in and near Samburu National Reserve in northern Kenya. Stable carbon isotopes record diet changes, principally enabling differentiation between browse and tropical grasses, which use the C3 and C4 photosynthetic pathways, respectively; stable nitrogen isotopes record regional patterns related to aridity, offering insight into localized ranging behavior. Isotopically identified range shifts were corroborated by global positioning system radio tracking data of the studied individuals. Comparison of the stable isotope record in the hair of one migrant individual with that of a resident population shows important differences in feeding and ranging behavior over time. Our analysis indicates that differences are the result of excursions into mesic environments coupled with intermittent crop raiding by the migrant individual. Variation in diet, quantified by using stable isotopes, can offer insight into diet-related wildlife behavior.

Descriptors: animal migration, diet, physiology, hair chemistry, hair metabolism, carbon

isotopes, metabolism, hair growth and development, nitrogen isotopes, seasons, time factors.

Cerling, T.E., B.H. Passey, L.K. Ayliffe, C.S. Cook, J.R. Ehleringer, J.M. Harris, M.B. Dhidha, and S.M. Kasiki (2004). **Orphans' tales: seasonal dietary changes in elephants from Tsavo National Park, Kenya.** *Palaeogeography Palaeoclimatology Palaeoecology* 206(3-4): 367-376. ISSN: 0031-0182.

Descriptors: African elephant, *Loxodonta africana*, teeth, hair, food plants, seasonal changes, Kenya, Tsavo East National Park, seasonal diet, dietary changes.

Clauss, M., Y. Wang, K. Ghebremeskel, C.E. Lendl, and W.J. Streich (2003). **Plasma and erythrocyte fatty acids in captive Asian (*Elephas maximus*) and African (*Loxodonta africana*) elephants.** *Veterinary Record* 153(2): 54-8.

NAL Call Number: 41.8 V641

Abstract: The fatty acid components of the plasma triglycerides and the phospholipid fractions of the red blood cells of a captive group of two African (*Loxodonta africana*) and four Asian (*Elephas maximus*) elephants were investigated. All the animals received the same diet of hay, fruits and vegetables, and concentrates. A comparison with data from free-ranging African elephants or Asian work-camp elephants showed that the captive elephants had lower proportions of polyunsaturated fatty acids (PUFAs), and for several lipid fractions a higher n-6:n-3 ratio, than their counterparts in the wild or under the more natural, in terms of diet, work-camp conditions. The difference in PUFA content was smaller in the African than in the Asian elephants. The captive Asian elephants tended to have lower levels of n-3 and total unsaturated fatty acids in their red blood cells than the captive African elephants.

Descriptors: metabolism, erythrocytes metabolism, unsaturated metabolism fatty acids, phospholipids metabolism, triglycerides metabolism, zoo animals, blood chemical analysis, diet, blood, unsaturated blood fatty acids, triglycerides blood, workload.

Clauss, M., N. Robert, C. Walzer, C. Vitaud, and J. Hummel (2005). **Testing predictions on body mass and gut contents: dissection of an African elephant *Loxodonta africana* Blumenbach 1797.** *European Journal of Wildlife Research* 51(4): 291-294. ISSN: 1612-4642.

NAL Call Number: SK351.Z45

Descriptors: African elephant, *Loxodonta africana*, weight, gut contents, diet, body mass, digestive system, gastrointestinal tract, ingesta, caecum, colon, dissection.

Emmett, M. (2003). **An analysis of the seasonal diet of African elephant at Ngala for the period August 2001-July 2002 with particular reference to nine key plant groups.** *CCA Ecological Journal* 5: 65-73.

Descriptors: African elephant, *Loxodonta africana*, seasonal diet, food plants, food availability, South Africa, Ngala, seasonal diet analysis.

Holdo, R.M. and L.R. McDowell (2004). **Termite mounds as nutrient-rich food patches for elephants.** *Biotropica* 36(2): 231-239. ISSN: 0006-3606.

NAL Call Number: QH301.B52

Descriptors: *Loxodonta africana*, browsing, food plants, termite mounds, dietary nutrient sources, nutrient content, mineral content, protein content, soil nutrients, botanical composition, woodlands, Zimbabwe, Kalahari, sand soils.

Leggett, K. (2004). **Coprophygy and unusual thermoregulatory behaviour in desert-dwelling elephants of north-western Namibia.** *Pachyderm* 36: 113-115. ISSN: 1026-2881.

Descriptors: African elephant, *Loxodonta africana*, body temperature, diet, coprophagy, behavior, thermoregulatory behavior, Namibia, unusual thermoregulatory behavior, desert dwelling.

Osthoff, G., H.O. De Waal, A. Hugo, M. de Wit, and P. Botes (2005). **Milk composition of a free-ranging African elephant (*Loxodonta africana*) cow during early lactation.**

Comparative Biochemistry and Physiology. Part A, Molecular and Integrative Physiology 141(2): 223-9.

NAL Call Number: QP1.C6

Abstract: Only one study previously reported comprehensively on the composition of African elephant's (*Loxodonta africana*) milk that was collected from 30 dead animals. In the current study milk was obtained from a tame but free-ranging African elephant cow without immobilization during the period when she was 4-47 days postpartum. At the respective collection times the nutrient content was 21.8 and 25.0 g protein; 56.0 and 76.0 g fat; 71.1 and 26.0 g sugars per kilogram of milk. The protein fraction, respectively, consisted of 10.0 and 14.0 g caseins/kg milk and of 11.8 and 11 g whey proteins/kg milk. During lactation the lactose content dropped from 52.5 to 11.8 g/kg milk, while the oligosaccharide content increased from 11.8 to 15.2 g/kg milk. The oligosaccharide was characterized as a galactosyllactose, which is digestible by cellulase. Electrophoresis and identification of protein bands showed a similar migrating sequence of proteins as seen in cow's milk, but some of the corresponding proteins were less negatively charged. The lipid fraction contains a high content of capric and lauric acids,

approximately 60% of the total fatty acids, and low content of myristic, palmitic and oleic acids.

Descriptors: physiology, lactation physiology, milk chemistry, albumins analysis, carbohydrates analysis, caseins analysis, cattle, fatty acids analysis, globulins analysis, milk proteins analysis.

Pendlebury, C., N.E. Odongo, A. Renjifo, J. Naelitz, E.V. Valdes, and B.W. McBride (2005). **Acid-insoluble ash as a measure of dry matter digestibility in captive African elephants (*Loxodonta africana*)**. *Zoo Biology* 24(3): 261-265. ISSN: 0733-3188.

NAL Call Number: QL77.5.Z6

Descriptors: zoo animals, biomarkers, ash content, dry matter, ash, digestibility, acid insoluble, captive African elephants.

[Back to Top](#)

.....
[<< Table of Contents](#)

[<< Previous](#) | [Next >>](#)
.....

Last Modified: Jan 23, 2014

[AWIC Home](#) | [NAL Home](#) | [USDA](#) | [AgNIC](#) | [ARS](#) | [Web Policies and Important Links](#) | [RSS Feeds](#) | [Site Map](#)
[FOIA](#) | [Accessibility Statement](#) | [Privacy Policy](#) | [Non-Discrimination Statement](#) | [Information Quality](#) | [USA.gov](#) | [White House](#)

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Browse by Subject

- ▷ Research Animals
- ▷ Farm Animals
- ▷ Zoo, Circus and Marine Animals
- ▷ Companion Animals
- ▷ Government and Professional Resources
- ▷ Alternatives
- ▷ Literature Searching and Databases
- ▷ Pain and Distress
- ▷ Humane Endpoints and Euthanasia

 You are here: [Home](#) / [Publications](#) / [Bibliographies and Resource Guides](#) / [Information Resources on Elephants](#) / [African Elephants - Diseases / Conditions](#)
 [Printer Friendly Page](#)

Publications

Information Resources on Elephants

[<< Table of Contents](#)
[>> Previous](#) | [Next >>](#)

African Elephants

- Anatomy / Histology / Physiology
- Anesthesia / Analgesia
- Behavior / Care / Enrichment / Handling / Training
- Blood / Circulation / Cardiac / Hematology
- Communication / Vocal / Hearing
- Digestive / Food / Nutrition
- Diseases / Conditions
- Genetics / DNA
- Parasites
- Reproductive
- Research
- Veterinary

Diseases / Conditions

Janssen, D.L., J.E. Oosterhuis, J. Fuller, and K. Williams (2004). **Field technique: a method for obtaining trunk wash mycobacterial cultures [cultures] in anesthetized free-ranging African elephants (*Loxodonta africana*)**. In: *Proceedings: American Association of Zoo Veterinarians, American Association of Wildlife Veterinarians, Wildlife Disease Association: Health and Conservation of Captive and Free-Ranging Wildlife. Joint Conference, August 28, 2004-September 3, 2004, San Diego, California*, American Association of Zoo Veterinarians: p. 586-587. 660 p.

Descriptors: African elephant, *Loxodonta africana*, diagnostic techniques, trunk wash, South Africa, tuberculosis, trunk wash method, mycobacterial cultures, anesthesia, free ranging.

Kaim, U., V. Paltian, C. Krudewig, A. Nieder, and P. Wohlsein (2009). **Pulmonary aspergillosis in an African elephant (*Loxodonta africana*)**. *DTW (Deutsche Tierärztliche Wochenschrift)* 116(4): 148-151. ISSN: 0341-6593.

Descriptors: African elephant, *Loxodonta africana*, infection, veterinary medicine, purulent pododermatitis, recurrent abdominal pain, severe weight loss, pyogranulomatous, fungal disease, necrotizing pneumonia, *Aspergillus* spp.

Lacasse, C., K. Terio, M.J. Kinsel, L.L. Farina, D.A. Travis, R. Greenwald, K.P. Lyashchenko, M. Miller, and K.C. Gamble (2007). **Two cases of atypical mycobacteriosis caused by *Mycobacterium szulgai* associated with mortality in captive African elephants (*Loxodonta africana*)**. *Journal of Zoo and Wildlife Medicine* 38(1): 101-107. ISSN: 1042-7260.

Online: <http://dx.doi.org/10.1638/06-051.1>

Descriptors: African elephant, *Loxodonta africana*, case report, disease transmission, lameness, mortality, osteomyelitis, zoo animals, *Mycobacterium*, *Mycobacterium bovis*,

Mycobacterium tuberculosis, Mycobacterium szulgai .

Maslow, J.N., S.K. Mikota, M. Zhu, R. Isaza, L.R. Peddie, F. Dunker, J. Peddie, H. Riddle, and C.A. Peloquin (2005). **Population pharmacokinetics of isoniazid in the treatment of *Mycobacterium tuberculosis* among Asian and African elephants (*Elephas maximus* and *Loxodonta africana*)**. *Journal of Veterinary Pharmacology and Therapeutics* 28(1): 21-7.

NAL Call Number: SF915.J63

Abstract: We recently described the clinical presentation and treatment of 18 elephants from six herds infected with TB. Treatment protocols and methods varied between herds to include both oral and rectal dosing using multiple drug doses and formulations. In this paper we present information regarding the pharmacokinetics (PK) of isoniazid (INH) in elephants and provide suggestions regarding initial treatment regimens. Forty-one elephants received INH daily by either oral or rectal administration with different formulations. Population PK analysis was performed using Non-linear Mixed Effect Modeling (NONMEM). Results of oral administration indicated that compared with premixed INH solution, the drug exposure was highest with a suspension prepared freshly with INH powder. When INH was concomitantly given as an admixture over food, T_{max} was delayed and variability in drug absorption was significantly increased. Compared with oral administration, similar drug exposures were found when INH was dosed rectally. The data generated suggest that a starting dose of 7.5 mg/kg of INH is appropriate for initial TB treatment in elephants when premixed solution is administered directly into the oropharynx or rectal vault and 4 mg/kg are when INH is administered following immediate suspension from powdered form.

Descriptors: antitubercular agents pharmacokinetics, metabolism, isoniazid pharmacokinetics, oral administration, rectal administration, administration and dosage of antitubercular agents, antitubercular agents in blood, therapeutic use of antitubercular agents, area under curve, isoniazid administration and dosage, isoniazid in blood, therapeutic use of isoniazid, *Mycobacterium tuberculosis*, tuberculosis drug therapy, tuberculosis.

Nath, I., V.S.C. Bose, S.K. Panda, B.C. Das, and L.K. Singh (2003). **A case of multiple abscesses in a baby elephant**. *Zoos' Print Journal* 18(11): 1270.

Descriptors: baby elephant, abscesses, multiple, disease, infection.

Sleeman, J.M., V.L. Clyde, M.V. Finnegan, E.C. Ramsay, and M.G. Shires (2003). **Mammary botryomycosis and mastectomy in an African elephant (*Loxodonta africana*)**. *Veterinary Record* 152(2): 54-5.

NAL Call Number: 41.8 V641

Descriptors: mastitis, staphylococcal infections, differential diagnosis, mastectomy, mastitis diagnosis, mastitis pathology, mastitis surgery, staphylococcal infections diagnosis, staphylococcal infections pathology, staphylococcal infections surgery, staphylococcus classification, staphylococcus isolation and purification.

Steenkamp, G., W.H. Ferguson, S.C. Boy, S.M. Ferreira, and M.N. Bester (2008). **Estimating exposed pulp lengths of tusks in the African elephant (*Loxodonta africana africana*)**. *Journal of the South African Veterinary Association* 79(1): 25-30. ISSN: 0038-2809.

Descriptors: African elephant, *Loxodonta africana*, tusks, estimating exposed pulp lengths, tusk fractures.

Yamada, M., K. Nakamura, H. Nozaki, and H. Tanaka (2003). **Hepatocellular endoplasmic reticulum storage disease in an African elephant (*Loxodonta africana*)**. *Journal of Comparative Pathology* 128(2-3): 192-4.

NAL Call Number: 41.8 J82

Abstract: Large intracytoplasmic inclusions were observed in hepatocytes of a 7-year-old African elephant (*Loxodonta africana*). The inclusions were oval to polyhedral with either a homogeneous glassy or a granular appearance. They were positive for the periodic acid-Schiff (PAS) reaction. Electron microscopical examination revealed that the inclusions consisted of granular material with moderate electron-density and were membrane-bounded. The findings suggested that the inclusions were derived from endoplasmic reticulum. The light and electron microscopical features were similar to those of endoplasmic reticulum storage disease of the liver in man. Such inclusions have not previously been reported in animals.

Descriptors: cytoplasm pathology, hepatocytes ultrastructure, inclusion bodies ultrastructure, liver diseases, cytoplasm metabolism, endoplasmic reticulum metabolism, endoplasmic reticulum ultrastructure, fatal outcome, immunoenzyme techniques, inclusion bodies metabolism, liver diseases pathology, electron microscopy, periodic acid schiff reaction.

Zhu, M., J.N. Maslow, S.K. Mikota, R. Isaza, F. Dunker, H. Riddle, and C.A. Peloquin (2005). **Population pharmacokinetics of pyrazinamide in elephants**. *Journal of Veterinary Pharmacology and Therapeutics* 28(5): 403-9.

NAL Call Number: SF915.J63

Abstract: This study was undertaken to characterize the population pharmacokinetics

(PK), therapeutic dose, and preferred route of administration for pyrazinamide (PZA) in elephants. Twenty-three African (*Loxodonta africana*) and Asian (*Elephas maximus*) elephants infected with or in contact with others culture positive for *Mycobacterium tuberculosis* were dosed under treatment conditions. PZA was dosed daily at 20-30 mg/kg via oral (fasting or nonfasting state) or rectal (enema or suppository) administration. Blood samples were collected 0-24 h postdose. Population PK was estimated using nonlinear mixed effect modeling. Drug absorption was rapid with T(max) at or before 2 h regardless of the method of drug administration. C(max) at a mean dose of 25.6 (+/-4.6) mg/kg was 19.6 (+/-9.5 microg/mL) for PZA given orally under fasting conditions. Under nonfasting conditions at a mean dose of 26.1 +/- 4.2 mg/kg, C(max) was 25% (4.87 +/- 4.89 microg/mL) and area under concentration curve (AUC) was 30% of the values observed under fasting conditions. Mean rectal dose of 32.6 +/- 15.2 mg/kg yielded C(max) of 12.3 +/- 6.3 microg/mL, but comparable AUC to PZA administered orally while fasting. Both oral and rectal administration of PZA appeared to be acceptable and oral dosing is preferred because of the higher C(max) and lower inter-subject variability. A starting dose of 30 mg/kg is recommended with drug monitoring between 1 and 2 h postdose. Higher doses may be required if the achieved C(max) values are below the recommended 20-50 microg/mL range.

Descriptors: antitubercular agents pharmacokinetics, metabolism, pyrazinamide pharmacokinetics, pulmonary tuberculosis, oral administration, rectal administration, antitubercular agents administration and dosage, antitubercular agents therapeutic use, area under curve, *Mycobacterium tuberculosis* pathogenicity, pyrazinamide administration and dosage, pyrazinamide therapeutic use, tuberculosis, pulmonary blood, pulmonary drug therapy.

[Back to Top](#)

[<< Table of Contents](#)

[<< Previous](#) | [Next >>](#)

Last Modified: Jan 23, 2014

Search AWIC

Go

- Search all USDA
- Advanced Search

Browse by Subject

- ▷ Research Animals
- ▷ Farm Animals
- ▷ Zoo, Circus and Marine Animals
- ▷ Companion Animals
- ▷ Government and Professional Resources
- ▷ Alternatives
- ▷ Literature Searching and Databases
- ▷ Pain and Distress
- ▷ Humane Endpoints and Euthanasia

 You are here: [Home](#) / [Publications](#) / [Bibliographies and Resource Guides](#) / [Information Resources on Elephants](#) / [African Elephants - Genetics / DNA](#)
 [Printer Friendly Page](#)

Publications

Information Resources on Elephants

[<< Table of Contents](#)
[>> Previous](#) | [Next >>](#)

African Elephants

- Anatomy / Histology / Physiology
- Anesthesia / Analgesia
- Behavior / Care / Enrichment / Handling / Training
- Blood / Circulation / Cardiac / Hematology
- Communication / Vocal / Hearing
- Digestive / Food / Nutrition
- Diseases / Conditions
- Genetics / DNA
- Parasites
- Reproductive
- Research
- Veterinary

Genetics / DNA

Archie, E., C. Moss, and S. Alberts (2003). **Characterization of tetranucleotide microsatellite loci in the African savannah elephant (*Loxodonta africana africana*)**. *Molecular Ecology Notes* 3(2): 244-246. ISSN: 1471-8278.

NAL Call Number: QH541.15.M632

Descriptors: African elephants, population genetics, molecular genetics, microsatellite loci characterization, tetranucleotide microsatellite locus.

Charif, R.A., R.R. Ramey, W.R. Langbauer, K.B. Payne, R.B. Martin, and L.M. Brown (2005). **Spatial relationships and matrilineal kinship in African savanna elephant (*Loxodonta africana*) clans**. *Behavioral Ecology and Sociobiology* 57(4): 327-338. ISSN: 0340-5443.

NAL Call Number: QL751.B4

Descriptors: African elephant, *Loxodonta africana*, spatial relationships, molecular genetics, mtdna, haplotypes, clans, home range, distribution, matrilineal kinship.

Comstock, K.E., E.A. Ostrander, and S.K. Wasser (2003). **Amplifying nuclear and mitochondrial DNA from African elephant ivory: a tool for monitoring the ivory trade**. *Conservation Biology*: 1840-1843.

NAL Call Number: QH75.A2C5

Descriptors: elephant ivory trade, mitochondrial DNA, tool, monitoring, genetic method, pulverized ivory, DNA, antipoaching efforts, forensic analysis.

Debruyne, R. (2004). **Apports de la phylogenie moleculaire et de la morphometrie a la systematique des elephants d'Afrique. [Contribution of molecular phylogeny and morphometrics to the systematics of African elephants]**. *Journal De La Societe De Biologie* 198(4): 335-342.

NAL Call Number: QH301.S6

Abstract: African elephants are conventionally classified as a single species: *Loxodonta africana* (Blumenbach 1797). However, the discovery in 1900 of a smaller form of the African elephant, spread throughout the equatorial belt of this land, has given rise to a debate over the relevance of a second species of elephant in Africa. The twentieth century has not provided any definite answer to this question. Actually, recent molecular analyses have sustained this issue by advocating either a division of forest elephants into a valid species, or their inclusion as a subspecies of *L. africana*. Our work initiated at the National Museum of Natural History of Paris provides new molecular (mitochondrial) and morphological (and morphometrical) evidence making it possible to propose a comprehensive phylogenetic hypothesis. It appears that there is no conclusive argument to keep forest elephants (cyclotis form) and savannah elephants (africana form) apart in two distinct species. A high level of mitochondrial introgression between the two forms, as well as a continuum in the morphology of the skulls of the two morphotypes rather suggests that, despite an ancient division, these two taxa freely interbreed wherever their ranges intersect. We thus adopt a conservative systematic position in considering these two forms as two subspecies, respectively: *L. africana africana*, the savannah elephant, and *L. africana cyclotis*, the forest elephant. We finally discuss the conservation topic in the light of this systematic framework.

Descriptors: classification, genetics, molecular evolution, phylogeny, Africa, body size, mitochondrial DNA genetics, anatomy and histology, museums, skull anatomy and histology.

Language of Text: French.

Lei, R., R.A. Brenneman, and E.E.J. Louis (2008). **Genetic diversity in the North American captive African elephant collection.** *Journal of Zoology* 275(3): 252-267. ISSN: 0952-8369.

Online: <http://dx.doi.org/10.1111/j.1469-7998.2008.00437.x>

Descriptors: African elephant, *Loxodonta africana*, genetic diversity, genotypes, heterozygosity, microsatellites, mitochondrial DNA, nucleotide sequences, zoo animals.

Nyakaana, S., J.B. Okello, V. Muwanika, and H.R. Siegismund (2005). **Six new polymorphic microsatellite loci isolated and characterized from the African savannah elephant genome.** *Molecular Ecology Notes* 5(2): 223-225. ISSN: 1471-8278.

NAL Call Number: QH541.15.M632

Descriptors: African elephant, savannah, polymorphic microsatellite loci, genome, polymerase chain reaction, PCR, screening, isolation, characterization, markers.

Okello, J.B., G. Wittemyer, H.B. Rasmussen, I. Douglas Hamilton, S. Nyakaana, P. Arctander, and H.R. Siegismund (2005). **Noninvasive genotyping and Mendelian analysis of microsatellites in African savannah elephants.** *Journal of Heredity* 96(6): 679-87.

NAL Call Number: 442.8 Am3

Abstract: We obtained fresh dung samples from 202 (133 mother-offspring pairs) savannah elephants (*Loxodonta africana*) in Samburu, Kenya, and genotyped them at 20 microsatellite loci to assess genotyping success and errors. A total of 98.6% consensus genotypes was successfully obtained, with allelic dropout and false allele rates at 1.6% (n = 46) and 0.9% (n = 37) of heterozygous and total consensus genotypes, respectively, and an overall genotyping error rate of 2.5% based on repeat typing. Mendelian analysis revealed consistent inheritance in all but 38 allelic pairs from mother-offspring, giving an average mismatch error rate of 2.06%, a possible result of null alleles, mutations, genotyping errors, or inaccuracy in maternity assignment. We detected no evidence for large allele dropout, stuttering, or scoring error in the dataset and significant Hardy-Weinberg deviations at only two loci due to heterozygosity deficiency. Across loci, null allele frequencies were low (range: 0.000-0.042) and below the 0.20 threshold that would significantly bias individual-based studies. The high genotyping success and low errors observed in this study demonstrate reliability of the method employed and underscore the application of simple pedigrees in noninvasive studies. Since none of the sires were included in this study, the error rates presented are just estimates.

Descriptors: DNA analysis, genetics, feces chemistry, genetic techniques, microsatellite repeats genetics, genotype, Kenya, polymerase chain reaction methods.

Rautian, G.S. and I.A. Dubrovo (2003). **Data on DNA give evidence for parallel development in mammoths and elephants.** *Deinsea* 9: 381-394. ISSN: 0923-9308.

Descriptors: *Elephas maximus*, *Loxodonta africana*, *Mammuthus primigenius*, Elephantidae, *Mammot americanus*, Mammotidae, nucleic acids, molecular genetics, DNA, parallel evolution, genetic data, phylogeny.

Roca, A.L., N. Georgiadis, and S.J. O'Brien (2005). **Cytonuclear genomic dissociation in African elephant species.** *Nature Genetics* 37(1): 96-100.

NAL Call Number: QH426.N37

Abstract: African forest and savanna elephants are distinct species separated by a hybrid zone. Because hybridization can affect the systematic and conservation status of populations, we examined gene flow between forest and savanna elephants at 21 African locations. We detected cytonuclear dissociation, indicative of different evolutionary histories for nuclear and mitochondrial genomes. Both paternally (n = 205 males) and

biparentally ($n = 2,123$ X-chromosome segments) inherited gene sequences indicated that there was deep genetic separation between forest and savanna elephants. Yet in some savanna locales distant from present-day forest habitats, many individuals with savanna-specific nuclear genotypes carried maternally transmitted forest elephant mitochondrial DNA. This extreme cytonuclear dissociation implies that there were ancient episodes of hybridization between forest females and savanna males, which are larger and reproductively dominant to forest or hybrid males. Recurrent backcrossing of female hybrids to savanna bulls replaced the forest nuclear genome. The persistence of residual forest elephant mitochondria in savanna elephant herds renders evolutionary interpretations based on mitochondrial DNA alone misleading and preserves a genomic record of ancient habitat changes.

Descriptors: genetics, gene frequency, population genetics, Africa south of the Sahara, mitochondrial DNA, haplotypes, molecular sequence data, phylogeny.

Roca, A.L. and S.J. O'Brien (2005). **Genomic inferences from Afrotheria and the evolution of elephants.** *Current Opinion in Genetics and Development* 15(6): 652-659.

NAL Call Number: QH426.C88

Abstract: Recent genetic studies have established that African forest and savanna elephants are distinct species with dissociated cytonuclear genomic patterns, and have identified Asian elephants from Borneo and Sumatra as conservation priorities. Representative of Afrotheria, a superordinal clade encompassing six eutherian orders, the African savanna elephant was among the first mammals chosen for whole-genome sequencing to provide a comparative understanding of the human genome. Elephants have large and complex brains and display advanced levels of social structure, communication, learning and intelligence. The elephant genome sequence might prove useful for comparative genomic studies of these advanced traits, which have appeared independently in only three mammalian orders: primates, cetaceans and proboscideans.

Descriptors: evolution, genetics, DNA, African elephants, Asian elephants, genomic patterns.

Wasser, S.K., W.J. Clark, O. Drori, E.S. Kisamo, C. Mailand, B. Mutayoba, and M. Stephens (2008). **Combating the illegal trade in African elephant ivory with DNA forensics.** *Conservation Biology* 22(4): 1065-1071. ISSN: 0888-8892.

Online: <http://dx.doi.org/10.1111/j.1523-1739.2008.01012.x>

Descriptors: African elephants, *Loxodonta africana*, wildlife crime, DNA, forensic science, trade in animals, conservation.

Language of Text: Summaries in English and Spanish.

Wasser, S.K., A.M. Shedlock, K. Comstock, E.A. Ostrander, B. Mutayoba, and M. Stephens (2004). **Assigning African elephant DNA to geographic region of origin: applications to the ivory trade.** *Proceedings of the National Academy of Sciences of the United States of America* 101(41): 14847-14852.

NAL Call Number: 500 N31P

Abstract: Resurgence of illicit trade in African elephant ivory is placing the elephant at renewed risk. Regulation of this trade could be vastly improved by the ability to verify the geographic origin of tusks. We address this need by developing a combined genetic and statistical method to determine the origin of poached ivory. Our statistical approach exploits a smoothing method to estimate geographic-specific allele frequencies over the entire African elephants' range for 16 microsatellite loci, using 315 tissue and 84 scat samples from forest (*Loxodonta africana cyclotis*) and savannah (*Loxodonta africana africana*) elephants at 28 locations. These geographic-specific allele frequency estimates are used to infer the geographic origin of DNA samples, such as could be obtained from tusks of unknown origin. We demonstrate that our method alleviates several problems associated with standard assignment methods in this context, and the absolute accuracy of our method is high. Continent-wide, 50% of samples were located within 500 km, and 80% within 932 km of their actual place of origin. Accuracy varied by region (median accuracies: West Africa, 135 km; Central Savannah, 286 km; Central Forest, 411 km; South, 535 km; and East, 697 km). In some cases, allele frequencies vary considerably over small geographic regions, making much finer discriminations possible and suggesting that resolution could be further improved by collection of samples from locations not represented in our study.

Descriptors: DNA genetics, dentin chemistry, Africa, geography, microsatellite repeats.

[Back to Top](#)

[<< Table of Contents](#)

[<< Previous](#) | [Next >>](#)

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Search AWIC

Go

- Search all USDA
- Advanced Search

Browse by Subject

- ▷ Research Animals
- ▷ Farm Animals
- ▷ Zoo, Circus and Marine Animals
- ▷ Companion Animals
- ▷ Government and Professional Resources
- ▷ Alternatives
- ▷ Literature Searching and Databases
- ▷ Pain and Distress
- ▷ Humane Endpoints and Euthanasia

 You are here: [Home](#) / [Publications](#) / [Bibliographies and Resource Guides](#) / [Information Resources on Elephants](#) / [African Elephants - Parasites](#)
 [Printer Friendly Page](#)

Publications

Information Resources on Elephants

[<< Table of Contents](#)
[<< Previous](#) | [Next >>](#)

African Elephants

- Anatomy / Histology / Physiology
- Anesthesia / Analgesia
- Behavior / Care / Enrichment / Handling / Training
- Blood / Circulation / Cardiac / Hematology
- Communication / Vocal / Hearing
- Digestive / Food / Nutrition
- Diseases / Conditions
- Genetics / DNA
- Parasites
- Reproductive
- Research
- Veterinary

Parasites

Gandolf, A.R., A. Lifschitz, C. Stadler, B. Watson, L. Galvanek, M. Ballent, and C. Lanusse (2009). **The pharmacokinetics of orally administered ivermectin in African elephants (*Loxodonta africana*): implications for parasite elimination.** *Journal of Zoo and Wildlife Medicine* 40(1): 107-112. ISSN: 1042-7260.

Online: <http://dx.doi.org/10.1638/2008-0082.1>

Descriptors: African elephant, *Loxodonta africana*, ivermectin, parasites, parasite resistance.

Kinsella, J.M., S.L. Deem, S. Blake, and A.S. Freeman (2004). **Endoparasites of African forest elephants (*Loxodonta africana cyclotis*) from the Republic of Congo and central African Republic.** *Comparative Parasitology* 71(2): 104-110. ISSN: 1525-2647.

NAL Call Number: QL391.J68

Descriptors: endoparasites, fecal samples, African elephants. necropsy, Republic of Congo, forest elephants, parasite fauna, intestinal parasites, schistosome, nematode.

McAloon, F.M. (2004). **Oribatid mites as intermediate hosts of *Anoplocephala manubriata*, cestode of the Asian elephant in India.** *Experimental and Applied Acarology* 32(3): 181-5.

NAL Call Number: SB940 .E9

Abstract: *Anoplocephala manubriata* (Cestoda: Anoplocephalidae) is a tapeworm that parasitizes both African (*Loxodonta africana*) and Asian (*Elephas maximus*) elephants. Its life cycle has not yet been completely elucidated nor have intermediate hosts been previously reported. Soil and substrate was collected in the Kodanadu Forest Range, Ernakulum District and Guruvayur Devaswom Temple grounds, Thrissur District, in Kerala, India. Oribatid mites (Acari: Oribatida) were collected from dung piles near captive elephants' bedding and examined for immature stages of the tapeworm. Five

species of oribatids were found to contain at least one immature life stage of *A. manubriata*: *Galumna flabellifera orientalis* Hammer 1958, *Scheloribates latipes* (C.L. Koch 1844), *S. praeincisus* (Berlese 1913), *Protoribates seminudus* (Hammer 1971), and *P. triangularis* (Hammer 1971).

Descriptors: Cestoda growth and development, cestode infections, mites parasitology, cestode infections parasitology, cestode infections transmission, India, mite infestations parasitology, mite infestations.

Saseendran, P.C., S. Rajendran, R. Subramanian, M. Sasikumar, G. Vivek, and K.S. Anil (2004).

Incidence of helminthic infection among annually dewormed captive elephants.
Zoos' Print Journal 19(3): 1422.

Descriptors: captive elephants, helminthic infection, dewormed, incidence.

[Back to Top](#)

[<< Table of Contents](#)

[<< Previous](#) | [Next >>](#)

Last Modified: Jan 23, 2014

[AWIC Home](#) | [NAL Home](#) | [USDA](#) | [AgNIC](#) | [ARS](#) | [Web Policies and Important Links](#) | [RSS Feeds](#) | [Site Map](#)
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Go

- Search all USDA
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- ▷ Research Animals
- ▷ Farm Animals
- ▷ Zoo, Circus and Marine Animals
- ▷ Companion Animals
- ▷ Government and Professional Resources
- ▷ Alternatives
- ▷ Literature Searching and Databases
- ▷ Pain and Distress
- ▷ Humane Endpoints and Euthanasia

You are here: [Home](#) / [Publications](#) / [Bibliographies and Resource Guides](#) / [Information Resources on Elephants](#) / [African Elephants - Reproductive](#)

[Printer Friendly Page](#)

Publications

Information Resources on Elephants

[<< Table of Contents](#)[>> Previous](#) | [Next >>](#)

African Elephants

- [Anatomy / Histology / Physiology](#)
- [Anesthesia / Analgesia](#)
- [Behavior / Care / Enrichment / Handling / Training](#)
- [Blood / Circulation / Cardiac / Hematology](#)
- [Communication / Vocal / Hearing](#)
- [Digestive / Food / Nutrition](#)
- [Diseases / Conditions](#)
- [Genetics / DNA](#)
- [Parasites](#)
- [Reproductive](#)
- [Research](#)
- [Veterinary](#)

Reproductive

Agnew, D.W., L. Munson, and E.C. Ramsay (2004). **Cystic endometrial hyperplasia in elephants.** *Veterinary Pathology* 41(2): 179-83.

NAL Call Number: 41.8 P27

Abstract: Most captive female elephants are nulliparous and aged and many have endometrial disease, factors that may hinder fertility. This study characterized the pathologic features and demographic distribution of endometrial lesions from 27 captive Asian (*Elephas maximus*) and 13 African elephants (*Loxodonta africanus*), 12- to 57-years of age. The principal lesion was marked cystic and polypoid endometrial hyperplasia (CEH), present in 67% of Asian and 15% of African elephants ranging from 26 to 57 years. The lower prevalence in African elephants likely reflects their younger age range in this study. Fourteen of 15 affected elephants with breeding information were nulliparous. These results suggest that CEH and polyps are common in aged nulliparous elephants, and the severity of these lesions may impair fertility. These findings will be useful in the interpretation of ultrasonographic findings during reproductive examinations of potential breeding cows. Also, breeding programs should focus on younger animals.

Descriptors: zoo animals, endometrial hyperplasia, endometrium pathology, fertility physiology, polyps, endometrial hyperplasia pathology, histological techniques, polyps pathology, species specificity.

Allen, W. R (2006). **Review. Ovulation, pregnancy, placentation and husbandry in the African elephant (*Loxodonta africana*).** *Philosophical Transactions of the Royal Society of London. Series B Biological Sciences* 361(1469): 821-34.

NAL Call Number: 501 L84Pb

Abstract: The African elephant reproduces so efficiently in the wild that overpopulation is now a serious problem in some game parks in Zimbabwe, Botswana and South Africa. The female reaches puberty between 10 and 12 years of age in the wild and, when in

captivity, shows oestrous cycles of 14-15 weeks duration. She readily conceives a singleton in the wild yet her uterus has the capacity for twins. She shows a gestation length of 22 months and, in the wild, shows a population density and feed dependent intercalving interval of 4-8 years. The trophoblast erodes the luminal epithelium of the endometrium and stimulates upgrowths of blood vessel-containing stromal villi, which develop eventually into the broad, tightly folded lamellae of the zony, endotheliochorial placenta. Significant quantities of leaked maternal erythrocytes and ferric iron are phagocytosed by specialized trophoblast cells in the haemophagous zones at the lateral edges of the placental band. Although the placenta itself is endocrinologically inert, the foetal gonads, which enlarge greatly during the second half of pregnancy can synthesize 5alpha-dihydroprogesterone and other 5alpha pregnane derivatives from cholesterol and pregnenolone. These products may synergize with progestagens secreted by the 2-8 large corpora lutea which are always present in the maternal ovaries throughout gestation to maintain the pregnancy state.

Descriptors: African elephant, ovulation, placentation, husbandry, puberty, estrus cycles, pregnancy, endometrium, gestation, corpora lutea.

Allen, W.R., S. Mathias, and M. Ford (2005). **Placentation in the African elephant, *Loxodonta africana*. IV. Growth and function of the fetal gonads.** *Reproduction* 130(5): 713-720. ISSN: 1470-1626.

NAL Call Number: QP251.J75

Abstract: The gonads, both ovaries and testes, of 44 elephant fetuses weighing 0.09-112 kg (6.1-21.3 months gestation) were examined grossly and histologically. As in equids, elephant fetal gonads undergo a phase of marked growth and enlargement during the second half of gestation, which is more pronounced in ovaries than testes due to growth and antrum formation of numerous follicles in the former. Stromal cells undergo hypertrophy and transformation to form zones of interstitial cells that are associated with the enlarged follicles in the ovaries and in which the primitive seminiferous tubules are embedded in the testes. The interstitial cells have the capacity to synthesize 5[alpha]-dihydroprogesterone and other 5[alpha]-reduced progestagens from cholesterol and pregnenolone and the hypothesis is raised that these fetal gonadal progestagens may supplement significantly the progestagens secreted by the multiple large corpora lutea of pregnancy in the elephant.

Descriptors: African elephant, placentation, fetal gonads, ovaries, testes, gestation, growth, function, corpora lutea, follicles, seminiferous tubules.

Allen, W.R., S. Mathias, F.B. Wooding, and R.J. van Aarde (2003). **Placentation in the African elephant (*Loxodonta africana*). II. Morphological changes in the uterus and placenta throughout gestation.** *Placenta* 24(6): 598-617.

NAL Call Number: QP281.P53

Abstract: The gross and microscopic development of the zony endotheliochorial placenta in the African elephant was studied in 22 gravid uteri that ranged in gestational stage from 0.5 to 20.6 months. The conceptus only ever occupies one horn of the uterus and is associated with 2-5 large corpora lutea that persist in the ipsilateral ovary throughout gestation. Initially, the trophoblast in the equatorial region of the conceptus completely replaces the luminal epithelium of the endometrium to which it is apposed. Blunt upgrowths of endometrial stroma then develop, each closely invested by trophoblast, and containing the capillaries that will vascularize this maternal component of the resulting placental band. With advancing gestation the lamellate stromal upgrowths increase markedly in length and become much thinner, thereby bringing the trophoblast into intimate contact with the endothelium of the maternal capillaries. They also become folded or pleated to increase the total area of intimate fetomaternal contact. At the lateral edges of the placental band the lamellae bend over towards the endometrium to form a blind cleft. Leakage of blood into this area creates haemophagous zones in which phenotypically specialized trophoblast cells phagocytose the blood components. The presence of large resorbing blood clots and circumferential scars in the uteri of three post parturient animals initiated the hypothesis that, when the standing elephant gives birth at term, the passage of the 120 kg fetus through the vagina may wrench the placenta off the endometrium by severing its very narrow maternal placental hilus. The resulting intrauterine haemorrhage may then play a role in preventing further conception for around 2 years.

Descriptors: physiology, placenta embryology, placentation physiology, uterus anatomy and histology, gestational age, placenta physiology, trophoblasts physiology, trophoblasts ultrastructure, uterus physiology.

Brown, J.L., D. Olson, M. Keele, and E.W. Freeman (2004). **Survey of the reproductive cyclicity status of Asian and African elephants in North America.** *Zoo Biology* 23(4): 309-321. ISSN: 0733-3188.

NAL Call Number: QL77.5.Z6

Descriptors: reproductive cyclicity, status, survey, African elephant, Asian elephant, North America.

Brown, J.L., M. Somerville, H.S. Riddle, M. Keele, C.K. Duer, and E.W. Freeman (2007).

Comparative endocrinology of testicular, adrenal and thyroid function in captive Asian and African elephant bulls. *General and Comparative Endocrinology* 151(2):

153-162. ISSN: (p) 0016-6480; (E) 1095-6840.

Online: <http://dx.doi.org/10.1016/j.ygcen.2007.01.006>

Descriptors: African elephant, *Loxodonta africana*, Asian elephant, *Elephas maximus*, comparative study, adrenal glands, hormone secretion, hydrocortisone, reproduction, sexual maturity, testes, testosterone, thyroid function, thyrotropin, thyroxine, triiodothyronine, cortisol, thyroid stimulating hormone, musth.

Brown, J.L., S.L. Walker, and T. Moeller (2004). **Comparative endocrinology of cycling and non-cycling Asian (*Elephas maximus*) and African (*Loxodonta africana*) elephants.** *General and Comparative Endocrinology* 136(3): 360-70.

NAL Call Number: 444.8 G28

Abstract: Up to 14% of Asian and 29% of African elephants in captivity are not cycling normally or exhibit irregular cycles based on progestin profiles. To determine if ovarian acyclicity is related to other disruptions in endocrine activity, serum pituitary, thyroid, adrenal, and ovarian hormones in weekly samples collected for 6-25 months were compared between normal cycling (n=22 each species) and non-cycling (n=6 Asian; n=30 African) elephants. A subset of cycling females (n=4 Asian, 7 African) also were blood sampled daily during the follicular phase to characterize the peri-ovulatory period. In normal cycling females, two luteinizing hormone (LH) surges were observed 3 weeks apart during a normal follicular phase, with the second inducing ovulation (ovLH). Serum FSH concentrations were highest at the beginning of the non-luteal phase, declining to nadir concentrations within 4 days of the ovLH surge. FSH remained low until after the ovLH surge and then increased during the luteal phase. A species difference was noted in prolactin secretion. In the African elephant, prolactin was increased during the follicular phase, but in Asian elephants concentrations remained stable throughout the cycle. Patterns of thyroid hormones (thyroid-stimulating hormone, TSH; free and total thyroxine, T4; free and total triiodothyronine, T3) and cortisol secretion were not affected by estrous cycle stage or season in cycling elephants. In non-cycling elephants, there were no fluctuating patterns of LH, FSH, or prolactin secretion. Overall mean concentrations of all hormones were similar to those in cycling animals, with the exception of FSH, prolactin, and estradiol. Mean serum FSH concentrations were lower due to females not exhibiting normal cyclic increases, whereas serum estradiol was higher overall in most acyclic females. Prolactin concentrations were significantly increased in 11 of 30 non-cycling females, all of which were African elephants. In sum, while there were no consistent endocrine anomalies associated with ovarian acyclicity, hyperprolactinemia may be one cause of ovarian dysfunction. The finding of elevated estrogens in some acyclic females also deserves further investigation, especially determining how it relates to reproductive tract pathologies.

Descriptors: physiology, estrous cycle physiology, ovary physiology, blood, estradiol blood, estrous cycle blood, follicle stimulating hormone blood, hydrocortisone blood, luteinizing hormone blood, prolactin blood, seasons, species specificity, thyrotropin blood, thyroxine blood, triiodothyronine blood.

Brown, J.L. and T.B. Hildebrandt (2003). **The science behind elephant artificial insemination.** *Biology of Reproduction* 68(Supplement 1): 95-96. ISSN: 0006-3363.

NAL Call Number: QL876.B5

Descriptors: reproduction, artificial insemination, clinical techniques, captive breeding, sperm cryopreservation, transrectal ultrasound, diagnostic techniques, imaging, estrous cycle, ovulation, parturition, pregnancy.

Dahl, N.J., D. Olson, D.L. Schmitt, D.R. Blasko, R.S. Kristipati, and J.F. Roser (2004).

Development of an enzyme-linked immunosorbent assay (ELISA) for luteinizing hormone (LH) in the elephant (*Loxodonta africana* and *Elephas maximus*). *Zoo Biology* 23(1): 65-78. ISSN: 0733-3188.

NAL Call Number: QL77.5.Z6

Descriptors: African elephant, Asian elephant, ELISA, luteinizing hormone, enzyme-linked immunosorbent assay, LH, development.

Dahl, N.J., D.L. Schmitt, D.R. Blasko, and J.F. Roser (2004). **A progesterone (p4) rise prior to and during the ovulatory luteinizing hormone (ovlh) peak may facilitate fertile ovulations in the African and Asian elephant (*Loxodonta africana* and *Elephas maximus*).** *Biology of Reproduction*(Special Issue): 102-103. ISSN: 0006-3363.

NAL Call Number: QL876.B5

Descriptors: reproduction, infertility, disease, reproductive system disease, fertile, ovulation, progesterone rise, ovulatory luteinizing hormone, peak.

Dill, W.M., B.L. Davis, A.R. Hicks, T.E. Goodwin, L.E.L. Rasmussen, H. Loizi, and B. Schulte (2003). **Chemical analysis of preovulatory female African elephant urine: a search for putative pheromones.** *Abstracts of Papers American Chemical Society* 225(1-2): CHED 409. ISSN: 0065-7727.

NAL Call Number: 381 Am33PA

Descriptors: African elephant, urinary system, chemical analysis, urine, putative pheromones, preovulatory, female.

Freeman, E.W., E. Weiss, and J.L. Brown (2004). **Examination of the interrelationships of**

behavior, dominance status, and ovarian activity in captive Asian and African elephants. *Zoo Biology* 23(5): 431-448. ISSN: 0733-3188.

NAL Call Number: QL77.5.Z6

Descriptors: ovarian activity, Asian elephants, African elephants, dominance status, behavior, interrelationships.

Freeman, E.W., G. Guagnano, D. Olson, M. Keele, and J.L. Brown (2009). **Social factors influence ovarian acyclicity in captive African elephants (*Loxodonta africana*).** *Zoo Biology* 28(1): 1-15. ISSN: 0733-3188.

NAL Call Number: QL77.5.Z6

Abstract: Nearly one-third of reproductive age African elephants in North America that are hormonally monitored fail to exhibit estrous cycle activity, which exacerbates the nonsustainability of the captive population. Three surveys were distributed to facilities housing female African elephants to determine how social and environmental variables contribute to cyclicity problems. Forty-six facilities returned all three surveys providing information on 90% of the SSP population and 106 elephants (64 cycling, 27 noncycling and 15 undetermined). Logistic analyses found that some physiological and social history variables were related to ovarian acyclicity. Females more likely to be acyclic had a larger body mass index and had resided longer at a facility with the same herdmates. Results suggest that controlling the weight of an elephant might be a first step to helping mitigate estrous cycle problems. Data further show that transferring females among facilities has no major impact on ovarian activity. Last, social status appears to impact cyclicity status; at 19 of 21 facilities that housed both cycling and noncycling elephants, the dominant female was acyclic. Further studies on how social and environmental dynamics affect hormone levels in free-living, cycling elephants are needed to determine whether acyclicity is strictly a captivity-related phenomenon.

Descriptors: African elephants, *Loxodonta africana*, captive animals, zoo animals, estrous cycle, body weight, social dominance, environmental factors, surveys, captive-elephants, ovarian acyclicity, acyclic females, noncycling females.

Ganswindt, A., H.B. Rasmussen, M. Heistermann, and J.K. Hodges (2005). **The sexually active states of free-ranging male African elephants (*Loxodonta africana*): defining musth and non-musth endocrinology, physical signals, and behavior.** *Hormones and Behavior* 47(1): 83-91. ISSN: 0018-506X.

NAL Call Number: QP801.H7H64

Descriptors: African elephant, *Loxodonta africana*, reproductive behavior, musth, characteristics, free ranging males, Kenya, temporal glands, secretions, glucocorticoid, urine dribbling, androgen levels, aggressive behavior.

Goodwin, T.E. and L.E.L. Rasmussen (2004). **Collaborative research at the interface of chemistry and biology: development and identity of sexually dimorphic reproductive signals and responses by African elephants.** *Abstracts of Papers American Chemical Society* 227(Part 1): U658. ISSN: 0065-7727.

NAL Call Number: 381 Am33PA

Descriptors: reproductive system, chemistry, biology, African elephants, research, reproductive signals.

Hollister Smith, J.A., J.H. Poole, E.A. Archie, E.A. Vance, N.J. Georgiadis, C.J. Moss, and S.C. Alberts (2007). **Age, musth and paternity success in wild male African elephants, *Loxodonta africana*.** *Animal Behaviour* 74(Part 2): 287-296. ISSN: 0003-3472; Online: 1095-8282.

Descriptors: African elephant, sexual activity, intrasexual selection, age-related paternity success, musth.

Ishengoma, D.R.S., A.M. Shedlock, C.A.H. Foley, L.J. Foley, S.K. Wasser, S.T. Balthazary, and B.M. Mutayoba (2008). **Effects of poaching on bull mating success in a free ranging African elephant (*Loxodonta africana*) population in Tarangire National Park, Tanzania.** *Conservation Genetics* 9(2): 247-255. ISSN: 1566-0621.

Online: <http://dx.doi.org/10.1007/s10592-007-9332-0>

NAL Call Number: QH75.A1 C56

Abstract: Poaching and habitat encroachment for human settlement are the two major factors that caused contraction of elephant populations in Africa. While the effects of poaching on many aspects of elephant social systems have been studied, the impacts on mating patterns are not yet understood and such information is still lacking in most African countries. In this study, we used elephant specific-microsatellite DNA to generate genotypes from 86 elephant samples (84 fresh feces and two tissue samples) from Tarangire National Park (TNP), Tanzania to assess the mating success of individual males. We also tested whether the oldest bulls are more likely to sire most of the offspring in a severely poached population. Genetic paternity analysis was compared to behavioural observations of matings collected over a 3-year period (1998-2001) to determine the success of bull mating strategy. The genotypes of 26 infants, their known mothers and 10 out of 43 potential breeding bulls in TNP were used to assign 31% of the offspring at 80% confidence level to their potential fathers with simulation assuming that 23% (10/43) of the breeding males were sampled. Mating success of individual bull based on both behavioural and genetic data showed that the oldest remaining bulls performed most of

the matings and fathered the majority of infants. We speculate that the lifetime fitness of bulls that have survived poaching may be elevated because their period of dominance increases.

Descriptors: African elephants, *Loxodonta africana*, DNA, poaching, bull mating success, microsatellite repeats, Tarangire National Park, Tanzania.

Jones, C.J., F.B. Wooding, S.S. Mathias, and W.R. Allen (2004). **Fetomaternal glycosylation of early placentation events in the African elephant *Loxodonta africana*.** *Placenta* 25(4): 308-20.

NAL Call Number: QP281.P53

Abstract: During implantation in the African elephant (*Loxodonta africana*), fetal trophoblast displaces the surface uterine epithelium and superficially penetrates the uterine glands. This limited invasion is followed by the upgrowth of blunt fingers of endometrial stroma, covered with trophoblast and containing capillaries that subsequently vascularize the growing placenta. We have used lectin histochemistry to compare the glycosylation of maternal endothelial cells in the endometrium with those growing within the trophoblastic processes of a 2 g embryo (approximately 125 days' gestation), and also examine changes in the endometrial glands associated with trophoblastic invasion. Maternal vessels at the apices of the trophoblast-covered stromal upgrowths showed increased expression of terminal N-acetyl galactosamine, N-acetyl glucosamine oligomers, some sialic acids, and tri/tetra-antennate non-bisected complex N-linked glycan, as indicated by increased lectin staining. The areas of increased staining were also more resistant to neuraminidase digestion. Invaded glands had distended walls composed of flattened epithelial cells, some of which showed heavy lectin staining suggestive of intracellular glycan accumulation. The vascular changes suggest that new maternal capillary growth is accompanied by alterations in surface glycosylation. This may be the result of increased glycosyl transferase activity associated with cell proliferation and may also indicate the expression of significantly increased anti-adhesive molecules preventing blood stasis and egress of maternal immunocompetent cells into the fetal compartment.

Descriptors: physiology, embryo implantation physiology, maternal fetal exchange physiology, trophoblasts metabolism, biological markers analysis, endometrium metabolism, gestational age, glycosylation, immunoenzyme techniques, lectins metabolism.

Meyer, J.M., S.L. Walker, E.W. Freeman, B.G. Steinetz, and J.L. Brown (2004). **Species and fetal gender effects on the endocrinology of pregnancy in elephants.** *General and Comparative Endocrinology* 138(3): 263-270.

NAL Call Number: 444.8 G28

Abstract: Quantitative and temporal progestin profiles vary during gestation in the elephant, sometimes making it difficult to determine if a pregnancy is progressing normally. The aim of the present study was to determine if circulating progestin variability was related to species or fetal gender effects. A similar comparison also was conducted for secretory profiles of prolactin, relaxin, and cortisol. Overall mean progestin concentrations during gestation in Asian (n = 19) and African (n = 8) elephants were similar; however, the temporal profiles differed (P < 0.001). Concentrations were higher in African elephants during the first half of pregnancy, but then declined to levels below those observed in Asian elephants (P < 0.05). There also was a fetal gender effect in Asian, but not African elephants. Progestin concentrations were higher in Asian cows carrying male calves (n = 9) as compared to those carrying females (n = 10) (P < 0.001). Overall prolactin concentrations were higher in Asian than in African elephants between 8 and 15 months of gestation (P < 0.001). There were no species differences in the secretory patterns of relaxin. Cortisol was relatively stable until the end of gestation when significant surges were observed, mainly between 8 and 11 days before parturition, and again on the day of birth. In sum, a comparison of progestin patterns between Asian and African elephants identified notable differences related to species and fetal gender. A role for cortisol in the initiation of parturition also was inferred from these data. From a practical standpoint, understanding the factors affecting gestational hormone characteristics and recognizing what the species differences are will help ensure that data used in diagnosing and monitoring elephant pregnancies are properly interpreted.

Descriptors: blood, embryology, hydrocortisone in blood, maternal fetal exchange physiology, pregnancy, progestins in blood, analysis of variance, fetus, prolactin in blood, relaxin in blood, sex factors, species specificity.

Ortolani, A., K. Leong, L. Graham, and A. Savage (2005). **Behavioral indices of estrus in a group of captive African elephants (*Loxodonta africana*).** *Zoo Biology* 24(4): 311-329. ISSN: 0733-3188.

NAL Call Number: QL77.5.Z6

Descriptors: estrous cycle, sexual behavior, flehmen, estrus detection, males, females.

Osthoff, G., M. de Wit, A. Hugo, and B.I. Kamara (2007). **Milk composition of three free ranging African elephant (*Loxodonta africana africana*) cows during mid lactation.** *Comparative Biochemistry and Physiology B, Biochemistry and Molecular Biology* 148(1): 1-5. ISSN: (p) 1096-4959; (E) 1879-1107.

Online: <http://dx.doi.org/10.1016/j.cbpb.2007.02.015>

Descriptors: African elephant, *Loxodonta africana*, milk composition, carbohydrates,

casein, fatty acids, lactation, lactose, lipids, milk fat, milk protein, oligosaccharides, whey protein.

Owens, M.J. and D. Owens (2009). **Early age reproduction in female savanna elephants (*Loxodonta africana*) after severe poaching.** *African Journal of Ecology* 47(2): 214-222. ISSN: 0141-6707.

Online: <http://dx.doi.org/10.1111/j.1365-2028.2008.01001.x>

NAL Call Number: 409.6 Ea7

Abstract: A 10-year study revealed that after severe poaching (>93% killed) of elephants (*Loxodonta africana*) in Zambia's North Luangwa National Park (NLNP) during the 1970s and 1980s, the age of reproduction in females was greatly reduced. Fifty-eight per cent of births were delivered by females aged 8.5-14 years, an age at which elephants were reported to be sexually immature in nearby South Luangwa National Park (SLNP) before poaching. The mean age of females at first birth (AFB) (1993, 1994) was 11.3 years. Prior to poaching, the mean age AFB in SLNP was 16 years. The NLNP age structure and sex ratio were skewed, mean family unit size was reduced, and 37% of family units contained no females older than 15 years. Twenty-eight per cent of family units were comprised entirely of a single mother and her calf, and 8% of units consisted only of orphans who would have been considered sexually immature prior to poaching. Only 6% of survivors were older than 20 years, the age at which females in little-poached populations generally become most reproductively active. After a community-based conservation programme and the UN-CITES ban on the ivory trade were introduced, no elephants were recorded killed. In spite of a high reproductive rate, 6 years after poaching decreased, the density of the NLNP population had not increased, supporting predictions that the removal of older matriarchs from family units will have serious consequences on the recovery of this species.

Descriptors: African elephant, *Loxodonta africana*, community based conservation, early age reproduction, ivory trade, ban, poaching, social dynamics.

Stumpf, P. and U. Welsch (2004). **Secretory and defensive functions of the duct system of the lactating mammary gland of the African elephant (*Loxodonta africana*, Proboscidea).** *Zoomorphology (Berlin)* 123(3): 155-167. ISSN: 0720-213X.

NAL Call Number: 442.8 Z33

Descriptors: African elephant, mammary gland, lactating, duct system, secretory, defensive functions, microorganisms, invading, IgA, lactation period.

Weissenböck, N.M., H.M. Schwammer, and T. Ruf (2009). **Estrous synchrony in a group of African elephants (*Loxodonta africana*) under human care.** *Animal Reproduction Science* 113(1/4): 322-327. ISSN: 0378-4320.

Online: <http://dx.doi.org/10.1016/j.anireprosci.2008.07.003>

Descriptors: African elephant, *Loxodonta africana*, estrous synchrony, captive zoo animals, dominance hierarchy.

Wittemyer, G., H. Barner Rasmussen, and I. Douglas Hamilton (2007). **Breeding phenology in relation to NDVI variability in free-ranging African elephant.** *Ecography* 30(1): 42-50. ISSN: 0906-7590.

Online: <http://dx.doi.org/10.1111/j.2006.0906-7590.04900.x>

NAL Call Number: QH540.H6

Abstract: The phenology of reproduction is often correlated with resource availability and is hypothesized to be shaped by selective forces in order to maximize lifetime reproductive success. African elephants have the distinctive life history traits of a 22 month gestation and extended offspring investment, necessitating a long-term strategy of energy acquisition and reproductive expenditure to ensure successful offspring recruitment. We investigated the relationship between the reproductive phenology of a wild elephant population and resource availability using remotely sensed Normalized Differential Vegetation Index (NDVI) data as a measure of time-specific primary productivity and hence forage quality. The initiation of female elephants' 3+yr reproductive bout was dependent on conditions during the season of conception but timed so parturition occurred during the most likely periods of high primary productivity 22 months later. Thus, the probability of conception is linked to the stochastic variation in seasonal quality and the phenology of parturition is related to the predictable seasonality of primary productivity, indicating elephants integrate information on known current and expected future conditions when reproducing. Juvenile mortality was not correlated with ecological variability, hence female fecundity rather than calf mortality appears to drive demographic processes in the study population. Extreme climatic events, such as those associated with the El Niño-Southern-Oscillation (ENSO), acted to synchronize female fecundity in the population. This study suggests that the relationship between fecundity and ecological variability instigates the characteristic demographic fluctuations in elephant populations, rather than the mortality-driven fluctuations observed in many ungulate populations.

Descriptors: African elephant, *Loxodonta africana*, breeding phenology, free ranging, reproductive success.

Wooding, F.B., F. Stewart, S. Mathias, and W.R. Allen (2005). **Placentation in the African elephant, *Loxodonta africanus*. III. Ultrastructural and functional features of the**

placenta. *Placenta* 26(6): 449-70.

NAL Call Number: QP281.P53

Abstract: Successful transfer of nutrients to the elephant fetus during pregnancy relies on a variety of placental modifications. Our light and electron microscopical investigations show that the structure is endotheliochorial from implantation to term, with unicellular, never syncytial trophoblast. Light and electron microscope immunocytochemistry shows the restriction of the glucose transporter 1 isoform to the basolateral surfaces of the trophoblast, with the glucose transporter 3 restricted to the apical plasmalemma of the trophoblast. Glucose transport to the fetus therefore requires a sequential use of both isoforms. Light and electron microscope cytochemistry indicate the presence of iron deposits only in the haemophagous zones confirming their iron transport function. No trophoblast areas with high concentrations of Calcium binding protein, specialised for Calcium transport were found. In situ hybridisation demonstrated the presence of IGF-II mRNA in the trophoblast from the earliest stage, with TGFbeta1 and HGF-SF mRNA expressed subsequently but only IGF-II and HGF mRNA present in the second half of pregnancy. The results are briefly discussed in terms of placental growth and function and indicate that the elephant placenta is another example of a unique solution to the variety of problems posed by a resident fetus.

Descriptors: physiology, placenta cytology, placenta physiology, pregnancy, calcium binding proteins metabolism, embryo implantation physiology, epidermal growth factor genetics, glucose transporter type 1, glucose transporter type 3, hepatocyte growth factor genetics, immunohistochemistry, in situ hybridization, insulin like growth factor II genetics, iron metabolism, keratin metabolism, microscopy, electron, monosaccharide transport proteins metabolism, nerve tissue proteins metabolism, proto oncogene proteins C met metabolism, transforming growth factor beta genetics, trophoblasts metabolism, trophoblasts ultrastructure.

Yon, L., S. Kanchanapangka, N. Chaiyabutr, S. Meehan, F.Z. Stanczyk, N. Dahl, and B. Lasley (2007). **A longitudinal study of LH gonadal and adrenal steroids in four intact Asian bull elephants (*Elephas maximus*) and one castrate African bull (*Loxodonta africana*) during musth and non-musth periods.** *General and Comparative Endocrinology* 151(3): 241-245. ISSN: 0016-6480; Online: 1095-6840.

Descriptors: African elephant, *Loxodonta africana*, Asian elephant, *Elephas maximus*, endocrine system, reproduction, castration, musth cycle.

[Back to Top](#)

[<< Table of Contents](#)

[<< Previous](#) | [Next >>](#)

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[Home](#)[About AWIC](#)[Publications](#)[Workshops](#)[Services](#)[News and Events](#)[Help](#)[Contact Us](#)

Search AWIC

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- ▷ Literature Searching and Databases
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Publications

Information Resources on Elephants

[<< Table of Contents](#)[<< Previous](#) | [Next >>](#)

African Elephants

- Anatomy / Histology / Physiology
- Anesthesia / Analgesia
- Behavior / Care / Enrichment / Handling / Training
- Blood / Circulation / Cardiac / Hematology
- Communication / Vocal / Hearing
- Digestive / Food / Nutrition
- Diseases / Conditions
- Genetics / DNA
- Parasites
- Reproductive
- Research
- Veterinary

Research

Cerling, T.E., G. Wittemyer, H.B. Rasmussen, F. Vollrath, C.E. Cerling, T.J. Robinson, and I. Douglas Hamilton (2006). **Stable isotopes in elephant hair document migration patterns and diet changes.** *Proceedings of the National Academy of Sciences of the United States of America* 103(2): 371-3.

NAL Call Number: 500 N31P

Abstract: We use chronologies of stable isotopes measured from elephant (*Loxodonta africana*) hair to determine migration patterns and seasonal diet changes in elephants in and near Samburu National Reserve in northern Kenya. Stable carbon isotopes record diet changes, principally enabling differentiation between browse and tropical grasses, which use the C3 and C4 photosynthetic pathways, respectively; stable nitrogen isotopes record regional patterns related to aridity, offering insight into localized ranging behavior. Isotopically identified range shifts were corroborated by global positioning system radio tracking data of the studied individuals. Comparison of the stable isotope record in the hair of one migrant individual with that of a resident population shows important differences in feeding and ranging behavior over time. Our analysis indicates that differences are the result of excursions into mesic environments coupled with intermittent crop raiding by the migrant individual. Variation in diet, quantified by using stable isotopes, can offer insight into diet-related wildlife behavior.

Descriptors: animal migration, diet, physiology, hair chemistry, hair metabolism, carbon isotopes, metabolism, hair growth and development, nitrogen isotopes, seasons, time factors.

Clauss, M., Y. Wang, K. Ghebremeskel, C.E. Lendl, and W.J. Streich (2003). **Plasma and erythrocyte fatty acids in captive Asian (*Elephas maximus*) and African (*Loxodonta africana*) elephants.** *Veterinary Record* 153(2): 54-8.

NAL Call Number: 41.8 V641

Abstract: The fatty acid components of the plasma triglycerides and the phospholipid fractions of the red blood cells of a captive group of two African (*Loxodonta africana*) and four Asian (*Elephas maximus*) elephants were investigated. All the animals received the same diet of hay, fruits and vegetables, and concentrates. A comparison with data from free-ranging African elephants or Asian work-camp elephants showed that the captive elephants had lower proportions of polyunsaturated fatty acids (PUFAs), and for several lipid fractions a higher n-6:n-3 ratio, than their counterparts in the wild or under the more natural, in terms of diet, work-camp conditions. The difference in PUFA content was smaller in the African than in the Asian elephants. The captive Asian elephants tended to have lower levels of n-3 and total unsaturated fatty acids in their red blood cells than the captive African elephants.

Descriptors: metabolism, erythrocytes metabolism, unsaturated metabolism fatty acids, phospholipids metabolism, triglycerides metabolism, zoo animals, blood chemical analysis, diet, blood, unsaturated blood fatty acids, triglycerides blood, workload.

Dahl, N.J., D. Olson, D.L. Schmitt, D.R. Blasko, R.S. Kristipati, and J.F. Roser (2004).

Development of an enzyme-linked immunosorbent assay (ELISA) for luteinizing hormone (LH) in the elephant (*Loxodonta africana* and *Elephas maximus*). *Zoo Biology* 23(1): 65-78. ISSN: 0733-3188.

NAL Call Number: QL77.5.Z6

Descriptors: African elephant, Asian elephant, ELISA, luteinizing hormone, enzyme-linked immunosorbent assay, LH, development.

Dehnhard, M. (2007). **Characterisation of the sympathetic nervous system of Asian (*Elephas maximus*) and African (*Loxodonta africana*) elephants based on urinary catecholamine analyses.** *General and Comparative Endocrinology* 151(3): 274-284. ISSN: (p) 0016-6480; (E) 1095-6840.

Online: <http://dx.doi.org/10.1016/j.ygcen.2007.01.001>

Abstract: Assessing the welfare status of captive animals using non-invasive measurements of hormones is of growing interest because this can serve as an effective tool to facilitate the optimization of environmental and husbandry conditions. Both the African elephant (*Loxodonta africana*) and the Asian elephant (*Elephas maximus*) exhibit extremely low breeding success in captivity, and because elevated levels of stress may negatively influence reproductive functions, this study sought to establish a method for assessing sympathoadrenal activity in captive female elephants. We found a circadian variation in urinary noradrenaline (norepinephrine, NE), adrenaline (epinephrine, Epi) and dopamine (DA) under short day length. Peak activity of noradrenaline and dopamine was noted at 3 a.m. Adrenaline showed a biphasic pattern with a minor peak recorded at 3 a.m. and a major peak 9 a.m. Under long-day photoperiodic conditions, simultaneous peaks of noradrenaline and adrenaline were again noted at 3 a.m. whereas dopamine does not appear to have a distinct circadian pattern under long-day length. A transfer of two elephant cows resulted in a marked increase in urinary adrenaline and noradrenaline levels, confirming that the transfer represented a stressful event. During the periparturient period, noradrenaline concentrations increased and maximum concentrations were obtained at delivery. Daily measurements of urinary dopamine throughout the follicular phase revealed an increase in dopamine secretion close to ovulation. This increase might indicate a role of dopamine in the ovulatory mechanisms. These results suggest that changes in urinary catecholamine excretion reflect fluctuations in sympathoadrenal activity and may be a useful indicator of stress. *Reproduced with Permission from CAB Abstracts.*

Descriptors: animal welfare, catecholamines, circadian rhythm, diurnal variation, dopamine, epinephrine, norepinephrine, reproductive performance, stress, sympathetic nervous system, urine, zoo animals, Asian elephant, *Elephas maximus*, African elephant, *Loxodonta africana*.

Dill, W.M., B.L. Davis, A.R. Hicks, T.E. Goodwin, L.E.L. Rasmussen, H. Loizi, and B. Schulte (2003). **Chemical analysis of preovulatory female African elephant urine: a search for putative pheromones.** *Abstracts of Papers American Chemical Society* 225(1-2): CHED 409. ISSN: 0065-7727.

NAL Call Number: 381 Am33PA

Descriptors: African elephant, urinary system, chemical analysis, urine, putative pheromones, preovulatory, female.

Ganswindt, A., M. Heistermann, and K. Hodges (2005). **Physical, physiological, and behavioral correlates of musth in captive African elephants (*Loxodonta africana*).** *Physiological and Biochemical Zoology* 78(4): 505-14.

NAL Call Number: QL1.P52

Abstract: Although musth in male African elephants (*Loxodonta africana*) is known to be associated with increased aggressiveness, urine dribbling (UD), temporal gland secretion (TGS), and elevated androgens, the temporal relationship between these changes has not been examined. Here, we describe the pattern of musth-related characteristics in 14 captive elephant bulls by combining long-term observations of physical and behavioral changes with physiological data on testicular and adrenal function. The length of musth periods was highly variable but according to our data set not related to age. Our data also confirm that musth is associated with elevated androgens and, in this respect, show that

TGS and UD are downstream effects of this elevation, with TGS responding earlier and to lower androgen levels than UD. Because the majority of musth periods were associated with a decrease in glucocorticoid levels, our data also indicate that musth does not represent a physiological stress mediated by the hypothalamic-pituitary-adrenal axis. Furthermore, we demonstrate that the occurrence of musth is associated with increased aggression and that this is presumably androgen mediated because aggressive males had higher androgen levels. Collectively, the information generated contributes to a better understanding of what characterizes and initiates musth in captive African elephants and provides a basis for further studies designed to examine in more detail the factors regulating the intensity and duration of musth.

Descriptors: zoo animals, physiology, reproduction physiology, sex behavior, animal physiology, adrenal glands physiology, aggression physiology, analysis of variance, androgens metabolism, feces chemistry, glucocorticoids metabolism, observation, testis physiology, time factors.

Ganswindt, A., R. Palme, M. Heistermann, S. Borrigan, and J.K. Hodges (2003). **Non-invasive assessment of adrenocortical function in the male African elephant (*Loxodonta africana*) and its relation to musth.** *General and Comparative Endocrinology* 134(2): 156-66.

NAL Call Number: 444.8 G28

Abstract: Adult male elephants periodically show the phenomenon of musth, a condition associated with increased aggressiveness, restlessness, significant weight reduction and markedly elevated androgen levels. It has been suggested that musth-related behaviours are costly and that therefore musth may represent a form of physiological stress. In order to provide data on this largely unanswered question, the first aim of this study was to evaluate different assays for non-invasive assessment of adrenocortical function in the male African elephant by (i) characterizing the metabolism and excretion of [3H]cortisol (3H-C) and [14C]testosterone (14C-T) and (ii) using this information to evaluate the specificity of four antibodies for determination of excreted cortisol metabolites, particularly with respect to possible cross-reactions with androgen metabolites, and to assess their biological validity using an ACTH challenge test. Based on the methodology established, the second objective was to provide data on fecal cortisol metabolite concentrations in bulls during the musth and non-musth condition. 3H-C (1 mCi) and 14C-T (100 microCi) were injected simultaneously into a 16 year old male and all urine and feces collected for 30 and 86 h, respectively. The majority (82%) of cortisol metabolites was excreted into the urine, whereas testosterone metabolites were mainly (57%) excreted into the feces. Almost all radioactive metabolites recovered from urine were conjugated (86% 3H-C and 97% 14C-T). In contrast, 86% and >99% of the 3H-C and 14C-T metabolites recovered from feces consisted of unconjugated forms. HPLC separations indicated the presence of various metabolites of cortisol in both urine and feces, with cortisol being abundant in hydrolysed urine, but virtually absent in feces. Although all antibodies measured substantial amounts of immunoreactivity after HPLC separation of peak radioactive samples and detected an increase in glucocorticoid output following the ACTH challenge, only two (in feces against 3 α ,11-oxo-cortisol metabolites, measured by an 11-oxo-etiocholanolone-EIA and in urine against cortisol, measured by a cortisol-EIA) did not show substantial cross-reactivity with excreted 14C-T metabolites and could provide an acceptable degree of specificity for reliable assessment of glucocorticoid output from urine and feces. Based on these findings, concentrations of immunoreactive 3 α ,11-oxo-cortisol metabolites were determined in weekly fecal samples collected from four adult bulls over periods of 11-20 months to examine whether musth is associated with increased adrenal activity. Results showed that in each male levels of these cortisol metabolites were not elevated during periods of musth, suggesting that in the African elephant musth is generally not associated with marked elevations in glucocorticoid output. Given the complex nature of musth and the variety of factors that are likely to influence its manifestation, it is clear, however, that further studies, particularly on free-ranging animals, are needed before a possible relationship between musth and adrenal function can be resolved. This study also clearly illustrates the potential problems associated with cross-reacting metabolites of gonadal steroids in EIAs measuring glucocorticoid metabolites. This has to be taken into account when selecting assays and interpreting results of glucocorticoid metabolite analysis, not only for studies in the elephant but also in other species.

Descriptors: adrenal cortex metabolism, adrenal cortex function tests, metabolism, feces chemistry, hydrocortisone analysis, stress, psychological physiopathology, testosterone analysis, adrenal cortex secretion, adrenal cortex function tests methods, diagnostic use of carbon isotopes, high pressure liquid chromatography, corticotropin physiology, urine, glucocorticoids analysis, glucocorticoids in urine, diagnostic use of hydrocortisone, hydrocortisone in urine, immunoenzyme techniques and methods, reproduction physiology, sex behavior, animal physiology, psychological diagnosis of stress, diagnostic use of testosterone, testosterone in urine.

Ganswindt, A., H.B. Rasmussen, M. Heistermann, and J.K. Hodges (2005). **The sexually active states of free-ranging male African elephants (*Loxodonta africana*): defining musth and non-musth using endocrinology, physical signals, and behavior.** *Hormones and Behavior* 47(1): 83-91.

NAL Call Number: QP801.H7H64

Abstract: Musth in male African elephants, *Loxodonta africana*, is associated with increased aggressive behavior, continuous discharge of urine, copious secretions from the swollen temporal glands, and elevated androgen levels. During musth, bulls actively seek out and are preferred by estrous females although sexual activity is not restricted to the musth condition. The present study combines recently established methods of fecal hormone analysis with long-term observations on male-female associations as well as the presence and intensity of physical signals to provide a more detailed picture about the physical, physiological, and behavioral characteristics of different states of sexual activity in free-ranging African elephants. Based on quantitative shifts in individual bull association patterns, the presence of different physical signals, and significant differences in androgen levels, a total of three potential sub-categories for sexually active bulls could be established. The results demonstrate that elevations in androgen levels are only observed in sexually active animals showing temporal gland secretion and/or urine dribbling, but are not related to the age of the individual. Further, none of the sexually active states showed elevated glucocorticoid output indicating that musth does not represent an HPA-mediated stress condition. On the basis of these results, we suggest that the term "musth" should be exclusively used for the competitive state in sexually active male elephants and that the presence of urine dribbling should be the physical signal used for defining this state.

Descriptors: behavior, animal physiology, competitive behavior physiology, sex behavior, age factors, androsterone analysis, feces chemistry, hydrocortisone analysis, hydrocortisone metabolism, longitudinal studies, testosterone analysis.

Greenwood, A.D., C.C. Englbrecht, and R.D. MacPhee (2004). **Characterization of an endogenous retrovirus class in elephants and their relatives.** *BMC Evolutionary Biology* 4(1): 38.

NAL Call Number: QH359.B63

Abstract: BACKGROUND: Endogenous retrovirus-like elements (ERV-Ls, primed with tRNA leucine) are a diverse group of reiterated sequences related to foamy viruses and widely distributed among mammals. As shown in previous investigations, in many primates and rodents this class of elements has remained transpositionally active, as reflected by increased copy number and high sequence diversity within and among taxa. RESULTS: Here we examine whether proviral-like sequences may be suitable molecular probes for investigating the phylogeny of groups known to have high element diversity. As a test we characterized ERV-Ls occurring in a sample of extant members of superorder Uranotheria (Asian and African elephants, manatees, and hyraxes). The ERV-L complement in this group is even more diverse than previously suspected, and there is sequence evidence for active expansion, particularly in elephantids. Many of the elements characterized have protein coding potential suggestive of activity. CONCLUSIONS: In general, the evidence supports the hypothesis that the complement had a single origin within basal Uranotheria.

Descriptors: genetics, virology, endogenous retroviruses classification, endogenous retroviruses genetics, Africa, Asia, molecular cloning methods, viral DNA genetics, hyraxes genetics, hyraxes virology, mice, molecular sequence data, phylogeny, proteins genetics, retroelements genetics, Trichechus genetics, Trichechus virology.

Hatfield, J.R., D.A. Samuelson, P.A. Lewis, and M. Chisholm (2003). **Structure and presumptive function of the iridocorneal angle of the West Indian manatee (*Trichechus manatus*), short-finned pilot whale (*Globicephala macrorhynchus*), hippopotamus (*Hippopotamus amphibius*), and African elephant (*Loxodonta africana*).** *Veterinary Ophthalmology* 6(1): 35-43.

Abstract: The iridocorneal angles of prepared eyes from the West Indian manatee, short-finned pilot whale, hippopotamus and African elephant were examined and compared using light microscopy. The manatee and pilot whale demonstrated capacity for a large amount of aqueous outflow, probably as part of a system compensating for lack of ciliary musculature, and possibly also related to environmental changes associated with life at varying depths. The elephant angle displayed many characteristics of large herbivores, but was found to have relatively low capacity for aqueous outflow via both primary and secondary routes. The hippopotamus shared characteristics with both land- and water-dwelling mammals; uveoscleral aqueous outflow may be substantial as in the marine mammals, but the angular aqueous plexus was less extensive and a robust pectinate ligament was present. The angles varied greatly in size and composition among the four species, and most structures were found to be uniquely suited to the habitat of each animal.

Descriptors: cornea anatomy and histology, cornea physiology, mammals anatomy and histology, mammals physiology, aqueous humor physiology, Artiodactyla anatomy and histology, Artiodactyla physiology, elephant anatomy and histology, elephant physiology, species specificity, *Trichechus manatus* anatomy and histology, *Trichechus manatus* physiology, whale anatomy and histology, whale physiology.

Hunt, K.E. and S.K. Wasser (2003). **Effect of long-term preservation methods on fecal glucocorticoid concentrations of grizzly bear and African elephant.** *Physiological and Biochemical Zoology* 76(6): 918-928. ISSN: 1522-2152.

NAL Call Number: QL1.P52

Descriptors: African elephant, fecal glucocorticoid, concentrations, long term preservation, effects, grizzly bear.

Jones, C.J., F.B. Wooding, S.S. Mathias, and W.R. Allen (2004). **Fetomaternal glycosylation of early placentation events in the African elephant *Loxodonta africana***. *Placenta* 25(4): 308-20.

NAL Call Number: QP281.P53

Abstract: During implantation in the African elephant (*Loxodonta africana*), fetal trophoblast displaces the surface uterine epithelium and superficially penetrates the uterine glands. This limited invasion is followed by the upgrowth of blunt fingers of endometrial stroma, covered with trophoblast and containing capillaries that subsequently vascularize the growing placenta. We have used lectin histochemistry to compare the glycosylation of maternal endothelial cells in the endometrium with those growing within the trophoblastic processes of a 2 g embryo (approximately 125 days' gestation), and also examine changes in the endometrial glands associated with trophoblastic invasion. Maternal vessels at the apices of the trophoblast-covered stromal upgrowths showed increased expression of terminal N-acetyl galactosamine, N-acetyl glucosamine oligomers, some sialic acids, and tri/tetra-antennate non-bisected complex N-linked glycan, as indicated by increased lectin staining. The areas of increased staining were also more resistant to neuraminidase digestion. Invaded glands had distended walls composed of flattened epithelial cells, some of which showed heavy lectin staining suggestive of intracellular glycan accumulation. The vascular changes suggest that new maternal capillary growth is accompanied by alterations in surface glycosylation. This may be the result of increased glycosyl transferase activity associated with cell proliferation and may also indicate the expression of significantly increased anti-adhesive molecules preventing blood stasis and egress of maternal immunocompetent cells into the fetal compartment.

Descriptors: physiology, embryo implantation physiology, maternal fetal exchange physiology, trophoblasts metabolism, biological markers analysis, endometrium metabolism, gestational age, glycosylation, immunoenzyme techniques, lectins metabolism.

Kinahan, A.A., R. Inge Moller, P.W. Bateman, A. Kotze, and M. Scantlebury (2007). **Body temperature daily rhythm adaptations in African savanna elephants (*Loxodonta africana*)**. *Physiology and Behavior* 92(4): 560-565. ISSN: 0031-9384.

Abstract: The savanna elephant is the largest extant mammal and often inhabits hot and arid environments. Due to their large size, it might be expected that elephants have particular physiological adaptations, such as adjustments to the rhythms of their core body temperature (T-b) to deal with environmental challenges. This study describes for the first time the T-b daily rhythms in savanna elephants. Our results showed that elephants had lower mean T-b values (36.2 +/- 0.49 degrees C) than smaller ungulates inhabiting similar environments but did not have larger or smaller amplitudes of T-b variation (0.40 +/- 0.12 degrees C), as would be predicted by their exposure to large fluctuations in ambient temperature or their large size. No difference was found between the daily T-b rhythms measured under different conditions of water stress. Peak T-b's occurred late in the evening (22: 10) which is generally later than in other large mammals ranging in similar environmental conditions. "Copyright (c) Thomson Reuters 2009".

Descriptors: savanna elephant, physiological adaptations, behavioral adaptations, hot arid environments, core body temperature, thermoregulation.

Meyer, W. (2007). **Demonstration of lysozyme and antimicrobial peptides in the temporal gland of the African elephant (*Loxodonta africana*)**. *Mammalian Biology* 72(4): 251-255. ISSN: 1616-5047.

Online: <http://dx.doi.org/10.1016/j.mambio.2006.05.003>

Descriptors: African elephant, *Loxodonta africana*, antimicrobial properties, biochemistry, lysozyme, peptides, temporal gland.

Miller, M., T.C. Chen, M.F. Holick, S. Mikota, and E. Dierenfeld (2009). **Serum concentrations of calcium, phosphorus, and 25-hydroxyvitamin D in captive African elephants (*Loxodonta africana*)**. *Journal of Zoo and Wildlife Medicine* 40(2): 302-305. ISSN: 1042-7260.

Online: <http://dx.doi.org/10.1638/2008-0098.1>

Descriptors: African elephant, *Loxodonta africana*, blood serum, bone density, calcium, joint diseases, phosphorus.

Morshedi, R.G., P. Brown, T.E. Goodwin, L.E.L. Rasmussen, and B. Schulte (2004). **Heterocycles (and other compounds) that we have identified in African elephant urine: a search for putative pheromones**. *Abstracts of the American Chemical Society* 227(Part 1): U639. ISSN: 0065-7727.

NAL Call Number: 381 Am33Pa

Descriptors: African elephant, urine, putative hormones, heterocycles, other compounds, search.

Munshi South, J., L. Tchignoumba, J. Brown, N. Abbondanza, J.E. Maldonado, A. Henderson, and A. Alonso (2008). **Physiological indicators of stress in African forest elephants (*Loxodonta africana cyclotis*) in relation to petroleum operations in Gabon, Central Africa**. *Diversity and Distributions* 14(6): 995-1003. ISSN: 1366-9516.

Online: <http://dx.doi.org/10.1111/j.1472-4642.2008.00509.x>

NAL Call Number: QH75.A1B573

Abstract: Human activities are major determinants of forest elephant (*Loxodonta africana cyclotis*) distribution in Gabon, but the types and intensity of disturbance that elephants can tolerate are not known. We conducted dung surveys within the Gamba Complex of Protected Areas in SW Gabon to examine (1) the feasibility of noninvasive fecal analyses for monitoring stress physiology, and (2) the influence of petroleum operations on stress levels in forest elephants. Gabon, Central Africa. We identified multiple dung piles from the same individual by matching their eight-locus microsatellite genotypes, and measured fecal concentrations of glucocorticoid metabolites as an indicator of stress in areas subject to different levels of disturbance: (1) Loango National Park (2) an 'industrial corridor' dominated by oil fields, and (3) a nearby area of human settlements. We obtained unique microsatellite genotypes and fecal glucocorticoid metabolite (FGM) concentrations for 150 forest elephant individuals, which is the largest hormonal data set for wild African forest elephants to date. Adults exhibited higher mean FGM concentrations than juveniles, and in contradiction of our expectations of chronic stress around oil fields, elephants in Loango National Park exhibited significantly higher FGM concentrations than elephants in the industrial corridor. We argue that forest elephants in the industrial corridor of the Gamba Complex have become acclimated to oil fields, resulting in part from oil company regulations that minimize stressful interactions between elephants and petroleum operations. Our findings for a flagship species with substantial ecological requirements bode well for other taxa, but additional studies are needed to determine whether oil operations are compatible over their life span with rain forest ecosystems in Central Africa.

Descriptors: African elephant, *Loxodonta africana cyclotis*, Conservation physiology, disturbance ecology, fecal DNA, fecal glucocorticoid metabolites, Gamba Complex of Protected Areas, oil fields.

Okello, J.B., G. Wittemyer, H.B. Rasmussen, I. Douglas Hamilton, S. Nyakaana, P. Arctander, and H.R. Siegismund (2005). **Noninvasive genotyping and Mendelian analysis of microsatellites in African savannah elephants.** *Journal of Heredity* 96(6): 679-87.

NAL Call Number: 442.8 Am3

Abstract: We obtained fresh dung samples from 202 (133 mother-offspring pairs) savannah elephants (*Loxodonta africana*) in Samburu, Kenya, and genotyped them at 20 microsatellite loci to assess genotyping success and errors. A total of 98.6% consensus genotypes was successfully obtained, with allelic dropout and false allele rates at 1.6% (n = 46) and 0.9% (n = 37) of heterozygous and total consensus genotypes, respectively, and an overall genotyping error rate of 2.5% based on repeat typing. Mendelian analysis revealed consistent inheritance in all but 38 allelic pairs from mother-offspring, giving an average mismatch error rate of 2.06%, a possible result of null alleles, mutations, genotyping errors, or inaccuracy in maternity assignment. We detected no evidence for large allele dropout, stuttering, or scoring error in the dataset and significant Hardy-Weinberg deviations at only two loci due to heterozygosity deficiency. Across loci, null allele frequencies were low (range: 0.000-0.042) and below the 0.20 threshold that would significantly bias individual-based studies. The high genotyping success and low errors observed in this study demonstrate reliability of the method employed and underscore the application of simple pedigrees in noninvasive studies. Since none of the sires were included in this study, the error rates presented are just estimates.

Descriptors: DNA analysis, genetics, feces chemistry, genetic techniques, microsatellite repeats genetics, genotype, Kenya, polymerase chain reaction methods.

Osthoff, G., H.O. De Waal, A. Hugo, M. de Wit, and P. Botes (2005). **Milk composition of a free-ranging African elephant (*Loxodonta africana*) cow during early lactation.** *Comparative Biochemistry and Physiology. Part A, Molecular and Integrative Physiology* 141(2): 223-9.

NAL Call Number: QP1.C6

Abstract: Only one study previously reported comprehensively on the composition of African elephant's (*Loxodonta africana*) milk that was collected from 30 dead animals. In the current study milk was obtained from a tame but free-ranging African elephant cow without immobilization during the period when she was 4-47 days postpartum. At the respective collection times the nutrient content was 21.8 and 25.0 g protein; 56.0 and 76.0 g fat; 71.1 and 26.0 g sugars per kilogram of milk. The protein fraction, respectively, consisted of 10.0 and 14.0 g caseins/kg milk and of 11.8 and 11 g whey proteins/kg milk. During lactation the lactose content dropped from 52.5 to 11.8 g/kg milk, while the oligosaccharide content increased from 11.8 to 15.2 g/kg milk. The oligosaccharide was characterized as a galactosyllactose, which is digestible by cellulase. Electrophoresis and identification of protein bands showed a similar migrating sequence of proteins as seen in cow's milk, but some of the corresponding proteins were less negatively charged. The lipid fraction contains a high content of capric and lauric acids, approximately 60% of the total fatty acids, and low content of myristic, palmitic and oleic acids.

Descriptors: physiology, lactation physiology, milk chemistry, albumins analysis, carbohydrates analysis, caseins analysis, cattle, fatty acids analysis, globulins analysis, milk proteins analysis.

Osthoff, G., L. Dickens, T. Urashima, S.L. Bonnet, Y. Uemura, and J.H. van der Westhuizen

(2008). **Structural characterization of oligosaccharides in the milk of an African elephant (*Loxodonta africana africana*)**. *Comparative Biochemistry and Physiology B, Biochemistry and Molecular Biology* 150(1): 74-84. ISSN: 1096-4959.

Online: <http://dx.doi.org/10.1016/j.cbpb.2008.01.010>

Descriptors: African elephant, *Loxodonta africana*, milk composition, nuclear magnetic resonance spectroscopy, oligosaccharides.

Pitts, N.I. and G. Mitchell (2003). **In vitro succinylcholine hydrolysis in plasma of the African elephant (*Loxodonta africana*) and impala (*Aepyceros melampus*)**. *Comparative Biochemistry and Physiology. Toxicology and Pharmacology* 134(1): 123-9.

NAL Call Number: QP901.C6

Abstract: In elephants the time lapsed from i.m. injection of an overdose of the muscle relaxant succinylcholine (SuCh) until death, is significantly longer than in impala. To determine a difference in the rate of SuCh hydrolysis, once the drug enters the circulation, contributes to this phenomenon we have measured the rate of hydrolysis of SuCh in elephant and impala plasma, and by elephant erythrocytes. Rate of hydrolysis was determined by incubating SuCh in plasma or erythrocyte lysate at 37 degrees C and quantifying the choline produced. Plasma SuCh hydrolytic activity in elephant plasma (12.1 +/- 1.7 UI(-1) mean +/- S.D.; n=9) was significantly higher than it was in impala plasma (6.6 +/- 0.6 UI(-1); n=5), but were approximately 12 and 21 times lower, respectively, than in human plasma. Elephant erythrocyte lysate had no SuCh hydrolytic activity. Applying this data to previous studies, we can show that the ratio of SuCh absorption to SuCh hydrolysis is expected to be 1.25:1 and 1.41:1 for elephants and impala respectively. It will thus take at least 1.7 times longer for elephant to achieve a plasma SuCh concentration similar to that in impala. We conclude that a more rapid hydrolysis of SuCh in elephant plasma is one factor that contributes to the longer time to death compared to impala.

Descriptors: antelopes metabolism, elephants metabolism, erythrocytes metabolism, neuromuscular depolarizing agents metabolism, succinylcholine metabolism, butyrylcholinesterase metabolism, cultured cells, choline analysis, choline metabolism, erythrocytes drug effects, hydrolysis drug effects, neuromuscular depolarizing agents pharmacology, species specificity, succinylcholine pharmacology.

Rasmussen, H.B., G. Wittemyer, and I. Douglas Hamilton (2005). **Estimating age of immobilized elephants from teeth impressions using dental silicon**. *African Journal of Ecology* 43(3): 215-219. ISSN: 0141-6707.

NAL Call Number: 409.6 EA7

Descriptors: *Loxodonta africana*, African elephant, estimating age, teeth impressions, dental silicon, molars, lower jaw.

Language of Text: English, with English and French summaries.

Ren, L. and J.R. Hutchinson (2008). **The three dimensional locomotor dynamics of African (*Loxodonta africana*) and Asian (*Elephas maximus*) elephants reveal a smooth gait transition at moderate speed**. *Journal of the Royal Society Interface* 5(19): 195-211. ISSN: 1742-5689; Online: 1742-5662.

Descriptors: African elephant, *Loxodonta africana*, Asian elephant, *Elephas maximus*, locomotion, smooth gait transition, center of mass motion.

Satterfield, G.L., R.G. Morshedi, R. Kopper, T.E. Goodwin, C.F. Lichti, L.E.L. Rasmussen, and B. Schulte (2004). **Use of sds page, hplc-ms/ms, and spme, gc-ms to study female African elephant urinary proteins**. *Abstracts of Papers American Chemical Society* 227(Part 1): U443. ISSN: 0065-7727.

NAL Call Number: 381 Am33PA

Descriptors: African elephant, urinary proteins, female, study, SDS page, HPLC-MS, MS, GC-MS.

Steenkamp, G., S.M. Ferreira, and M.N. Bester (2007). **Tusklessness and tusk fractures in free-ranging African savanna elephants (*Loxodonta africana*)**. *Journal of the South African Veterinary Association* 78(2): 75-80. ISSN: 0038-2809.

Descriptors: African elephant, *Loxodonta africana*, population studies, tusk fracture, injury, tusklessness, genetic diseases, genetic drift, poaching, founder effect, culling, sex specific incidence .

Stumpf, P. and U. Welsch (2004). **Secretory and defensive functions of the duct system of the lactating mammary gland of the African elephant (*Loxodonta africana*, Proboscidea)**. *Zoomorphology (Berlin)* 123(3): 155-167. ISSN: 0720-213X.

NAL Call Number: 442.8 Z33

Descriptors: African elephant, mammary gland, lactating, duct system, secretory, defensive functions, microorganisms, invading, IgA, lactation period.

Wilson, M.L., M.A. Bloomsmith, and T.L. Maple (2004). **Stereotypic swaying and serum cortisol concentrations in three captive African elephants (*Loxodonta africana*)**. *Animal Welfare* 13(1): 39-43. ISSN: 0962-7286.

NAL Call Number: HV4701.A557

Descriptors: zoo animals, stereotyped behavior, cortisol, animal welfare.

[Back to Top](#)

[<< Table of Contents](#)

[<< Previous](#) | [Next >>](#)

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 [Printer Friendly Page](#)

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[<< Table of Contents](#)[>> Previous](#) | [Next >>](#)

African Elephants

- [Anatomy / Histology / Physiology](#)
- [Anesthesia / Analgesia](#)
- [Behavior / Care / Enrichment / Handling / Training](#)
- [Blood / Circulation / Cardiac / Hematology](#)
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- [Digestive / Food / Nutrition](#)
- [Diseases / Conditions](#)
- [Genetics / DNA](#)
- [Parasites](#)
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- [Research](#)
- [Veterinary](#)

Veterinary

Agnew, D.W., L. Munson, and E.C. Ramsay (2004). **Cystic endometrial hyperplasia in elephants.** *Veterinary Pathology* 41(2): 179-83.

NAL Call Number: 41.8 P27

Abstract: Most captive female elephants are nulliparous and aged and many have endometrial disease, factors that may hinder fertility. This study characterized the pathologic features and demographic distribution of endometrial lesions from 27 captive Asian (*Elephas maximus*) and 13 African elephants (*Loxodonta africanus*), 12- to 57-years of age. The principal lesion was marked cystic and polypoid endometrial hyperplasia (CEH), present in 67% of Asian and 15% of African elephants ranging from 26 to 57 years. The lower prevalence in African elephants likely reflects their younger age range in this study. Fourteen of 15 affected elephants with breeding information were nulliparous. These results suggest that CEH and polyps are common in aged nulliparous elephants, and the severity of these lesions may impair fertility. These findings will be useful in the interpretation of ultrasonographic findings during reproductive examinations of potential breeding cows. Also, breeding programs should focus on younger animals.

Descriptors: zoo animals, endometrial hyperplasia, endometrium pathology, fertility physiology, polyps, endometrial hyperplasia pathology, histological techniques, polyps pathology, species specificity.

Atthi, R., P. Chuaplaivech, W. Pintawong, S. Takoonwong, P. Sunpachudayan, N. Ruksri, and W. Teerathavorawan (2003). **Comparison of serum antibody responses in domestic elephants to three different haemorrhagic septicaemia oil adjuvant vaccine formulations.** *Journal of the Thai Veterinary Medical Association* 54(3): 29-37. ISSN: 0125-0620.

Descriptors: adjuvants, antibody formation, disease control, disease prevention, disease resistance, hemorrhagic septicemia, immune response, immunity, vaccination, vaccine

development, vaccines, wild animals, *Elephas maximus*, *Loxodonta africana*, *Pasteurella multocida*, ELISA.

Language of Text: Thai, with English summary.

Atthi, R., P. Chuaplaivech, W. Pintawong, S. Takoonwong, P. Sunpachudayan, N. Ruksri, and W. Teerathavorawan (2003). **Comparison of serum antibody responses in domestic elephants to three different hemorrhagic septicaemia oil adjuvant vaccine formulations.** *Journal of the Thai Veterinary Medical Association* 54(3): 29-37. ISSN: 0125-0620.

Descriptors: Asian elephant, *Elephas maximus*, African elephant, *Loxodonta africana*, adjuvants, antibody formation, disease control, disease prevention, disease resistance, hemorrhagic septicemia, immune response, immunity, vaccine development, vaccines.

Language of Text: Thai, Summary in English.

Boy, S.C. and G. Steenkamp (2004). **Neural innervation of the tusk pulp of the African elephant (*Loxodonta africana*).** *Veterinary Record* 154(12): 372-374. ISSN: 0042-4900.

NAL Call Number: 41.8 V641

Descriptors: tooth pulp, *Loxodonta africana*, innervation, autonomic nervous system, peripheral nerves, histology, pain, animal welfare.

Chinnadurai, S.K., W.K. Suedmeyer, and W.H. Fales (2009). **Microbiology of the external ear canal in six African elephants (*Loxodonta africana*).** *Veterinary Record* 164(8): 238-240. ISSN: 0042-4900.

Descriptors: African elephant, *Loxodonta africana*, external ear canal, microbiology, microbial flora, ears, zoo animals, *Acinetobacter calcoaceticus Iwoffii*, alpha -haemolytic *Streptococcus*, *Corynebacterium*, *Aeromonas caviae*.

Gakuya, F., E. Wambwa, D. Ndeereh, and T. Manyibe (2003). **Physiological and haematological findings in immobilized free-ranging African elephants.** *Pachyderm* 35: 77-81. ISSN: 1026-2881.

Descriptors: African elephant, *Loxodonta africana*, physiology, blood, hematological parameters, immobilized, Kenya.

Language of Text: English, with English and French summaries.

Gandolf, A.R., A. Lifschitz, C. Stadler, B. Watson, L. Galvanek, M. Ballent, and C. Lanusse (2009). **The pharmacokinetics of orally administered ivermectin in African elephants (*Loxodonta africana*): implications for parasite elimination.** *Journal of Zoo and Wildlife Medicine* 40(1): 107-112. ISSN: 1042-7260.

Online: <http://dx.doi.org/10.1638/2008-0082.1>

Descriptors: African elephant, *Loxodonta africana*, ivermectin, parasites, parasite resistance.

Hildebrandt, T.B., T. Strike, E. Flach, L. Sambrook, J. Dodds, N. Lindsay, C.F. Furley, P.S. Glatzel, and M. McGowan (2003). **Fetotomy in the elephant.** *Erkrankungen der Zootiere: Verhandlungsbericht des 41 Internationalen Symposiums über die Erkrankungen der Zoo und Wildtiere. Proceedings of the Institute for Zoo and Wildlife Research, Berlin, No.5, May 1, 1928-June 1, 2003, Rome, Italy, Vol. 5, p. 315-318.*

NAL Call Number: SF996.I5

Descriptors: fetotomy, dystocia, fetus, surgery, *Elephas maximus*, *Loxodonta africana*, reproduction.

Janssen, D.L., J.E. Oosterhuis, J. Fuller, and K. Williams (2004). **Field technique: a method for obtaining trunk wash mycobacterial cultures [cultures] in anesthetized free-ranging African elephants (*Loxodonta africana*).** In: *Proceedings: American Association of Zoo Veterinarians, American Association of Wildlife Veterinarians, Wildlife Disease Association: Health and Conservation of Captive and Free-Ranging Wildlife. Joint Conference, August 28, 2004-September 3, 2004, San Diego, California, American Association of Zoo Veterinarians: p. 586-587. 660 p.*

Descriptors: African elephant, *Loxodonta africana*, diagnostic techniques, trunk wash, South Africa, tuberculosis, trunk wash method, mycobacterial cultures, anesthesia, free ranging.

Kovacs, K., I. Jaros, and E. Papp (2009). **Afrikaielefant-bika (*Loxodonta africana*) megniyilt agyarpulpauregenek lezerkezelessel tamogatott tomesse. [Laser assisted treatment and filling of an exposed pulp cavity of a four years old African elephant bull (*Loxodonta africana*)/ Case report.]** *Magyar Allatorvosok Lapja* 131(1): 48-52. ISSN: 0025-004X.

Abstract:

Descriptors: African elephant, *Loxodonta africana*, dental infection, veterinary medicine, pulp cavity, laser assisted treatment, pain killer.

Language of Text: Hungarian, Summary in English.

Maslow, J.N., S.K. Mikota, M. Zhu, R. Isaza, L.R. Peddie, F. Dunker, J. Peddie, H. Riddle, and C.A. Peloquin (2005). **Population pharmacokinetics of isoniazid in the treatment of *Mycobacterium tuberculosis* among Asian and African elephants (*Elephas***

maximus and *Loxodonta africana*). *Journal of Veterinary Pharmacology and Therapeutics* 28(1): 21-7.

NAL Call Number: SF915.J63

Abstract: We recently described the clinical presentation and treatment of 18 elephants from six herds infected with TB. Treatment protocols and methods varied between herds to include both oral and rectal dosing using multiple drug doses and formulations. In this paper we present information regarding the pharmacokinetics (PK) of isoniazid (INH) in elephants and provide suggestions regarding initial treatment regimens. Forty-one elephants received INH daily by either oral or rectal administration with different formulations. Population PK analysis was performed using Non-linear Mixed Effect Modeling (NONMEM). Results of oral administration indicated that compared with premixed INH solution, the drug exposure was highest with a suspension prepared freshly with INH powder. When INH was concomitantly given as an admixture over food, T_{max} was delayed and variability in drug absorption was significantly increased. Compared with oral administration, similar drug exposures were found when INH was dosed rectally. The data generated suggest that a starting dose of 7.5 mg/kg of INH is appropriate for initial TB treatment in elephants when premixed solution is administered directly into the oropharynx or rectal vault and 4 mg/kg are when INH is administered following immediate suspension from powdered form.

Descriptors: antitubercular agents pharmacokinetics, metabolism, isoniazid pharmacokinetics, oral administration, rectal administration, administration and dosage of antitubercular agents, antitubercular agents in blood, therapeutic use of antitubercular agents, area under curve, isoniazid administration and dosage, isoniazid in blood, therapeutic use of isoniazid, *Mycobacterium tuberculosis*, tuberculosis drug therapy, tuberculosis.

Maslow, J.N., S.K. Mikota, M. Zhu, H. Riddle, and C.A. Peloquin (2005). **Pharmacokinetics of ethambutol (EMB) in elephants**. *Journal of Veterinary Pharmacology and Therapeutics* 28(3): 321-3.

NAL Call Number: SF915.J63

Descriptors: antitubercular agents pharmacokinetics, metabolism, ethambutol pharmacokinetics, oral administration, rectal administration, antitubercular agents administration and dosage, antitubercular agents in blood, area under curve, ethambutol administration and dosage, ethambutol in blood.

McAloon, F.M. (2004). **Oribatid mites as intermediate hosts of *Anoplocephala manubriata*, cestode of the Asian elephant in India**. *Experimental and Applied Acarology* 32(3): 181-5.

NAL Call Number: SB940 .E9

Abstract: *Anoplocephala manubriata* (Cestoda: Anoplocephalidae) is a tapeworm that parasitizes both African (*Loxodonta africana*) and Asian (*Elephas maximus*) elephants. Its life cycle has not yet been completely elucidated nor have intermediate hosts been previously reported. Soil and substrate was collected in the Kodanadu Forest Range, Ernakulum District and Guruvayur Devaswom Temple grounds, Thrissur District, in Kerala, India. Oribatid mites (Acari: Oribatida) were collected from dung piles near captive elephants' bedding and examined for immature stages of the tapeworm. Five species of oribatids were found to contain at least one immature life stage of *A. manubriata*: *Galumna flabellifera orientalis* Hammer 1958, *Scheloribates latipes* (C.L. Koch 1844), *S. praeincisus* (Berlese 1913), *Protoribates seminudus* (Hammer 1971), and *P. triangularis* (Hammer 1971).

Descriptors: Cestoda growth and development, cestode infections, mites parasitology, cestode infections parasitology, cestode infections transmission, India, mite infestations parasitology, mite infestations.

Mpanduji, D.G., T.B. Hildebrant, R. Fyumagwa, H. Wiik, L. Siege, R.D. Baldus, S.B. Bittegeko, R. Hermes, R. Hahn, H. Hofer, and F. Goeritz (2003). **Immobilizations and evaluation of clinical parameters from free-ranging elephants in southern Tanzania**. *Pachyderm* 35: 140-145. ISSN: 1026-2881.

Descriptors: African elephants, *Loxodonta africana*, blood, serum, immobilization, clinical parameters, evaluation, Tanzania, blood parameters, immobilized individuals.

Nath, I., V.S.C. Bose, S.K. Panda, B.C. Das, and L.K. Singh (2003). **A case of multiple abscesses in a baby elephant**. *Zoos' Print Journal* 18(11): 1270.

Descriptors: baby elephant, abscesses, multiple, disease, infection.

Neiffer, D.L., M. Miller, M. Weber, M. Setter, D. Fontenot, P.K. Robbins, and G.W. Pye (2005). **Standing sedation in African elephant (*Loxodonta africana*) using detomidine-buttorphanol combinations**. *Journal of Zoo and Wildlife Medicine* 36(2): 250-256. ISSN: 1042-7260.

NAL Call Number: SF601.J6

Descriptors: African elephants, *Loxodonta africana*, standing sedation, detomidine-buttorphanol, i.m., supplemental dosage, recovery, reversal agents, side effects, dose ranges.

Pitts, N.I. and G. Mitchell (2003). **In vitro succinylcholine hydrolysis in plasma of the**

African elephant (*Loxodonta africana*) and impala (*Aepyceros melampus*).

Comparative Biochemistry and Physiology. Toxicology and Pharmacology 134(1): 123-9.

NAL Call Number: QP901.C6

Abstract: In elephants the time lapsed from i.m. injection of an overdose of the muscle relaxant succinylcholine (SuCh) until death, is significantly longer than in impala. To determine a difference in the rate of SuCh hydrolysis, once the drug enters the circulation, contributes to this phenomenon we have measured the rate of hydrolysis of SuCh in elephant and impala plasma, and by elephant erythrocytes. Rate of hydrolysis was determined by incubating SuCh in plasma or erythrocyte lysate at 37 degrees C and quantifying the choline produced. Plasma SuCh hydrolytic activity in elephant plasma (12.1 +/- 1.7 UI(-1) mean +/- S.D.; n=9) was significantly higher than it was in impala plasma (6.6 +/- 0.6 UI(-1); n=5), but were approximately 12 and 21 times lower, respectively, than in human plasma. Elephant erythrocyte lysate had no SuCh hydrolytic activity. Applying this data to previous studies, we can show that the ratio of SuCh absorption to SuCh hydrolysis is expected to be 1.25:1 and 1.41:1 for elephants and impala respectively. It will thus take at least 1.7 times longer for elephant to achieve a plasma SuCh concentration similar to that in impala. We conclude that a more rapid hydrolysis of SuCh in elephant plasma is one factor that contributes to the longer time to death compared to impala.

Descriptors: antelopes metabolism, elephants metabolism, erythrocytes metabolism, neuromuscular depolarizing agents metabolism, succinylcholine metabolism, butyrylcholinesterase metabolism, cultured cells, choline analysis, choline metabolism, erythrocytes drug effects, hydrolysis drug effects, neuromuscular depolarizing agents pharmacology, species specificity, succinylcholine pharmacology.

Rajakse, R.C., G.U.S.P. Mendis, C.G. Wijesinghe, J. Alahakoon, and L.N.T. De Silva (2005).

Treatment and management of an elephant calf with a head injury. *Zoos Print Journal* 20(9): 1995-1996. ISSN: 0971-6378.

Descriptors: elephant calf, head injury, treatment, management.

Roocroft, A. (2005). **Indoors natural substrates for elephants & medical issues associated with hard surfaces.** *Animal Keepers' Forum* 32(10): 480-492. ISSN: 0164-9531.

NAL Call Number: QL77.5.A54

Descriptors: Elephantidae, housing techniques, indoor natural substrates, medical issues associated with hard surfaces, treatment techniques, injuries.

Singleton, C., J. Ramer, and J. Proudfoot (2004). **Use of unpasteurized honey for treatment of a deeply infected wound in an African elephant (*Loxodonta africana*).** In: *Proceedings: American Association of Zoo Veterinarians, American Association of Wildlife Veterinarians, Wildlife Disease Association: Health and Conservation of Captive and Free-Ranging Wildlife. Joint Conference, August 28, 2004-September 3, 2004, San Diego, California, American Association of Zoo Veterinarians:* p. 626-628. 660 p.

Descriptors: African elephant, *Loxodonta africana*, treatment techniques, unpasteurised honey, treatment of deeply infected wound, case report, injuries.

Sleeman, J.M., V.L. Clyde, M.V. Finnegan, E.C. Ramsay, and M.G. Shires (2003). **Mammary botryomycosis and mastectomy in an African elephant (*Loxodonta africana*).** *Veterinary Record* 152(2): 54-5.

NAL Call Number: 41.8 V641

Descriptors: mastitis, staphylococcal infections, differential diagnosis, mastectomy, mastitis diagnosis, mastitis pathology, mastitis surgery, staphylococcal infections diagnosis, staphylococcal infections pathology, staphylococcal infections surgery, staphylococcus classification, staphylococcus isolation and purification.

Steiner, M., A.R. Gould, T.J. Clark, and R. Burns (2003). **Induced elephant (*Loxodonta africana*) tusk removal.** *Journal of Zoo and Wildlife Medicine* 34(1): 93-5. ISSN: 1042-7260.

NAL Call Number: SF601.J6

Abstract: Elephant tusk removal usually requires costly surgical procedures that are time-consuming and present a significant risk to the animal when performed using general anesthesia. Such techniques require gauges, chisels, and forceps to remove the tusk. This article reports the simple removal of the tusk of an 18-yr-old African elephant (*Loxodonta africana*) without the use of surgical instruments and anesthesia. Rubber elastics were placed around a tusk, causing loss of alveolar bone with subsequent exfoliation of the tusk within 3 wk. The healing process was uneventful.

Descriptors: injuries, incisor surgery, pulpitis, tooth extraction, zoo animals, anti infective agents, incisor injuries, irrigation, povidone iodine administration and dosage, pulpitis etiology, pulpitis therapy, tooth extraction methods, tooth mobility, tooth socket.

Weissenboeck, N.M., H.M. Schwammer, and T. Voracek (2007). **Thermographische diagnostik bei afrikanischen (*Loxodonta africana*) und asiatischen (*Elephas maximus*) elefanten. [Thermographic diagnostic in African (*Loxodonta africana*) and Asiatic elephants (*Elephas maximus*)]. *Zoologische Garten* 76(5-6): 331-344. ISSN: 0044-5169.**

Descriptors: African elephant, *Loxodonta africana*, Asian elephant, *Elephas maximus*,

thermography, diagnostic techniques.

Language of Text: German.

Weissengruber, G.E., M. Egerbacher, and G. Forstenpointner (2003). **Mechanisms of loss and repair in traumatically injured tusks of African elephants.** In: *Erkrankungen der Zootiere: Verhandlungsbericht des 41 Internationalen Symposiums über die Erkrankungen der Zoo und Wildtiere, May 1, 1928-June 1, 2003, Rome, Italy*, Vol. 5, p. 425.

NAL Call Number: SF996.15

Descriptors: African elephant, tusks, injured, loss and repair, anatomy, mechanisms, teeth, trauma, trauma, *Loxodonta africana*.

Weissengruber, G.E., M. Egerbacher, and G. Forstenpointner (2005). **Structure and innervation of the tusk pulp in the African elephant (*Loxodonta africana*).** *Journal of Anatomy* 206(4): 387-93.

NAL Call Number: 447.8 J826

Abstract: African elephants (*Loxodonta africana*) use their tusks for digging, carrying and behavioural display. Their healing ability following traumatic injury is enormous. Pain experience caused by dentin or pulp damage of tusks seems to be negligible in elephants. In this study we examined the pulp tissue and the nerve distribution using histology, electron microscopy and immunohistochemistry. The results demonstrate that the pulp comprises two differently structured regions. Randomly orientated collagen fibres characterize a cone-like part lying rostral to the foramen apicis dentis. Numerous nerve fibres and Ruffini endings are found within this cone. Rostral to the cone, delicate collagen fibres and large vessels are orientated longitudinally. The rostral two-thirds of the pulp are highly vascularized, whereas nerve fibres are sparse. Vessel and nerve fibre distribution and the structure of connective tissue possibly play important roles in healing and in the obviously limited pain experience after tusk injuries and pulp alteration. The presence of Ruffini endings is most likely related to the use of tusks as tools.

Descriptors: dental pulp anatomy and histology, tooth anatomy and histology, Africa, biological markers analysis, dental pulp innervation, immunohistochemistry methods, nerve fibers ultrastructure, staining and labeling.

Weissengruber, G.E., F.K. Fuss, G. Egger, G. Stanek, K.M. Hittmair, and G. Forstenpointner (2006). **The elephant knee joint: morphological and biomechanical considerations.** *Journal of Anatomy* 208(1): 59-72.

NAL Call Number: 447.8 J826

Abstract: Elephant limbs display unique morphological features which are related mainly to supporting the enormous body weight of the animal. In elephants, the knee joint plays important roles in weight bearing and locomotion, but anatomical data are sparse and lacking in functional analyses. In addition, the knee joint is affected frequently by arthrosis. Here we examined structures of the knee joint by means of standard anatomical techniques in eight African (*Loxodonta africana*) and three Asian elephants (*Elephas maximus*). Furthermore, we performed radiography in five African and two Asian elephants and magnetic resonance imaging (MRI) in one African elephant. Macerated bones of 11 individuals (four African, seven Asian elephants) were measured with a pair of callipers to give standardized measurements of the articular parts. In one Asian and three African elephants, kinematic and functional analyses were carried out using a digitizer and according to the helical axis concept. Some peculiarities of healthy and arthrotic knee joints of elephants were compared with human knees. In contrast to those of other quadruped mammals, the knee joint of elephants displays an extended resting position. The femorotibial joint of elephants shows a high grade of congruency and the menisci are extremely narrow and thin. The four-bar mechanism of the cruciate ligaments exists also in the elephant. The main motion of the knee joint is extension-flexion with a range of motion of 142 degrees. In elephants, arthrotic alterations of the knee joint can lead to injury or loss of the cranial (anterior) cruciate ligament.

Descriptors: knee joint, anatomy, morphological, biomechanical, weight bearing, locomotion, radiography, MRI, magnetic resonance imaging, arthrosis.

Wilson, M.L., M.A. Bloomsmith, and T.L. Maple (2004). **Stereotypic swaying and serum cortisol concentrations in three captive African elephants (*Loxodonta africana*).** *Animal Welfare* 13(1): 39-43. ISSN: 0962-7286.

NAL Call Number: HV4701.A557

Descriptors: zoo animals, stereotyped behavior, cortisol, animal welfare.

Xie, H.S. (2004). **How to use acupuncture for elephants.** In: *Small animal and exotics. Book two: Pain management zoonosis. Proceedings of the North American Veterinary Conference, January 17, 2004-January 21, 2004, Orlando, Florida, USA*, Eastern States Veterinary Association: Gainesville, USA, Vol. 18, p. 1457-1458.

Descriptors: African elephants, acupuncture, veterinary conference, clinical aspects, lameness, pain, traditional treatment, *Loxodonta africana*.

Yamada, M., K. Nakamura, H. Nozaki, and H. Tanaka (2003). **Hepatocellular endoplasmic reticulum storage disease in an African elephant (*Loxodonta africana*).** *Journal of Comparative Pathology* 128(2-3): 192-4.

NAL Call Number: 41.8 J82

Abstract: Large intracytoplasmic inclusions were observed in hepatocytes of a 7-year-old African elephant (*Loxodonta africana*). The inclusions were oval to polyhedral with either a homogeneous glassy or a granular appearance. They were positive for the periodic acid-Schiff (PAS) reaction. Electron microscopical examination revealed that the inclusions consisted of granular material with moderate electron-density and were membrane-bounded. The findings suggested that the inclusions were derived from endoplasmic reticulum. The light and electron microscopical features were similar to those of endoplasmic reticulum storage disease of the liver in man. Such inclusions have not previously been reported in animals.

Descriptors: cytoplasm pathology, hepatocytes ultrastructure, inclusion bodies ultrastructure, liver diseases, cytoplasm metabolism, endoplasmic reticulum metabolism, endoplasmic reticulum ultrastructure, fatal outcome, immunoenzyme techniques, inclusion bodies metabolism, liver diseases pathology, electron microscopy, periodic acid schiff reaction.

Zhu, M., J.N. Maslow, S.K. Mikota, R. Isaza, F. Dunker, H. Riddle, and C.A. Peloquin (2005).

Population pharmacokinetics of pyrazinamide in elephants. *Journal of Veterinary Pharmacology and Therapeutics* 28(5): 403-9.

NAL Call Number: SF915.J63

Abstract: This study was undertaken to characterize the population pharmacokinetics (PK), therapeutic dose, and preferred route of administration for pyrazinamide (PZA) in elephants. Twenty-three African (*Loxodonta africana*) and Asian (*Elephas maximus*) elephants infected with or in contact with others culture positive for *Mycobacterium tuberculosis* were dosed under treatment conditions. PZA was dosed daily at 20-30 mg/kg via oral (fasting or nonfasting state) or rectal (enema or suppository) administration. Blood samples were collected 0-24 h postdose. Population PK was estimated using nonlinear mixed effect modeling. Drug absorption was rapid with T(max) at or before 2 h regardless of the method of drug administration. C(max) at a mean dose of 25.6 (+/-4.6) mg/kg was 19.6 (+/-9.5 microg/mL) for PZA given orally under fasting conditions. Under nonfasting conditions at a mean dose of 26.1 +/- 4.2 mg/kg, C(max) was 25% (4.87 +/- 4.89 microg/mL) and area under concentration curve (AUC) was 30% of the values observed under fasting conditions. Mean rectal dose of 32.6 +/- 15.2 mg/kg yielded C(max) of 12.3 +/- 6.3 microg/mL, but comparable AUC to PZA administered orally while fasting. Both oral and rectal administration of PZA appeared to be acceptable and oral dosing is preferred because of the higher C(max) and lower inter-subject variability. A starting dose of 30 mg/kg is recommended with drug monitoring between 1 and 2 h postdose. Higher doses may be required if the achieved C(max) values are below the recommended 20-50 microg/mL range.

Descriptors: antitubercular agents pharmacokinetics, metabolism, pyrazinamide pharmacokinetics, pulmonary tuberculosis, oral administration, rectal administration, antitubercular agents administration and dosage, antitubercular agents therapeutic use, area under curve, *Mycobacterium tuberculosis* pathogenicity, pyrazinamide administration and dosage, pyrazinamide therapeutic use, tuberculosis, pulmonary blood, pulmonary drug therapy.

Zuba, J.R., M.D. Stetter, S.R. Dover, and M. Briggs (2003). **Development of rigid laparoscopy techniques in elephants and rhinoceros.** *Proceedings of the American Association of Zoo Veterinarians Annual Conference, October 4, 2003-October 10, 2003, Minneapolis, Minnesota*, American Association of Zoo Veterinarians: p. 223-227. 333 p.

NAL Call Number: SH171.I22

Descriptors: Rhinocerotidae, *Loxodonta africana*, *Elephas maximus*, literature review, diagnostic techniques, rigid laparoscopy techniques, development, applications, review.

[Back to Top](#)

[<< Table of Contents](#)

[<< Previous](#) | [Next >>](#)

Last Modified: Jan 23, 2014

[Home](#)[About AWIC](#)[Publications](#)[Workshops](#)[Services](#)[News and Events](#)[Help](#)[Contact Us](#)

Search AWIC

Go

- Search all USDA
- Advanced Search

Browse by Subject

- ▷ Research Animals
- ▷ Farm Animals
- ▷ Zoo, Circus and Marine Animals
- ▷ Companion Animals
- ▷ Government and Professional Resources
- ▷ Alternatives
- ▷ Literature Searching and Databases
- ▷ Pain and Distress
- ▷ Humane Endpoints and Euthanasia

 You are here: [Home](#) / [Publications](#) / [Bibliographies and Resource Guides](#) / [Information Resources on Elephants](#) / [Asian Elephants - Anatomy / Histology / Physiology](#)
[Printer Friendly Page](#)

Publications

Information Resources on Elephants

[<< Table of Contents](#)[>> Previous](#) | [Next >>](#)

Asian Elephants

- [Anatomy / Histology / Physiology](#)
- [Anesthesia / Analgesia / Sedation / Capture](#)
- [Behavior / Care / Enrichment / Handling / Training](#)
- [Blood / Circulation / Cardiac / Hematology](#)
- [Communication / Vocal / Hearing](#)
- [Digestive / Food / Nutrition](#)
- [Diseases / Conditions](#)
- [Genetics / DNA](#)
- [Parasites](#)
- [Reproductive](#)
- [Research](#)
- [Veterinary](#)

Anatomy / Histology / Physiology

Clauss, M., H. Steinmetz, U. Eulenberger, P. Ossent, R. Zingg, J. Hummel, and J.M. Hatt (2007). **Observations on the length of the intestinal tract of African *Loxodonta africana* (Blumenbach 1797) and Asian elephants *Elephas maximus* (Linne 1735).**

European Journal of Wildlife Research 53(1): 68-72. ISSN: 1612-4642; (E) 1439-0574.

Descriptors: African elephant, *Loxodonta africana*, Asian elephant, *Elephas maximus*, intestinal tract length, digestive system, species differences, comparative study.

Endo, H., E. Narushima, T. Komiya, and M. Sasaki (2004). **Ligament of head of femur in the acetabulum of the Asian elephant.** *Japanese Journal of Zoo and Wildlife Medicine* 9(1): 45-49. ISSN: 1342-6133.

Descriptors: Asian elephant, anatomy, femur, acetabulum, histology, ligament head, morphology, wild animals, *Elephas maximus*.

Language of Text: English, with Japanese summary.

Endo, H., T. Sakai, T. Itou, H. Koie, and J. Kimura (2005). **Macroscopic observation and CT examination of the heart ventricular walls in the Asian elephant.** *Mammal Study* 30(2): 125-130. ISSN: 1343-4152.

Descriptors: heart, ventricular walls, cardiovascular system, circulation, CT scanning, microscopy, imaging, examination, Asian elephant, structure.

Hoffmann, J.N., A.G. Montag, and N.J. Dominy (2004). **Meissner corpuscles and somatosensory acuity: the prehensile appendages of primates and elephants.** *Anatomical Record. Part A, Discoveries in Molecular, Cellular, and Evolutionary Biology* 281(1): 1138-47.

NAL Call Number: QL801.A53

Descriptors: adaptation, physiological physiology, elephant anatomy and histology,

mechanoreceptors physiology, primate anatomy and histology, skin innervation, touch physiology, elephant physiology, evolution, feeding behavior physiology, hand innervation, hand physiology, hand strength physiology, motor skills physiology, phylogeny, primate physiology, sensory thresholds physiology, species specificity.

- Hutchinson, J.R., D. Famini, R. Lair, and R. Kram (2003). **Biomechanics: Are fast-moving elephants really running?** *Nature* 422(6931): 493-494.
NAL Call Number: 472 N21
Descriptors: elephant physiology, gait physiology, running physiology, walking physiology, biomechanics, kinetics, Thailand, time factors, video recording.
- Liamsiricharoen, M., T. Prapong, C. Thitaram, C. Somgird, C. Sarachai, W. Wongkalasin, S. Mahasawangkul, P. Kongtueng, N. Tongtip, and A. Suprasert (2005). **Gross and microscopic anatomy of cranial dura mater of Asian elephant (*Elephas maximus*)**. *Kasetsart Journal, Natural Sciences* 39(3): 477-481. ISSN: 0075-5192.
Abstract: The gross and microscopic anatomy of the cranial dura mater of 2 dying, male, Asian elephants (*Elephas maximus*) aged 24 and 68 years was studied. The cranial dura mater consisted of 2 layers, an outer periosteal layer and an inner meningeal layer. The porous appearance formed by blood vessels was seen between the 2 layers. Some completed foramina were found in the falx cerebri sheet. Unlike most of domestic animals, there were 2 falx cerebelli running along the 2 sides of the vermis and also many small tubercles on the surface of the inner meningeal layer. By staining with hematoxylin and eosin, Masson trichrome and Weigert stains, these small tubercles were observed as collagenous mass protrusions. *Reproduced with Permission from CAB Abstracts.*
Descriptors: Asian elephant, *Elephas maximus*, animal anatomy, blood vessels, brain, meninges.
- Pothiwong, W., P. Kamonrat, P. Uthaichotiwan, P. Prachammuang, and S. Kanchanapangka (2003). **A morphological study and diagnostic ultrasonography of Asian elephant kidney**. *Thai Journal of Veterinary Medicine* 33(4): 79-88. ISSN: 0125-6491.
NAL Call Number: SF604.T43
Descriptors: Asian elephant, kidney anatomy, arteries, histology, morphology, ultrasonography, *Elephas maximus*, study.
Language of Text: Thai, with English summary.
- Rajaram and V. Krishnamurthy (2003). **Elephant temporal gland ultrastructure and androgen secretion during musth**. *Current Science (Bangalore)* 85(10): 1467-1471. ISSN: 0011-3891.
NAL Call Number: 475 SCI23
Descriptors: musth, temporal gland, androgen secretion, ultrastructure, Asian male elephant, mitochondria, testosterone.
- Ren, L. and J. Hutchinson (2007). **Three dimensional locomotor dynamics of African (*Loxodonta africana*) and Asian (*Elephas maximus*) elephants**. *Comparative Biochemistry and Physiology Part A Molecular and Integrative Physiology* 146(4, Suppl. S): S110-S111. ISSN: 1095-6433.
Descriptors: African elephant, *Loxodonta africana*, Asian elephant, *Elephas maximus*, movement and support, footfall pattern, trunk rotation, locomotor dynamics, hindlimb stance, comparative study.
- Sacks, O. (2003). **Early work on elephant gait not to be forgotten**. *Nature* 423(6937): 221.
NAL Call Number: 472 N21
Descriptors: physiology, gait physiology, photography history, biomechanics, 19th century history.
- Sajjarengpong, K., A. Adirekthaworn, and P. Uthaichotiwan (2005). **The anatomy and radiography of the lungs of a stillborn Asian elephant (*Elephas maximus indicus*)**. *Thai Journal of Veterinary Medicine* 35(1): 67-72. ISSN: 0125-6491.
NAL Call Number: SF604.T43
Descriptors: Asian elephant, stillborn, anatomy, radiography, lungs, *Elephas maximus*, tracheobronchial, lobes.
Language of Text: Thai, with English summary.
- Sarma, M., S.N. Kalita, J.P. Das, and K.K. Sarma (2006). **Anatomical study of the mandible of Asian elephant (*Elephas maximus*)**. *Indian Journal of Veterinary Anatomy* 18(2): 19-23. ISSN: 0971-1937.
Abstract: The study was conducted to determine the anatomical features of the mandibles of two adult and two young Asian elephants from Kaziranga National Park, Assam, India. It was observed that the mandibles were composed of rostral body and two caudal rami. Each ramus was comprised of a horizontal and a vertical part. The body of the mandible of the adult Asian elephant was thick and rounded rostrocaudally and showed a median rostral process with a median groove which indicated the line of fusion of the body. The lingual surface of the body was smooth and concave transversely, while the lateral surface was smooth and convex dorsoventrally. Three mental foramina were present on the lateral surface of the body. The horizontal part of each ramus was thick and rounded, and laterally smooth and convex, while the medial surface was smooth and

convex. The mandibular space between the two rami was narrow at the middle and gradually expanded rostrally and caudally. The alveolar border presented a single alveolus to accommodate the large cheek tooth on each side. The ventral border was concave and convex rostrocaudally. The vertical part of each ramus was wide and consisted of a condylar process and coronoid process. The condylar processes were convex rostrocaudally and articulated with the squamous part of the temporal bone. The coronoid process was not well developed. A wide concave mandibular notch was observed between the two processes. The lateral surface of the vertical part of the ramus presented a wide masseteric fossa for the masseter muscle. The medial surface presented a large pterygoid fovea and caudal to it was a large mandibular foramen. Rostral border of the vertical ramus was thin when compared with the caudal border and it had a coronoid process dorsally. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, age differences, animal anatomy, mandible, morphology, morphometrics.

Sarma, M., M. Talukdar, K.B.D. Choudhury, and K.K. Sharma (2004). **Macromorphology of the tongue of an Asian elephant (*Elephas maximus*)**. *Zoos' Print Journal* 19(10): 1653.

Descriptors: Asian elephant, tongue, macromorphology, anatomy.

Siegal Willott, J., R. Isaza, R. Johnson, and M. Blaik (2008). **Distal limb radiography, ossification, and growth plate closure in the juvenile Asian elephant (*Elephas maximus*)**. *Journal of Zoo and Wildlife Medicine* 39(3): 320-334. ISSN: 1042-7260.

Online: <http://dx.doi.org/10.1638/2007-0031.1>

Abstract: Eleven juvenile Asian elephants (*Elephas maximus*) were evaluated radiographically to determine the relative times of growth plate closure and phalangeal ossification in the bones of the distal forelimb. Specifically, the first, second, and third phalanges of the third digit (D3) were evaluated, as well as the third phalanx of digits 1, 2, 4, and 5. All elephants were healthy at the time of examination. A retrospective evaluation of radiographs from six of the 11 juvenile elephants was also completed to augment the data set. This study reports the methods used to obtain high-quality radiographs of the distal juvenile elephant limb, ossification characteristics of the phalanges, relative times of growth plate closure within the proximal phalanges of D3, and a method for age estimation based on radiographic findings. This study will help clinicians in conducting elephant foot radiography, in evaluating foot radiographs in juvenile elephants, in recognizing normal versus pathologic change, and in estimating juvenile elephant age based on radiographic ossification characteristics and growth plate closure times. Consistent use of the proposed foot radiograph technique is recommended to facilitate foot disease recognition and as part of the annual examination of captive Asian elephants. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, bones, foot diseases, ossification, phalanges, radiography.

Uthaichotiwan, P., A. Adirekthaworn, and K. Sajjarengpong (2005). **The cerebral arterial circle of a newborn Asian elephant brain (*Elephas maximus*)**. *Thai Journal of Veterinary Medicine* 35(3): 67-73. ISSN: 0125-6491.

NAL Call Number: SF604.T43

Descriptors: Asian elephant, newborn, anatomy, arteries, brain, morphology, cerebral arterial circle, *Elephas maximus*.

Language of Text: Thai, with English summary.

Weissengruber, G.E., F.K. Fuss, G. Egger, G. Stanek, K.M. Hittmair, and G. Forstenpointner (2006). **The elephant knee joint: morphological and biomechanical considerations**. *Journal of Anatomy* 208(1): 59-72.

NAL Call Number: 447.8 J826

Abstract: Elephant limbs display unique morphological features which are related mainly to supporting the enormous body weight of the animal. In elephants, the knee joint plays important roles in weight bearing and locomotion, but anatomical data are sparse and lacking in functional analyses. In addition, the knee joint is affected frequently by arthrosis. Here we examined structures of the knee joint by means of standard anatomical techniques in eight African (*Loxodonta africana*) and three Asian elephants (*Elephas maximus*). Furthermore, we performed radiography in five African and two Asian elephants and magnetic resonance imaging (MRI) in one African elephant. Macerated bones of 11 individuals (four African, seven Asian elephants) were measured with a pair of callipers to give standardized measurements of the articular parts. In one Asian and three African elephants, kinematic and functional analyses were carried out using a digitizer and according to the helical axis concept. Some peculiarities of healthy and arthrotic knee joints of elephants were compared with human knees. In contrast to those of other quadruped mammals, the knee joint of elephants displays an extended resting position. The femorotibial joint of elephants shows a high grade of congruency and the menisci are extremely narrow and thin. The four-bar mechanism of the cruciate ligaments exists also in the elephant. The main motion of the knee joint is extension-flexion with a range of motion of 142 degrees. In elephants, arthrotic alterations of the knee joint can lead to injury or loss of the cranial (anterior) cruciate ligament.

Descriptors: knee joint, anatomy, morphological, biomechanical, weight bearing, locomotion, radiography, MRI, magnetic resonance imaging, arthrosis.

West, J.B., Z. Fu, A.P. Gaeth, and R.V. Short (2003). **Fetal lung development in the elephant reflects the adaptations required for snorkeling in adult life.** *Respiratory Physiology and Neurobiology* 138(2-3): 325-33.

NAL Call Number: QP121.A1R4

Abstract: The adult elephant is unique among mammals in that the pleural membranes are thickened and the pleural cavity is obliterated by connective tissue. It has been suggested that this peculiar anatomy developed because the animal can snorkel at depth, and this behavior subjects the microvessels in the parietal pleura to a very large transmural pressure. To investigate the development of the parietal pleura, the thickness of the endothoracic fascia (ET) was measured in four fetal African elephants of approximate gestational age 111-130 days, and the appearances were compared with those in human, rabbit, rat and mouse fetuses of approximately the same stage of lung organogenesis. The mean thicknesses of ET in the elephant, human, rabbit, rat and mouse were 403, 53, 29, 27 and 37 microm, respectively. This very early development of a thick parietal pleura in the elephant fetus is consistent with the hypothesis of a long history of snorkeling in the elephant's putative aquatic ancestors.

Descriptors: adaptation, biological physiology, embryonic and fetal development, lung embryology, pleura embryology, fetus, gestational age, intercostal muscles, lung anatomy and histology, mice, pleura anatomy and histology, rabbits, rats, species specificity.

Wimon Pothiwon, Phiwipha Kamonra, Pawana Uthaichotiwa, Pakorn Prachammuan, and Sumolya Kanchanapangk (2003). **Laksana thang maha kai wiphak chunla kai wiphak lae phap ultrasound khong tai chang Asia. [Morphological study and diagnostic ultrasonography of Asian elephant kidney].** *Thai Journal of Veterinary Medicine* 33(4): 79-88. ISSN: 0125-6491.

NAL Call Number: SF604.T43

Descriptors: Indian elephant, kidneys, morphology, ultrastructure, ultrasonics, body parts, radiation, sound, urinary tract, urogenital system.

Language of Text: Thai.

[Back to Top](#)

[<< Table of Contents](#)

[<< Previous](#) | [Next >>](#)

Last Modified: Jan 23, 2014

[Home](#)[About AWIC](#)[Publications](#)[Workshops](#)[Services](#)[News and Events](#)[Help](#)[Contact Us](#)

Search AWIC

Go

- Search all USDA
- Advanced Search

Browse by Subject

- ▷ Research Animals
- ▷ Farm Animals
- ▷ Zoo, Circus and Marine Animals
- ▷ Companion Animals
- ▷ Government and Professional Resources
- ▷ Alternatives
- ▷ Literature Searching and Databases
- ▷ Pain and Distress
- ▷ Humane Endpoints and Euthanasia

You are here: [Home](#) / [Publications](#) / [Bibliographies and Resource Guides](#) / [Information Resources on Elephants](#) / [Asian Elephants - Anesthesia / Analgesia / Sedation / Capture](#)

[Printer Friendly Page](#)

Publications

Information Resources on Elephants

[<< Table of Contents](#)[>> Previous](#) | [Next >>](#)

Asian Elephants

- [Anatomy / Histology / Physiology](#)
- [Anesthesia / Analgesia / Sedation / Capture](#)
- [Behavior / Care / Enrichment / Handling / Training](#)
- [Blood / Circulation / Cardiac / Hematology](#)
- [Communication / Vocal / Hearing](#)
- [Digestive / Food / Nutrition](#)
- [Diseases / Conditions](#)
- [Genetics / DNA](#)
- [Parasites](#)
- [Reproductive](#)
- [Research](#)
- [Veterinary](#)

Anesthesia / Analgesia / Sedation / Capture

Ashoka Dangolla, I. Silva, and V.Y. Kuruwita (2004). **Neuroleptanalgesia in wild Asian elephants (*Elephas maximus maximus*)**. *Veterinary Anesthesia and Analgesia* 31(4): 276-279. ISSN: (p) 1467-2987; Online: 1467-2995.

Online: <http://dx.doi.org/10.1111/j.1467-2995.2004.00166.x>

NAL Call Number: SF914.V47

Abstract: OBJECTIVE: To evaluate the suitability of etorphine with acepromazine for producing prolonged neuroleptanalgesia in wild Asian elephants. ANIMALS: Ten adult wild elephants (four males, six females), free-roaming in the jungles of the north-western province of Sri Lanka. MATERIALS AND METHODS: Ten wild elephants were tranquilized for attachment of radio transmitter collars from September to November 1997, using Large-Animal Immobilon (C-Vet Veterinary Products, Leyland, UK), which is a combination of etorphine (2.45 mg mL(-1)) and acepromazine (10 mg mL(-1)). This was injected using projectile syringes fired from a Cap-Chur gun (Palmer Chemical Co. Inc., Atlanta, USA). A volume of 3.3 (2.5-4.5) mL Immobilon (6.12-11.02 mg of etorphine and 25-45 mg acepromazine) was injected intramuscularly after body mass estimation of individual elephants. RESULTS: The body condition of all darted elephants was good, and the mean (minimum-maximum) shoulder height was 225 (180-310) cm. The average approximate distance to elephants at firing was 26 (15-50) m. The average time to recumbency after injection was 18 (15-45) minutes. Nine out of 10 elephants remained in lateral recumbency (and did not require additional dosing) for a period of 42 (28-61) minutes. The respiratory and heart rates during anaesthesia were 7 (4-10) breaths and 52 (40-60) beats minute(-1), respectively. An equal volume (8.15-14.67 mg) of diprenorphine hydrochloride (Revivon, 3.26 mg mL(-1) diprenorphine; C-Veterinary Products, Leyland, UK) was given intravenously when the procedure was completed. Recovery (return to standing position) occurred in 6 (2-12) minutes after diprenorphine injection. Immediately afterwards, all elephants slowly retreated into the jungle without

complications. Continuous radio tracking of the animals involved in this study indicated no post-operative mortality for several months after restraint. **CONCLUSIONS/CLINICAL RELEVANCE:** Etorphine-acepromazine combinations can be used safely in healthy wild Asian elephants for periods of restraint lasting up to 1 hour.

Descriptors: Asian elephant, *Elephas maximus*, acepromazine, anesthesia, anesthetics, analgesics, diprenorphine, drug combinations, etorphine, heart rate, neuroleptics, pharmacodynamics, respiration rate, telemetry.

Bechert, U., J.M. Christensen, C. Nguyen, R. Neelkant, and E. Bendas (2008). **Pharmacokinetics of orally administered phenylbutazone in African and Asian elephants (*Loxodonta africana* and *Elephas maximus*)**. *Journal of Zoo and Wildlife Medicine* 39(2): 188-200. ISSN: 1042-7260.

Online: <http://dx.doi.org/10.1638/2007-0139R.1>

Descriptors: African elephant, *Loxodonta africana*, Asian elephant, *Elephas maximus*, phenylbutazone, dosage effects, oral administration, species differences.

Indramani Nath, S.K. Panda, Jasmeet Singh, and P.K. Roy (2009). **Complication of immobilon-LA tranquilization in an Asian elephant (*Elephas maximus*)**. *Indian Journal of Veterinary Surgery* 30(1): 69. ISSN: 0254-4105.

Abstract: A captive male Asian elephant, 45 years old, showed excitement and uncontrollable behaviour on 16 August 2007. The behaviour caused damages to nearby villages and properties. Forest officials guided the animal back to the sanctuary. It was immediately hobbled and tethered securely. Then, the animal became aggressive and it was decided to tranquilize it using 4 ml Immobilon-LA. After darting, the animal became more excited, broke its chain and ate two bags of wheat and turmeric from a store by breaking its door. An antidote, 8 ml M 50-50 (Diprenorphine), was administered to the ear vein. The elephant died within 45 min. Postmortem examination revealed that the larynx was blocked with pasty wheat material. The oesophagus was filled with food materials and the lungs were congested. The heart was soft and flabby with blood clots inside the ventricles. The cause of death was respiratory blockage resulting from feeding during sedation. The excitation of the bull after darting as evidenced by breaking of the chain and eating of grains in semi-sedated condition resulted to choking and death of the elephant. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, aggression, animal behavior, case reports, mortality, neuroleptics.

Sarma, K.K., M. Sarma, and D.K. Sarma (2004). **Safety of repeated xylazine hydrochloride administrations in elephants**. *Indian Veterinary Journal* 81(8): 886-889. ISSN: 0019-6479.

NAL Call Number: 41.8 IN2

Descriptors: anesthesia, xylazine hydrochloride, repeated administration, elephants, safety, veterinary care.

[Back to Top](#)

[<< Table of Contents](#)

[<< Previous](#) | [Next >>](#)

Last Modified: Jan 23, 2014

Search AWIC

Go

- Search all USDA
- Advanced Search

Browse by Subject

- ▷ Research Animals
- ▷ Farm Animals
- ▷ Zoo, Circus and Marine Animals
- ▷ Companion Animals
- ▷ Government and Professional Resources
- ▷ Alternatives
- ▷ Literature Searching and Databases
- ▷ Pain and Distress
- ▷ Humane Endpoints and Euthanasia

You are here: [Home](#) / [Publications](#) / [Bibliographies and Resource Guides](#) / [Information Resources on Elephants](#) / [Asian Elephants - Behavior / Care / Enrichment / Handling / Training](#)

 [Printer Friendly Page](#)

Publications

Information Resources on Elephants

[<< Table of Contents](#)
[<< Previous](#) | [Next >>](#)

Asian Elephants

- [Anatomy / Histology / Physiology](#)
- [Anesthesia / Analgesia / Sedation / Capture](#)
- [Behavior / Care / Enrichment / Handling / Training](#)
- [Blood / Circulation / Cardiac / Hematology](#)
- [Communication / Vocal / Hearing](#)
- [Digestive / Food / Nutrition](#)
- [Diseases / Conditions](#)
- [Genetics / DNA](#)
- [Parasites](#)
- [Reproductive](#)
- [Research](#)
- [Veterinary](#)

Behavior / Care / Enrichment / Handling / Training

de Oliveira, C.A., G.D. West, R. Houck, and M. Leblanc (2004). **Control of musth in an Asian elephant bull (*Elephas maximus*) using leuprolide acetate.** *Journal of Zoo and Wildlife Medicine* 35(1): 70-6.

NAL Call Number: SF601.J6

Abstract: The results of long-term administration of leuprolide acetate (LA) depot in a 52-yr-old Asian elephant bull (*Elephas maximus*) for control of musth are presented. Twelve injections were administered for 6 yr during our interpretation of early musth or "premusth." Intervals between musth periods during the study varied from 2 to 34 mo. Blood samples, drawn weekly, were assayed for serum testosterone concentrations; mean levels were 11.78 +/- 1.97 nmol/L throughout the first 26 mo of the study, 7.28 +/- 1.28 nmol/L during the following 21 mo, and 0.45 +/- 0.035 nmol/L in the last 34 mo of this study. Early musth signs ceased within 3 days of drug administration after 10 of 12 injections. The mean serum testosterone concentrations were significantly decreased by the last 34 mo of the study. The results suggest leuprolide is a suitable alternative for controlling or preventing (or both) musth in captive Asian elephants, although permanent reproductive effects may occur. Zoos and wildlife conservation institutions could benefit from the use of LA in Asian elephants to increase the male availability in captivity, consequently ensuring genetic diversity and the perpetuation of the species.

Descriptors: drug effects behavior, physiology, gonadorelin agonists, leuprolide administration and dosage, drug effects on aggression, blood, drug effects on eliminative behavior, leuprolide pharmacology, drug effects on sex behavior, social dominance, testosterone.

Dumon, M., J. Stevens, and L. Van Elsacker (2003). **An elephantine problem? A study on elephant behaviour.** *Proceedings of the Fifth Annual Symposium on Zoo Research,*

Marwell Zoological Park, Federation of Zoological Gardens of Great Britain and Ireland, July 7, 2003, London, UK, p. 262-265. 342 p.

Descriptors: Asian elephant, *Elephas maximus*, aggressive behavior, female dominance, aggression in captivity, Belgium.

Dumonceaux, G. (2005). **Elephant behaviour**. In: *Small Animal and Exotics, Proceedings of the North American Veterinary Conference, January 8, 2005-January 12, 2005, Orlando, Florida, USA*, Gainesville, USA: Eastern States Veterinary Association, Vol. 19, p. 1413.

Descriptors: behavior, training, zoo elephants, *Elephas maximus*, *Loxodonta africana*, Asian elephants, African elephants, handling.

Elzanowski, A. and A. Sergiel (2006). **Stereotypic behaviour of a female Asiatic elephant (*Elephas maximus*) in a zoo**. *Journal of Applied Animal Welfare Science* 9(3): 223-232. ISSN: 1088-8705.

Online: http://dx.doi.org/10.1207/s15327604jaws0903_4

Abstract: This study recorded daytime behaviour of a female Asiatic elephant at the Municipal Zoo, Wroclaw, Poland, in both an indoor pen and an outdoor paddock as continuous scan sampling for 140 hr, over 35 days in 1 year. Stereotypic sequences involved bouts of highly repetitive stereotypic movements and much more variable interbout behaviour. The study found both stereotypic movements, nodding and body (corpus) swaying, were asymmetric, accompanied by protraction of the right hind leg and to-and-from swinging of the trunk. The elephant spent 52% of the daytime in stereotypic movements, 3.5 times the level reported for females in other zoos' groups. The share of time devoted to stereotypic behaviour was lowest in the summer when the elephant was regularly released to the paddock and highest in the late fall after she had stayed in the pen after months of days outside. This suggests that changes in the management routine enhance stereotypies. Comparing the summer and winter stable management periods, stereotypies were much more frequent in the indoor pen than the outdoor paddock, suggesting that the confinement to a barren pen contributed to the observed levels of stereotypies. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, animal behavior, animal housing, seasonality, stereotypic sequences.

Feng, L. and L. Zhang (2005). **Habitat selection by Asian elephant (*Elephas maximus*) in Xishuangbanna, Yunnan, China**. *Acta Theriologica Sinica* 25(3): 229-236. ISSN: 1000-1050.

Descriptors: Asian elephant, *Elephas maximus*, habitat preference, forest, woodland, bamboo, evergreen, broadleaf mixed forest, shrubland, grassland.

Language of Text: Chinese, with English summary.

Flach, E.J., L. Sambrook, W. Boardman, J. Dodds, R. Chaplin, T. Strike, and A. Routh (2007).

Hand rearing and growth of a female Asian elephant (*Elephas maximus*) calf.

Proceedings of the Institute for Zoo and Wildlife Research, Berlin(7): 187-190. ISSN: 1431-7338.

Abstract: An Asian elephant calf which failed to suck effectively was successfully hand reared to weaning. From one to seven months of age Salvana elephant milk formula was used as a supplementary feed (maximum intake 13 L per day) and then, from eight months until weaning at 18 months, SMA Gold human milk formula (maximum intake 22 L per day). The SMA Gold was supplemented with calcium and vitamins C and D. The calf was also exposed to UV light during its first winter. Daily intake of measured solids increased from seven to 14 months of age and this allowed a gradual reduction, and eventual removal, of milk from the diet. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, calves, case report, infant formula, milk composition, sucklings.

Freeman, E.W., E. Weiss, and J.L. Brown (2004). **Examination of the interrelationships of behavior, dominance status, and ovarian activity in captive Asian and African elephants**. *Zoo Biology* 23(5): 431-448. ISSN: 0733-3188.

NAL Call Number: QL77.5.Z6

Descriptors: ovarian activity, Asian elephants, African elephants, dominance status, behavior, interrelationships.

Greenwood, D.R., D. Comeskey, M.B. Hunt, and L.E. Rasmussen (2005). **Chemical communication: chirality in elephant pheromones**. *Nature* 438(7071): 1097-8.

NAL Call Number: 472 N21

Abstract: Musth in male elephants is an annual period of heightened sexual activity and aggression that is linked to physical, sexual and social maturation. It is mediated by the release of chemical signals such as the pheromone frontalin, which exists in two chiral forms (molecular mirror images, or enantiomers). Here we show that enantiomers of frontalin are released by Asian elephants in a specific ratio that depends on the animal's age and stage of musth, and that different responses are elicited in male and female conspecifics when the ratio alters. This precise control of communication by molecular chirality offers insight into societal interactions in elephants, and may be useful in implementing new conservation protocols.

Descriptors: heterocyclic chemistry of bicyclo compounds, heterocyclic pharmacology of

bicyclo compounds, physiology, pheromones chemistry, pheromones secretion, drug effects on animal sex behavior, aging physiology, heterocyclic metabolism of bicyclo compounds, pheromones pharmacology, sex behavior, animal physiology, stereoisomerism.

Isaza, R. and R.P. Hunter (2004). **Drug delivery to captive Asian elephants - treating Goliath.** *Current Drug Delivery* 1(3): 291-8.

Abstract: Captive Asian elephants have been maintained in captivity by humans for over 4000 years. Despite this association, there is little published literature on the treatment of elephant diseases or methods of drug administration to these animals. Elephants in captivity are generally healthy and require few therapeutic interventions over the course of their lifetime. However, when they become acutely ill, treatment becomes a serious issue. The successful and consistent administration of therapeutics to elephants is formidable in an animal that presents significant limitations in drug delivery options. The single most important factor in administering drugs to an elephant is the animal's cooperation in accepting the medication. Working around elephants can be very dangerous and this is magnified when working around sick or injured animals where the elephant is subject to increased stress, pain, and unusual situations associated with treatment. The large body size of the Asian elephant produces a separate set of issues. In this paper, methods of drug administration and their associated limitations will be reviewed. Considerations of medicating such large animals can serve to highlight the problems and principles of treatment that are inherent in these species.

Descriptors: zoo animal physiology, drug delivery system methods, drug administration routes, veterinary medicine methods.

Laws, N., A. Ganswindt, M. Heistermann, M. Harris, S. Harris, and C. Sherwin (2007). **A case study: fecal corticosteroid and behavior as indicators of welfare during relocation of an Asian elephant.** *Journal of Applied Animal Welfare Science* 10(4): 349-358. ISSN: 1088-8705.

Abstract: This study was a preliminary investigation of an enzyme immunoassay for measuring fecal glucocorticoid metabolites in a male Asian elephant (*Elephas maximus*) by investigating changes in behavior and cortisol metabolite excretion associated with a putative stressful event. The study collected fecal samples for 10 days prior to, and 10 days after, 24-hr transport and relocation of the elephant to a new herd. The study measured cortisol metabolites using 2 enzyme immunoassays indicating a 389% and 340% increase in cortisol metabolite excretion following relocation. Maximal cortisol metabolite excretion occurred 2 days after relocation and remained elevated during establishment of the new herd. Stereotypic behavior increased approximately 400% after relocation. The relocation disturbed sleep patterns, the elephant spent less time sleeping during the night, and the elephant slept standing up. These results provide preliminary evidence that noninvasive monitoring of fecal cortisol metabolites can be used to investigate adrenal activity in Asian elephants and may be a safe, practical, and accurate welfare indicator. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, animal behavior, animal welfare, case report, corticoids, excretion, feces, glucocorticoids, hydrocortisone, immunoassay.

Litchfield, P. (2005). **Leaders and matriarchs - a new look at elephant social hierarchies.** *International Zoo News* 52(6, No. 343): 338-339. ISSN: 0020-9155.

NAL Call Number: QL76.I58

Descriptors: Asian elephants, *Elephas maximus*, social hierarchy, observations, captive herd, wildlife park, England, Kent, observations, leaders, matriarchs.

Malhotra, A.K. and Manoj Kumar (2003). **Management of musth Indian elephant at National Zoological Park, New Delhi.** *Zoos' Print Journal* 18(10): 8. ISSN: 0971-6378.

Descriptors: Indian elephant, musth, behavior, management, case report, clinical aspects, zoo elephant, *Elephas maximus*, New Delhi.

Mallapur, A. and A. Ramanathan (2009). **Differences in husbandry and management systems across ten facilities housing Asian elephants *Elephas maximus* in India.** *International Zoo Yearbook* 43(1): 189-197. ISSN: 0074-9664.

Online: <http://dx.doi.org/10.1111/j.1748-1090.2008.00077.x>

NAL Call Number: QL76.I5

Abstract: A face-to-face questionnaire survey was conducted to document the husbandry and management systems followed by ten facilities housing Asian elephants *Elephas maximus* in India. Eighty-two Asian elephants at these ten facilities were surveyed between November 2004 and February 2005. A significantly greater percentage of the elephants managed by zoos (n=4 zoos; 13 elephants surveyed) and the forest elephant camp (n=1 forest elephant camp; five elephants surveyed) were housed in pairs or groups; whereas animals maintained by tourist camps (n=2 tourist camps; 40 elephants surveyed) and temples (n=3 temples; 24 elephants surveyed) were permanently restrained with minimal social contact (physical contact with other elephants). A considerably larger proportion of elephants from tourist camps and temples were housed in environments devoid of natural features, such as trees, shrubs and water bodies. Forest elephant camp and zoo elephants, on the other hand, were housed in complex species-specific environments, which included water bodies, trees/shrubs and a substrate

of compacted mud. From this paper, it is evident that the husbandry and management protocols vary significantly across the degrees of captivity, with some facilities (e.g. zoos and a forest elephant camp) being more conducive for housing elephants than others (e.g. temples and tourist camps). *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, zoos, India, forest elephant camps, husbandry, management, temples, tourist camps.

Martin, F. and C. Niemitz (2003). "**Right-trunkers" and "left-trunkers": side preferences of trunk movements in wild Asian elephants (*Elephas maximus*)**". *Journal of Comparative Psychology* 117(4): 371-9.

NAL Call Number: BF671.J6

Abstract: In this article, the side preferences of feeding-related trunk movements of free-ranging Asian elephants (*Elephas maximus*) were investigated for the first time. It is hypothesized that a functional asymmetry of the trunk is necessary to perform skillful feeding movements more efficiently. This might be connected with a corresponding hemispheric specialization. Video recordings of 41 wild elephants provided frequencies and durations of the following trunk-movement categories: object contact, retrieval, and reaching. In each category, individual side preferences were found. The strength of side preferences varied between the trunk-movement categories and the sexes. Mean durations of retrieval and reaching correlated negatively with the strength of side biases. Comparing the side preferences in the unpaired trunk with analogous phenomena in other unpaired grasping organs and in primate handedness, the authors discuss possible explanations for the evolution of asymmetries in unpaired grasping organs.

Descriptors: brain physiology, choice behavior, laterality physiology, movement, behavior, videotape recording.

Meller, C.L., C.C. Croney, and D. Shepherdson (2007). **Effects of rubberized flooring on Asian elephant behavior in captivity**. *Zoo Biology* 26(1): 51-61. ISSN: 0733-3188.

Online: <http://dx.doi.org/10.1002/zoo.20119>

Abstract: Six Asian elephants at the Oregon Zoo were observed to determine the effects of a poured rubber flooring substrate on captive Asian elephant behavior. Room utilization also was evaluated in seven rooms used for indoor housing, including Front and Back observation areas. Data were collected in three phases. Phase I (Baseline Phase) examined elephant behavior on old concrete floors. In Phase II (Choice Phase), elephant behavior was observed in the Back observation area where room sizes were comparable and when a choice of flooring substrates was available. Phase III (Final Phase) examined elephant behavior when all rooms in both observation areas, Front and Back, were converted to rubberized flooring. Room use in both observation areas remained stable throughout the study, suggesting that flooring substrate did not affect room use choice. However, there was a clear pattern of decreased discomfort behaviors on the new rubber flooring. Normal locomotion as well as stereotypic locomotion increased on the new rubber flooring. In addition, resting behavior changed to more closely reflect the resting behavior of wild elephants, which typically sleep standing up, and spend very little time in lateral recumbence. Overall, these findings suggest that the rubber flooring may have provided a more comfortable surface for locomotion as well as standing resting behavior. It is suggested that poured rubber flooring may be a beneficial addition to similar animal facilities. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, animal behavior, animal welfare, floors, locomotion, rubber, zoo animals, zoological gardens.

Menargues, A., V. Urios, and M. Mauri (2008). **Welfare assessment of captive Asian elephants (*Elephas maximus*) and Indian rhinoceros (*Rhinoceros unicornis*) using salivary cortisol measurement**. *Animal Welfare* 17(3): 305-312. ISSN: 0962-7286.

Abstract: The measurement of salivary cortisol allows non invasive assessment of welfare in captive animals. We utilised this technique to test the effect of zoo opening on six Asian elephants and two Indian rhinoceros at the Terra Natura Zoological Park, Alicante, Spain, during pre opening, opening and post opening periods. Salivary cortisol concentrations were found to be significantly higher during the opening period than during pre and post opening periods for both species. This method could prove a useful tool in monitoring the success of decisions taken to improve the welfare of captive animals. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, animal welfare assessment, cortisol measurement, zoo animals, Indian Rhinoceros, *Rhinoceros unicornis*.

Moss, A., D. Francis, and M. Esson (2008). **The relationship between viewing area size and visitor behavior in an immersive Asian elephant exhibit**. *Visitor Studies* 11(1): 26-40. ISSN: 1064-5578.

Online: <http://dx.doi.org/10.1080/10645570801938418>

Abstract: Immersive exhibits are increasingly popular in zoos, being seen as benefiting both animals and visitors. Multiple, discreet viewing areas are one of the key features of immersive zoo exhibits. Small, discreet viewing areas afford the visitor a very personal and intimate experience and may promote an affiliative response between the visitor and the animals on display, thus enhancing the immersive experience. This investigation sought to determine the effect of these viewing areas on visitor behavior, particularly in

exhibits where the same animals could be viewed from different-sized viewing areas. This study in the Elephants of the Asian Forest exhibit at Chester Zoo, used unobtrusive visitor tracking to investigate how visitors behave at the exhibit's different-sized viewing areas. The results show that visitors are much more likely to stop, and stay for longer, at the largest viewing areas. Furthermore, there appears to be a proportional increase in visitor interest with increasing viewing area size. These findings have implications for zoo exhibit designers, particularly on the order in which viewing areas should be positioned.

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Descriptors: Asian elephant, *Elephas maximus*, animal exhibits, spatial distribution, visitor behavior, zoo animals.

Nissani, M. (2006). **Do Asian elephants (*Elephas maximus*) apply causal reasoning to tool-use tasks?** *Journal of Experimental Psychology. Animal Behavior Processes* 32(1): 91-6.

NAL Call Number: QL750.J682

Descriptors: tool use, causal reasoning, associative learning, food reward, clinical trials.

Nissani, M., D. Hoeffler Nissani, U.T. Lay, and U.W. Htun (2005). **Simultaneous visual discrimination in Asian elephants.** *Journal of the Experimental Analysis of Behavior* 83(1): 15-29.

Abstract: Two experiments explored the behavior of 20 Asian elephants (*Elephas aximus*) in simultaneous visual discrimination tasks. In Experiment 1, 7 Burmese logging elephants acquired a white+/black- discrimination, reaching criterion in a mean of 2.6 sessions and 117 discrete trials, whereas 4 elephants acquired a black+/white-discrimination in 5.3 sessions and 293 trials. One elephant failed to reach criterion in the white+/black- task in 9 sessions and 549 trials, and 2 elephants failed to reach criterion in the black+/white- task in 9 sessions and 452 trials. In Experiment 2, 3 elephants learned a large/small transposition problem, reaching criterion within a mean of 1.7 sessions and 58 trials. Four elephants failed to reach criterion in 4.8 sessions and 193 trials. Data from both the black/white and large/small discriminations showed a surprising age effect, suggesting that elephants beyond the age of 20 to 30 years either may be unable to acquire these visual discriminations or may require an inordinate number of trials to do so. Overall, our results cannot be readily reconciled with the widespread view that elephants possess exceptional intelligence.

Descriptors: discrimination psychology, visual perception, aging, behavior, cognition, visual acuity.

Oliveira, C.A. de, G.D. West, R. Houck, and M. Leblanc (2004). **Control of musth in an Asian elephant bull (*Elephas maximus*) using leuprolide acetate.** *Journal of Zoo and Wildlife Medicine* 35(1): 70-76. ISSN: 1042-7260.

NAL Call Number: SF601.J6

Descriptors: Asian elephant, bull, musth, behavior, testosterone, control, leuprolide acetate, *Elephas maximus*.

Pan WenJing, Lin Liu, Luo AiDong, and Zhang Li (2009). **Corridor use by Asian elephants.** *Integrative Zoology* 4(2): 220-231. ISSN: 1749-4869.

Online: <http://dx.doi.org/10.1111/j.1749-4877.2009.00154.x>

Abstract: There are 18 km of Kunming-Bangkok Highway passing through the Mengyang Nature Reserve of Xishuangbanna National Nature Reserve in Yunnan Province, China. From September 2005 to September 2006 the impact of this highway on movement of wild Asian elephants between the eastern and western part of the nature reserve was studied using track transecting, rural surveys and direct monitoring. Our results showed that the number of crossroad corridors used by Asian elephants diminished from 28 to 23 following the construction of the highway. In some areas, the elephant activity diminished or even disappeared, which indicated a change in their home ranges. The utilization rate of artificial corridors was 44%. We also found that elephants preferred artificial corridors that were placed along their original corridors. During the research, wild elephants revealed their adaptation to the highway. They were found walking across the highway road surface many times and for different reasons. We suggest that the highway management bureau should revise their management strategies to mitigate the potential risks caused by elephants on the road for the safety of the public and to protect this endangered species from harm. It is also very important to protect and maintain current Asian elephants corridors in this region. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, wild animals, wildlife management, conservation.

Plotnik, J.M., F.B.M.d. Waal, and D. Reiss (2006). **Self-recognition in an Asian elephant.** *Proceedings of the National Academy of Sciences of the United States of America* 103(45): 17053-17057. ISSN: 0027-8424.

Online: <http://dx.doi.org/10.1073/pnas.0608062103>

Abstract: Considered an indicator of self-awareness, mirror self-recognition (MSR) has long seemed limited to humans and apes. In both phylogeny and human ontogeny, MSR is thought to correlate with higher forms of empathy and altruistic behaviour. Apart from humans and apes, dolphins and elephants are also known for such capacities. After the recent discovery of MSR in dolphins (*Tursiops truncatus*), elephants thus were the next logical candidate species. We exposed three Asian elephants (*Elephas maximus*) to a

large mirror to investigate their responses. Animals that possess MSR typically progress through four stages of behaviour when facing a mirror: (i) social responses, (ii) physical inspection (e.g., looking behind the mirror), (iii) repetitive mirror-testing behaviour, and (iv) realization of seeing themselves. Visible marks and invisible sham-marks were applied to the elephants' heads to test whether they would pass the litmus "mark test" for MSR in which an individual spontaneously uses a mirror to touch an otherwise imperceptible mark on its own body. Here, we report a successful MSR elephant study and report striking parallels in the progression of responses to mirrors among apes, dolphins, and elephants. These parallels suggest convergent cognitive evolution most likely related to complex sociality and cooperation. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, animal behavior, awareness, cognitive development, mental ability, mirrors, social behavior.

Rasmussen, L., V. Krishnamurthy, and R. Sukumar (2005). **Behavioural and chemical confirmation of the preovulatory pheromone, (Z) -7-dodecenyl acetate, in wild Asian elephants: its relationship to musth.** *Behaviour* 142(3): 351-396. ISSN: 0005-7959.

NAL Call Number: 410 B393

Descriptors: Asian elephant, *Elephas maximus*, age, reproductive behavior, musth, mating strategies, female preovulatory hormone, pheromones, preovulatory urinary hormone, social behavior, India, preovulatory hormone identification, male chemosensory responses.

Rees, P.A. (2009). **Activity budgets and the relationship between feeding and stereotypic behaviors in Asian elephants (*Elephas maximus*) in a Zoo.** *Zoo Biology* 28(2): 79-97. ISSN: 0733-3188.

Online: <http://dx.doi.org/10.1002/zoo.20200>

Abstract: Activity budgets were studied in eight Asian elephants (*Elephas maximus*) at Chester Zoo (UK) for 35 days, between January and November 1999. Recordings were made between 10:00 and 16:00 hr (with most behavior frequencies calculated between 10:00 and 14:00 hr). The elephants exhibited variation in activity depending on their age, sex, the time of day and the time of year. Only the five adult cows exhibited stereotypic behavior, with frequencies ranging from 3.9 to 29.4% of all observations. These elephants exhibited individual, diurnal and seasonal variation in stereotypic behavior. This has implications for studies that use short sampling periods and may make comparisons of data collected at different times of the day or year invalid. The six adult elephants spent 27.4-41.4% of the time feeding (between 10:00 and 14:00 hr), 22.9-42.0% standing still, 6.1-19.2% walking and 3.9-9.6% dusting. The hypothesis that the frequency of stereotypic behavior in adult cow elephants was negatively correlated with the frequency of feeding behavior was tested and was found to be true. Stereotypic behavior increased in frequency toward the end of the day - while waiting to return to the elephant house for food - and elephants spent more time stereotyping during the winter months than during the summer months. Elephants were inactive (i.e. exhibited behaviors other than locomotion) for between 70.1 and 93.9% of the time. Creating more opportunities for elephants to exhibit foraging behavior and the introduction of greater unpredictability into management regimes, especially feeding times, may reduce the frequency of stereotypic behavior and increase general activity levels. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, animal behavior, activity budgets, feeding, seasonal variation, zoo animals.

Rees, P.A. (2004). **Low environmental temperature causes an increase in stereotypic behaviour in captive Asian elephants (*Elephas maximus*).** *Journal of Thermal Biology* 29(1): 37-43. ISSN: 0306-4565.

NAL Call Number: QP82.2.T4J6

Descriptors: captive Asian elephants, behavior, low environmental temperature, stress, stress response, stereotypic behavior, *Elephas maximus*.

Rees, P.A. (2004). **Some preliminary evidence of the social facilitation of mounting behavior in a juvenile bull Asian elephant (*Elephas maximus*).** *Journal of Applied Animal Welfare Science* 7(1): 49-58.

NAL Call Number: HV4701.J68

Abstract: This study recorded sexual behavior within a captive herd of 8 Asian elephants for approximately 230 hr on 50 days over a period of 10 months. The study observed a single adult and a single juvenile bull mounting cows more than 160 times. When the juvenile bull was between 4 years, 2 months and 4 years, 8 months old, he exhibited mounting behavior only on days when adult mounting occurred. Adult mounting always occurred first. Beyond the age of 4 years, 8 months, the juvenile bull exhibited spontaneous mounting behavior in the absence of adult mounting. This suggests that mounting behavior may develop because of social facilitation. Determining the significance of the presence of sexually active adults in the normal development of sexual behavior in juveniles will require further studies. Encouraging the establishment of larger captive herds containing adults and calves of both sexes-if their presence is important-would improve the welfare of elephants in zoos and increase their potential conservation

value.

Descriptors: sex behavior, social environment, zoo animals.

Rees, P. (2004). **Unreported appeasement behaviours in the Asian elephant (*Elephas maximus*)**. *Journal of the Bombay Natural History Society* 101(1): 71-78. ISSN: 0006-6982.

NAL Call Number: 513 B63

Descriptors: Asian elephant, *Elephas maximus*, agonistic behavior, submissive behavior, captive population, adult bull, cows. bow down, musth.

Rees, P.A. (2009). **Activity budgets and the relationship between feeding and stereotypic behaviors in Asian elephants (*Elephas maximus*) in a Zoo**. *Zoo Biology* 28(2): 79-97. ISSN: 0733-3188.

Online: <http://dx.doi.org/10.1002/zoo.20200>

NAL Call Number: QL77.5.Z6

Abstract: Activity budgets were studied in eight Asian elephants (*Elephas maximus*) at Chester Zoo (UK) for 35 days, between January and November 1999. Recordings were made between 10:00 and 16:00 hr (with most behavior frequencies calculated between 10:00 and 14:00 hr). The elephants exhibited variation in activity depending on their age, sex, the time of day and the time of year. Only the five adult cows exhibited stereotypic behavior, with frequencies ranging from 3.9 to 29.4% of all observations. These elephants exhibited individual, diurnal and seasonal variation in stereotypic behavior. This has implications for studies that use short sampling periods and may make comparisons of data collected at different times of the day or year invalid. The six adult elephants spent 27.4-41.4% of the time feeding (between 10:00 and 14:00 hr), 22.9-42.0% standing still, 6.1-19.2% walking and 3.9-9.6% dusting. The hypothesis that the frequency of stereotypic behavior in adult cow elephants was negatively correlated with the frequency of feeding behavior was tested and was found to be true. Stereotypic behavior increased in frequency toward the end of the day--while waiting to return to the elephant house for food--and elephants spent more time stereotyping during the winter months than during the summer months. Elephants were inactive (i.e. exhibited behaviors other than locomotion) for between 70.1 and 93.9% of the time. Creating more opportunities for elephants to exhibit foraging behavior and the introduction of greater unpredictability into management regimes, especially feeding times, may reduce the frequency of stereotypic behavior and increase general activity levels. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, zoo animals, animal behavior, diurnal variation, seasonal variation, feeding behavior, stereotyped behavior, animal age, gender differences.

Rees, P.A. (2003). **Early experience of sexual behaviour in Asian elephants**. *International Zoo News* 50(4): 200-206; No 325. ISSN: 0020-9155.

NAL Call Number: QL76.I58

Descriptors: Asian elephant, *Elephas maximus*, reproductive behavior, early experience of sexual behavior, captive observations.

Roocroft, A. (2005). **Indoors natural substrates for elephants & medical issues associated with hard surfaces**. *Animal Keepers' Forum* 32(10): 480-492. ISSN: 0164-9531.

NAL Call Number: QL77.5.A54

Descriptors: Elephantidae, housing techniques, indoor natural substrates, medical issues associated with hard surfaces, treatment techniques, injuries.

Slade Cain, B.E., L.E.L. Rasmussen, and B.A. Schulte (2008). **Estrous state influences on investigative, aggressive, and tail flicking behavior in captive female Asian elephants**. *Zoo Biology* 27(3): 167-180. ISSN: 0733-3188.

Online: <http://dx.doi.org/10.1002/zoo.20181>

NAL Call Number: QL77.5.Z6

Abstract: Females of species that live in matrilineal hierarchies may compete for temporally limited resources, yet maintain social harmony to facilitate cohesion. The relative degree of aggressive and nonaggressive interactions may depend on the reproductive condition of sender and receiver. Individuals can benefit by clearly signaling and detecting reproductive condition. Asian elephants (*Elephas maximus*) live in social matrilineal herds. Females have long estrous cycles (14-16 weeks) composed of luteal (8-12 weeks) and follicular (4-8 weeks) phases. In this study, we observed the behavior of four captive Asian elephant females during multiple estrous cycles over 2 years. We evaluated whether investigative, aggressive, and tail flicking behaviors were related to reproductive condition. Investigative trunk tip contacts showed no distinct pattern by senders, but were more prevalent toward female elephants that were in their follicular compared with their luteal phase. The genital area was the most frequently contacted region and may release reproductively related chemosignals. Aggression did not differ significantly with estrus; however, rates of aggression were elevated when senders were approaching ovulation and receivers were in the luteal phase. Females in the follicular phase may honestly advertise their condition. Contacts by conspecifics may serve to assess condition and reduce aggression. A behavior termed "tail flicking" was performed mainly during the mid-follicular phase when estrogen and luteinizing hormone levels are

known to spike. Tail flicking may disperse chemical signals in urine or mucus as well as act as a tonic signal that could provide a means of anticipating forthcoming ovulation by elephants and also for human observers and caretakers. Reproduced with Permission from CAB Abstracts.

Descriptors: Asian elephant, *Elephas maximus*, estrous cycle, estrus, ovulation, animal behavior, social behavior, aggression, tail, touch, animal communication, zoo animals, follicular phase, luteal phase, female behavior, investigative behavior, tactile behavior.

Swain, D. and L.K. Singh (2003). **Musth in female asian elephant.** *Zoos' Print Journal* 18(9): 1202.

Descriptors: Asian elephant, female, reproduction, musth.

Vodicka, R. and J. Kral (2003). **Purulent trunk dermatitis in a male Ceylon elephant (*Elephas maximus maximus*).** In: *Erkrankungen der Zootiere: Verhandlungsbericht des 41 Internationalen Symposiums über die Erkrankungen der Zoo und Wildtiere, May 1, 1928-June 1, 2003, Rome, Italy*, Vol. 5, p. 151-153.

NAL Call Number: SF996.15

Descriptors: Asian elephant, trunk, purulent dermatitis, pyoderma, skin diseases, treatment, aggressive male, anesthesia, handling, *Elephas maximus*.

[Back to Top](#)

[<< Table of Contents](#)

[<< Previous](#) | [Next >>](#)

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[Home](#)[About AWIC](#)[Publications](#)[Workshops](#)[Services](#)[News and Events](#)[Help](#)[Contact Us](#)

Search AWIC

Go

- Search all USDA
- Advanced Search

Browse by Subject

- ▷ Research Animals
- ▷ Farm Animals
- ▷ Zoo, Circus and Marine Animals
- ▷ Companion Animals
- ▷ Government and Professional Resources
- ▷ Alternatives
- ▷ Literature Searching and Databases
- ▷ Pain and Distress
- ▷ Humane Endpoints and Euthanasia

 You are here: [Home](#) / [Publications](#) / [Bibliographies and Resource Guides](#) / [Information Resources on Elephants](#) / [Asian Elephants - Blood / Circulation / Cardiac / Hematology](#)
 [Printer Friendly Page](#)

Publications

Information Resources on Elephants

[<< Table of Contents](#)[>> Previous](#) | [Next >>](#)

Asian Elephants

- [Anatomy / Histology / Physiology](#)
- [Anesthesia / Analgesia / Sedation / Capture](#)
- [Behavior / Care / Enrichment / Handling / Training](#)
- [Blood / Circulation / Cardiac / Hematology](#)
- [Communication / Vocal / Hearing](#)
- [Digestive / Food / Nutrition](#)
- [Diseases / Conditions](#)
- [Genetics / DNA](#)
- [Parasites](#)
- [Reproductive](#)
- [Research](#)
- [Veterinary](#)

Blood / Circulation / Cardiac / Hematology

Duggan, N., B. Beaumont, L. Calder, and M. Merrilees (2004). **Structural adaptations to naturally occurring high blood pressure: a study of collagen, elastin and versican in the aorta and coronary arteries of the Asian elephant (*Elephas maximus*)**. *Anatomical Science International* 79(August): 293. ISSN: 1447-6959.

Descriptors: blood, circulation, electron microscopy, imaging, light microscopy, high blood pressure, collagen, elastin, aorta, coronary arteries.

Endo, H., T. Sakai, T. Itou, H. Koie, and J. Kimura (2005). **Macroscopic observation and CT examination of the heart ventricular walls in the Asian elephant**. *Mammal Study* 30(2): 125-130. ISSN: 1343-4152.

Descriptors: heart, ventricular walls, cardiovascular system, circulation, CT scanning, microscopy, imaging, examination, Asian elephant, structure.

Hama, N., A. Yamada, A. Noda, K. Murata, Y. Shimada, M. Ashida, K.M.Y. Ishikawa, and K. Okuno (2003). **Serum hormonal changes in a female Asian elephant (*Elephas maximus*) with stillbirth**. *Japanese Journal of Zoo and Wildlife Medicine* 8(2): 109-113. ISSN: 1342-6133.

Descriptors: Asian elephant, female, hormonal changes, seasonal, stillbirth, serum, progesterone, estradiol, prolactin, radioimmunoassay, RIA.

Language of Text: Japanese, with English summary.

Isaza, R., B.J. Behnke, J.K. Bailey, P. McDonough, N.C. Gonzalez, and D.C. Poole (2003). **Arterial blood gas control in the upright versus recumbent Asian elephant**. *Respiratory Physiology and Neurobiology* 134(2): 169-76.

NAL Call Number: QP121.A1R4

Abstract: In the elephant, there is concern that lateral recumbency (LR) impairs

respiratory muscle and lung function resulting in clinically significant arterial hypoxemia. Using healthy adult female Asian elephants (*Elephas maximus*, n=6), the hypothesis was tested that, given the O₂ binding characteristics of elephant blood, substantial reductions in arterial O₂ pressure (Pa(O₂)) in LR could be tolerated without lowering arterial O₂ content appreciably. Fifteen minutes of LR decreased Pa(O₂) from 103+/-2 (upright, U) to 77+/-4 mmHg (P<0.05) and hemoglobin O₂ saturation (U, 97.8+/-0.1, LR, 95.3+/-0.5%, P<0.05). However, due to a recumbency-induced hemoconcentration, arterial O₂ content was unchanged (U, 18.2+/-2.4, LR, 18.3+/-2.1 ml O₂ per 100 ml). In addition, there was a mild hyperventilation in LR that reduced arterial CO₂ pressure (P(CO₂)) from 39.4+/-0.3 to 37.1+/-1.0 mmHg (P<0.05). These data indicate that the Asian elephant can endure at least short periods of LR without lowering arterial O₂ content.

Descriptors: acid base equilibrium physiology, anoxemia, blood pressure physiology, posture physiology, anoxemia blood, arteries, blood gas analysis.

Rezaian, M. and S. Yamashiro (2005). **Comparison between elephant and bovine platelet ultra structure.** *Indian Journal of Animal Sciences* 75(3): 267-270. ISSN: 0367-8318.

NAL Call Number: 41.8 IN22

Descriptors: Asian elephant, bovine platelet, ultra structure, elephant platelets, comparison, discoid shape.

Sabapara, R., D. Bhayani, and R. Jani (2004). **Morphometric study of blood cells of Indian elephants (*Elephas maximus*).** *Zoos' Print Journal* 19(1): 1330.

Descriptors: Asian elephant, *Elephas maximus*, size, blood cell diameter, blood cells described, morphometrics.

Salakij, J., C. Salakij, N.A. Narkkong, S. Apibal, P. Suthunmapinuntra, J. Rattanakukuprakarn, G. Nunklang, and M. Yindee (2005). **Hematology, cytochemistry and ultrastructure of blood cells from Asian elephant (*Elephas maximus*).** *Kasetsart Journal, Natural Sciences* 39(3): 482-493. ISSN: 0075-5192.

Abstract: The blood cells from 14 adult Asian elephants were examined and cytochemically stained with Sudan Black B (SBB), peroxidase, periodic acid Schiff's reaction (PAS), anaphthyl acetate esterase (ANAE) and beta -glucuronidase (beta -glu). The complete blood counts were performed using an automated cell counter. Insignificant differences were observed in almost all the hematological values between the male and female elephants, except the leukocyte count and fibrinogen concentration which were higher and lower, respectively, in the males than in the females. The neutrophils had poorly segmented nuclei and many well-differentiated granules. The neutrophils stained strongly positive to SBB, faintly stained with PAS, focal dot stained to ANAE and beta -glu. Eosinophils contained 2-3 lobed nuclei and numerous small, round, red-refractive granules with some vacuoles. The eosinophils stained moderately positive to SBB and strongly positive to ANAE but negative to beta -glu. The basophils had variable number of intense granules which did not obscure the lobed nuclei. The basophils were negative for SBB but moderately positive to ANAE and beta -glu. Monocytes stained moderately positive to SBB and moderately to strongly positive to ANAE and beta -glu. The bilobed cells stained moderately positive to SBB and strongly positive for ANAE and beta -glu which were similar to monocytes. Ultrastructurally, they contained a large number of mitochondria similar to those of monocytes, except the shape of the nuclei. The number of bilobed cells exceeded the number of the other leukocytes. Scanning electron microscopy revealed the surfaces of all blood cells. Transmission electron microscopy revealed organelles within erythrocytes, platelets and all leukocytes especially bilobed cells. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, basophils, blood cells, cell ultrastructure, cytochemistry, eosinophils, erythrocytes, fibrinogen, hematology, leukocyte count, mitochondria, monocytes, neutrophils, nuclei, organelles, platelets, sex differences.

[Back to Top](#)

[<< Table of Contents](#)

[<< Previous](#) | [Next >>](#)

Last Modified: Jan 23, 2014



Search AWIC

Go

- Search all USDA
- Advanced Search

Browse by Subject

- ▷ Research Animals
- ▷ Farm Animals
- ▷ Zoo, Circus and Marine Animals
- ▷ Companion Animals
- ▷ Government and Professional Resources
- ▷ Alternatives
- ▷ Literature Searching and Databases
- ▷ Pain and Distress
- ▷ Humane Endpoints and Euthanasia

You are here: [Home](#) / [Publications](#) / [Bibliographies and Resource Guides](#) / [Information Resources on Elephants](#) / [Asian Elephants - Communication / Vocal / Hearing](#)

[Printer Friendly Page](#)

Publications

Information Resources on Elephants

[<< Table of Contents](#)

[<< Previous](#) | [Next >>](#)

Asian Elephants

- [Anatomy / Histology / Physiology](#)
- [Anesthesia / Analgesia / Sedation / Capture](#)
- [Behavior / Care / Enrichment / Handling / Training](#)
- [Blood / Circulation / Cardiac / Hematology](#)
- [Communication / Vocal / Hearing](#)
- [Digestive / Food / Nutrition](#)
- [Diseases / Conditions](#)
- [Genetics / DNA](#)
- [Parasites](#)
- [Reproductive](#)
- [Research](#)
- [Veterinary](#)

Communication / Vocal / Hearing

Garstang, M. (2004). **Long-distance, low-frequency elephant communication.** *Journal of Comparative Physiology. A, Neuroethology, Sensory, Neural, and Behavioral Physiology* 190(10): 791-805.

NAL Call Number: QP33.68

Descriptors: communication, physiology, auditory threshold, hearing physiology, sex behavior, social behavior, sound, sound localization, vocalization, weather.

Garstang, M. (2005). **Long-distance, low-frequency elephant communication (vol 190, pg 791, 2004).** *Journal of Comparative Physiology A Neuroethology Sensory Neural and Behavioral Physiology* 191(3): 299. ISSN: 0340-7594.

NAL Call Number: QP33.68

Descriptors: long distance communication, low frequency communication.

[Back to Top](#)

[<< Table of Contents](#)

[<< Previous](#) | [Next >>](#)

Last Modified: Jan 23, 2014

Search AWIC

Go

- Search all USDA
- Advanced Search

Browse by Subject

- ▷ Research Animals
- ▷ Farm Animals
- ▷ Zoo, Circus and Marine Animals
- ▷ Companion Animals
- ▷ Government and Professional Resources
- ▷ Alternatives
- ▷ Literature Searching and Databases
- ▷ Pain and Distress
- ▷ Humane Endpoints and Euthanasia

You are here: [Home](#) / [Publications](#) / [Bibliographies and Resource Guides](#) / [Information Resources on Elephants](#) / [Asian Elephants - Digestive / Food / Nutrition](#)

 [Printer Friendly Page](#)

Publications

Information Resources on Elephants

[<< Table of Contents](#)
[<< Previous](#) | [Next >>](#)

Asian Elephants

- [Anatomy / Histology / Physiology](#)
- [Anesthesia / Analgesia / Sedation / Capture](#)
- [Behavior / Care / Enrichment / Handling / Training](#)
- [Blood / Circulation / Cardiac / Hematology](#)
- [Communication / Vocal / Hearing](#)
- [Digestive / Food / Nutrition](#)
- [Diseases / Conditions](#)
- [Genetics / DNA](#)
- [Parasites](#)
- [Reproductive](#)
- [Research](#)
- [Veterinary](#)

Digestive / Food / Nutrition

Ashoka Dangolla, A.G. Malitha, and Indira Silva (2004). **Mineral status in blood serum of domesticated elephants (*Elephas maximus*) and certain plants of Sri Lanka.** *Zoos' Print Journal* 19(7): 1549-1550. ISSN: 0971-6378.

Descriptors: bark, blood serum, calcium, coconuts, jackfruits, leaves, magnesium, mineral deficiencies, nutritional state, nutritive value, phosphorus, potassium, sodium, *Artocarpus heterophyllus*, *Caryota urens*, *Cocos nucifera*, *Elephas maximus*, coconut, jak, kitul, ear vein.

Clauss, M., W. Loehlein, E. Kienzle, and H. Wiesner (2003). **Studies on feed digestibilities in captive Asian elephants (*Elephas maximus*).** *Journal of Animal Physiology and Animal Nutrition* 87(3-4): 160-73.

NAL Call Number: 389.78 Z3

Abstract: In order to test the suitability of the horse as a nutritional model for elephants, digestibility studies were performed with six captive Asian elephants on six different dietary regimes, using the double marker method with acid detergent lignin as an internal and chromium oxide as an external digestibility marker. Elephants resembled horses in the way dietary supplements and dietary crude fibre content influenced digestibility, in calcium absorption parameters and in faecal volatile fatty acid composition. However, the absolute digestibility coefficients achieved for all nutrients are distinctively lower in elephants. This is because of much faster ingesta passage rates reported for elephants. No answer is given to why elephants do not make use of their high digestive potential theoretically provided by their immense body weight. Differences in volatile fatty acid concentrations between these captive elephants and those reported from elephants from the wild are in accord with a reported high dependence of free-ranging elephants on browse forage.

Descriptors: animal nutrition, dietary fiber metabolism, digestion, elephant metabolism,

animal feed, zoo animals, biological markers analysis, fatty acids, volatile analysis, feces chemistry, gastrointestinal transit physiology, lignin metabolism, animal models.

Clauss, M., Y. Wang, K. Ghebremeskel, C.E. Lendl, and W.J. Streich (2003). **Plasma and erythrocyte fatty acids in captive Asian (*Elephas maximus*) and African (*Loxodonta africana*) elephants.** *Veterinary Record* 153(2): 54-8.

NAL Call Number: 41.8 V641

Abstract: The fatty acid components of the plasma triglycerides and the phospholipid fractions of the red blood cells of a captive group of two African (*Loxodonta africana*) and four Asian (*Elephas maximus*) elephants were investigated. All the animals received the same diet of hay, fruits and vegetables, and concentrates. A comparison with data from free-ranging African elephants or Asian work-camp elephants showed that the captive elephants had lower proportions of polyunsaturated fatty acids (PUFAs), and for several lipid fractions a higher n-6:n-3 ratio, than their counterparts in the wild or under the more natural, in terms of diet, work-camp conditions. The difference in PUFA content was smaller in the African than in the Asian elephants. The captive Asian elephants tended to have lower levels of n-3 and total unsaturated fatty acids in their red blood cells than the captive African elephants.

Descriptors: metabolism, erythrocytes metabolism, unsaturated metabolism fatty acids, phospholipids metabolism, triglycerides metabolism, zoo animals, blood chemical analysis, diet, blood, unsaturated blood fatty acids, triglycerides blood, workload.

Groendahl Nielsen, C. (2004). **Drunken Asian elephants (*Elephas maximus*) from ryegrass hay.** *Proceedings: American Association of Zoo Veterinarians, American Association of Wildlife Veterinarians, Wildlife Disease Association: Health and Conservation of Captive and Free-Ranging Wildlife. Joint Conference, August 28, 2004-September 3, 2004, San Diego, California, American Association of Zoo Veterinarians:* p. 372-373. 660 p.

Descriptors: Asian elephant, *Elephas maximus*, diet, ryegrass hay, diseases, disorders, ethanol intoxication, ataxia associated with ryegrass hay, captivity, drunken elephants.

Pradhan, N.M.B., P. Wegge, and S.R. Moe (2007). **How does a recolonizing population of Asian elephants affect the forest habitat.** *Journal of Zoology* 273(2): 183-191. ISSN: 0952-8369; Online: 1469-7998.

Online: <http://dx.doi.org/10.1111/j.1469-7998.2007.00313.x>

NAL Call Number: QL1.J68

Abstract: The Asian elephant *Elephas maximus* is currently re-colonizing the Bardia National Park in lowland Nepal. We studied their impact on woody vegetation in the nutrient-rich floodplain and in the relatively nutrient-poor sal forest. The types and extent of tree impact were recorded along fixed-width transects (335 km). Species composition, density and size classes ≥ 8 cm diameter breast height (dbh) were recorded in 15-m radius random plots (n=95). Impact was higher in the floodplain complex than in the sal-dominated forest. Our hypothesis that elephants were more selective on species in the nutrient-poor sal forest was only partly supported; the niche breadth of impacted trees was slightly higher in the floodplain complex. Pushed-over trees accounted for the highest proportion of impact (55%), followed by killed trees (39%). Of the pushed trees, 10% were not used for food. Among food trees, elephants selectively impacted size class 12-16 cm dbh, whereas non-food trees were impacted independently of size. A large proportion of the freshly browsed trees had been felled previously, indicating that most felled trees survived, enabling elephants to feed on them again. This may reflect an evolutionary adaptation among long-lived species with high site fidelity. Owing to preferential use but low abundance, two species in sal forest, *Grewia* spp. and *Desmodium oojeinense*, were found to be particularly vulnerable to local extinction due to elephants. Although the elephants had impacted a large number of species (62, 73% of all), 56.4% of the impacted trees consisted of *Mallotus philippinensis*. A recently observed increase in the density of *M. philippinensis* and the concurrent reduction of the hardly utilized *Shorea robusta* indicates that the rapidly growing elephant population may modify the composition of the forest by increasing its preferred food species. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, Asia, Nepal, alluvial-floodplain, *Mallotus philippinensis*, megaherbivores, sal forest, tree impact.

Pradhan, N.M.B., P. Wegge, S.R. Moe, and A.K. Shrestha (2008). **Feeding ecology of two endangered sympatric megaherbivores: Asian elephant *Elephas maximus* and greater one horned rhinoceros *Rhinoceros unicornis* in lowland Nepal.** *Wildlife Biology* 14(1): 147-154. ISSN: 0909-6396.

Online: [http://dx.doi.org/10.2981/0909-6396\(2008\)14\[147:FEOTES\]2.0.CO;2](http://dx.doi.org/10.2981/0909-6396(2008)14[147:FEOTES]2.0.CO;2)

Abstract: We studied the diets of low-density but increasing populations of sympatric Asian elephants *Elephas maximus* and greater one-horned rhinoceros *Rhinoceros unicornis* in the Bardia National Park in lowland Nepal. A microhistological technique based on fecal material was used to estimate the seasonal diet composition of the two megaherbivores. Rhinos ate more grass than browse in all seasons, and their grass/browse ratio was significantly higher than that of elephants. Both species ate more browse in the dry season, with bark constituting an estimated 73% of the elephant diet in the cool part of that season. Diet overlap was high in the resource-rich monsoon season and lower in the resource-poor dry season, indicating partitioning of food between the

two species in the period of resource limitation. Both species consumed large amounts of the floodplain grass *Saccharum spontaneum*, particularly during the monsoon season. As the numbers of both species increase, intraspecific and interspecific competition for *S. spontaneum* in the limited floodplains is likely to occur. Owing to their higher grass diet and more restricted all year home ranges within the floodplain habitat complex, rhinos are then expected to be affected more than elephants. Reproduced with Permission from CAB Abstracts.

Descriptors: Asian elephant, *Elephas maximus*, animal behavior, browsing, diet, feces composition, feeding behavior, food preferences, herbivores, interspecific competition, intraspecific competition, lowland areas, sympatric species, Rhinoceros, *Rhinoceros unicornis*.

Steinheim, G., P. Wegge, J.I. Fjellstad, S.R. Jnawali, and R.B. Weladji (2005). **Dry season diets and habitat use of sympatric Asian elephants (*Elephas maximus*) and greater one-horned rhinoceros (*Rhinoceros [Rhinoceros] unicornis*) in Nepal.** *Journal of Zoology (London)* 265(4): 377-385. ISSN: 0952-8369.

NAL Call Number: 410.9 L84P

Descriptors: *Rhinoceros unicornis*, *Elephas maximus*, food plants, dry season diets, habitat utilization, dry season habitat, semi aquatic habitat, forest, woodland, grassland, Nepal, grass, browse, bark.

[Back to Top](#)

[<< Table of Contents](#)

[<< Previous](#) | [Next >>](#)

Last Modified: Jan 23, 2014

[AWIC Home](#) | [NAL Home](#) | [USDA](#) | [AgNIC](#) | [ARS](#) | [Web Policies and Important Links](#) | [RSS Feeds](#) | [Site Map](#)
[FOIA](#) | [Accessibility Statement](#) | [Privacy Policy](#) | [Non-Discrimination Statement](#) | [Information Quality](#) | [USA.gov](#) | [White House](#)

Search AWIC

Go

- Search all USDA
- Advanced Search

Browse by Subject

- ▷ Research Animals
- ▷ Farm Animals
- ▷ Zoo, Circus and Marine Animals
- ▷ Companion Animals
- ▷ Government and Professional Resources
- ▷ Alternatives
- ▷ Literature Searching and Databases
- ▷ Pain and Distress
- ▷ Humane Endpoints and Euthanasia

You are here: [Home](#) / [Publications](#) / [Bibliographies and Resource Guides](#) / [Information Resources on Elephants](#) / [Asian Elephants - Diseases / Conditions](#)

 [Printer Friendly Page](#)

Publications

Information Resources on Elephants

[<< Table of Contents](#)
[<< Previous](#) | [Next >>](#)

Asian Elephants

- [Anatomy / Histology / Physiology](#)
- [Anesthesia / Analgesia / Sedation / Capture](#)
- [Behavior / Care / Enrichment / Handling / Training](#)
- [Blood / Circulation / Cardiac / Hematology](#)
- [Communication / Vocal / Hearing](#)
- [Digestive / Food / Nutrition](#)
- [Diseases / Conditions](#)
- [Genetics / DNA](#)
- [Parasites](#)
- [Reproductive](#)
- [Research](#)
- [Veterinary](#)

Diseases / Conditions

- Abou Madi, N., G.V. Kollias, R.P. Hackett, N.G. Ducharme, R.D. Glead, and J.P. Moakler (2004). **Umbilical herniorrhaphy in a juvenile Asian elephant (*Elephas maximus*)**. *Journal of Zoo and Wildlife Medicine* 35(2): 221-5.
NAL Call Number: SF601.J6
Abstract: An umbilical hernia was diagnosed in a 2-wk-old Asian elephant (*Elephas maximus*) by physical and ultrasonographic examinations. Umbilical herniorrhaphy was elected because the defect was large (approximately 7 cm long and 10 cm deep) and could potentially lead to incarceration of an intestinal loop. General anesthesia was induced with a combination of ketamine, xylazine, and diazepam and maintained with isoflurane in oxygen. The hernial sac was explored and contained fibrous tissue, fat, and an intestinal loop but no adhesions. The hernial sac was resected and the body wall closed using the technique of simple apposition. Following a superficial wound infection, the surgical site healed with no further complications.
Descriptors: umbilical hernia, anesthesia, zoo animals, umbilical hernia diagnosis, umbilical hernia surgery, treatment outcome, wound infection.
- Aravind, B., M. Anilkumar, S. Raju, and M.R. Saseendranath (2006). **A case of rabies in an Indian elephant *Elephas maximus***. *Zoos' Print Journal* 21(2): 2172. ISSN: 0973-25350973-2551.
Descriptors: infection, epidemiology, rabies, viral disease, polymerase chain reaction, fluorescent antibody test.
- Ashwani, K. and S. Neetu (2004). **Diseases of Indian elephants: an overview**. *Veterinary Practitioner* 5(2): 179-183. ISSN: 0972-4036.
Descriptors: bacterial diseases, cardiovascular diseases, digestive disorders, granuloma, kidney diseases, liver diseases, nervous system diseases, parasitism, skin diseases, viral

diseases, *Elephas maximus*, *Loxodonta africana*.

Aupperle, H., A. Reischauer, F. Bach, T. Hildebrandt, F. Goritz, K. Jager, R. Scheller, H.J. Klaue, and H.A. Schoon (2008). **Chronic endometritis in an Asian elephant (*Elephas maximus*)**. *Journal of Zoo and Wildlife Medicine* 39(1): 107-110. ISSN: 1042-7260.

Abstract: A 48-yr-old female Asian elephant with a history of pododermatitis developed recurrent hematuria beginning in 2002. Transrectal ultrasonography and endoscopic examination in 2004 identified the uterus as the source of hematuria and excluded hemorrhagic cystitis. Treatment with Desloreline implants, antibiotics, and homeopathic drugs led to an improved general condition of the elephant. In July 2005, the elephant was suddenly found dead. During necropsy, the severely enlarged uterus contained about 250 L of purulent fluid, and histopathology revealed ulcerative suppurative endometritis with high numbers of *Streptococcus equi* ssp. *zooepidemicus* and *Escherichia coli* identified on aerobic culture. Additional findings at necropsy included: multifocal severe pododermatitis, uterine leiomyoma, and numerous large calcified areas of abdominal fat necrosis. Microbiologic culture of the pododermatitis lesion revealed the presence of *Streptococcus agalactiae*, *Streptococcus equi* ssp. *zooepidemicus*/ *Staphylococcus* sp., *Corynebacterium* sp., and *Enterococcus* sp. *Reproduced with Permission from CAB Abstracts*.

Descriptors: Asian elephant, *Elephas maximus*, case report, chronic infections, endometritis, pododermatitis lesion, *Escherichia coli*, *Streptococcus agalactiae*, *Streptococcus equi* subsp. *zooepidemicus*.

Bojesen, A.M.O.K.E.P.B.M.F. (2006). **Fatal enterocolitis in Asian elephants (*Elephas maximus*) caused by *Clostridium difficile***. *Veterinary Microbiology* 116(4): 329-335. ISSN: 0378-1135.

Online: <http://dx.doi.org/10.1016/j.vetmic.2006.04.025>

NAL Call Number: SF601.V44

Abstract: Two cases of fatal enteritis caused by *Clostridium difficile* in captive Asian elephants are reported from an outbreak affecting five females in the same zoo. Post mortem examination including histopathology demonstrated fibrinonecrotic enterocolitis. *C. difficile* was isolated by selective cultivation from two dead and a third severely affected elephant. Four isolates were obtained and found positive for toxin A and B by PCR. All isolates were positive in a toxigenic culture assay and toxin was demonstrated in the intestinal content from one of the fatal cases and in a surviving but severely affected elephant. PCR ribotyping demonstrated that the *C. difficile* isolates shared an identical profile, which was different from an epidemiologically unrelated strain, indicating that the outbreak was caused by the same *C. difficile* clone. It is speculated that the feeding of large quantities of broccoli, a rich source of sulforaphane, which has been shown to inhibit the growth of many intestinal microorganisms may have triggered a subsequent overgrowth by *C. difficile*. This is the first report of *C. difficile* as the main cause of fatal enterocolitis in elephants. The findings emphasize the need to regard this organism as potentially dangerous for elephants and caution is recommended concerning antibiotic treatment and feeding with diets containing antimicrobials, which may trigger an expansion of a *C. difficile* population in the gut. *Reproduced with Permission from CAB Abstracts*>

Descriptors: animal diseases, Asian elephant, *Elephas maximus*, enterocolitis, bacterial infections, *Clostridium difficile*, disease diagnosis, polymerase chain reaction, DNA profiling, pathogen identification, strains, animal nutrition, animal feeding, broccoli.

Dumonceaux, G., R. Isaza, D.E. Koch, and R.P. Hunter (2005). **Pharmacokinetics and i.m. bioavailability of ceftiofur in Asian elephants (*Elephas maximus*)**. *Journal of Veterinary Pharmacology and Therapeutics* 28(5): 441-6.

NAL Call Number: SF915.J63

Abstract: Captive elephants are prone to infections of the feet, lungs, and skin. Often treatment regimens are established with no pharmacokinetic data on the agents being used for treatment in these species. A pharmacokinetic study using ceftiofur (1.1 mg/kg) was conducted in four adult female captive Asian elephants (*Elephas maximus*) at Busch Gardens in Tampa, Florida. Elephants were given both i.v. and i.m. administrations in a complete crossover design with a 3-week washout period between treatments. Blood samples were collected prior to drug administration and at 0.33, 0.67, 1, 1.5, 2, 4, 8, 12, 24, 48 and 72 h postadministration. Ceftiofur analysis was performed using a validated liquid chromatography/mass spectrophotometric (LC/MS) assay. Plasma concentrations for the i.m. samples were lower than expected. The mean C(max) following i.m. administration was 1.63 microg/mL with a corresponding T(max) of 0.55 h. Following i.v. administration, the median V(d(ss)) was 0.51 L/kg and a median Cl(p) of 0.069 L/kg/h. Mean i.m. bioavailability was 19%. The results indicate that ceftiofur used at 1.1 mg/kg i.m. could be useful in elephants when given two to three times a day or alternatively, 1.1 mg/kg i.v. once daily, depending upon the MIC of the pathogen.

Descriptors: cephalosporins pharmacokinetics, metabolism, area under curve, biological availability, cephalosporins administration and dosage, cephalosporins blood, intramuscular veterinary injections.

Fickel, J., D. Lieckfeldt, L.K. Richman, W.J. Streich, T.B. Hildebrandt, and C. Pitra (2003).

Comparison of glycoprotein B (gB) variants of the elephant endotheliotropic

herpesvirus (EEHV) isolated from Asian elephants (*Elephas maximus*). *Veterinary Microbiology* 91(1): 11-21. ISSN: 0378-1135.

NAL Call Number: SF601.V44

Abstract: The recently described elephant endotheliotropic herpesviruses (EEHV) have been associated with the deaths of numerous captive elephants. A proposed tool for the detection of EEHV infection in elephants is the PCR-based screening for EEHV-DNA in whole blood samples. Unfortunately, this detection method has only been successful in post-mortem analyses or in animals already displaying clinical signs of EEHV disease, thus rendering this method unsuitable for identification of carrier elephants. Here, we focus on glycoprotein B (gB) for serologic assay development, since gB is an envelope protein known to induce a neutralising antibody response in other herpesvirus infections. We sequenced the entire gB gene from five Asian elephants with EEHV, representing four different gB variants. Computer-aided methods were used to predict functionally important regions within EEHVgB. An extra-cytoplasmic region of 153 amino acids was predicted to be under positive selection and may potentially contain antigenic determinants that will be useful for future serologic assay development.

Descriptors: *Elephas maximus*, viral proteins, glycoproteins, disease transmission, detection, polymerase chain reaction, cytoplasm, amino acid sequences, molecular sequence data.

Garner, M.M., K. Helmick, J. Ochsenreiter, L.K. Richman, E. Latimer, A.G. Wise, R.K. Maes, M. Kiupel, R.W. Nordhausen, J.C. Zong, and G.S. Hayward (2009). **Clinico-pathologic features of fatal disease attributed to new variants of endotheliotropic herpesviruses in two Asian elephants (*Elephas maximus*).** *Veterinary Pathology* 46(1): 97-104. ISSN: 0300-9858.

Online: <http://dx.doi.org/10.1354/vp.46-1-97>

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. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, herpesviruses, endotheliotropic herpesviruses (EEHV), virulence.

Hildebrandt, T.B., R. Hermes, P. Ratanakorn, W. Rietschel, J. Fickel, R. Frey, G. Wibbelt, C. Reid, and F. Goritz (2005). **Ultrasonographic assessment and ultrasound-guided biopsy of the retropharyngeal lymph nodes in Asian elephants (*Elephas maximus*).** *Veterinary Record* 157(18): 544-8.

NAL Call Number: 41.8 V641

Abstract: Endotheliotropic herpesvirus causes a fatal disease in young Asian elephants, but there are no methods for identifying latent carriers of the virus. During the postmortem study of one female African elephant and three male and two female Asian elephants, a lymph node located bilaterally caudoventral to the parotid gland, approximately 1.5 to 5 cm below the skin, was identified as suitable for transcutaneous ultrasound-guided biopsy. An ultrasonographic assessment and two biopsies were performed on 39 Asian elephants, and these lymph nodes were classified ultrasonographically as active, inactive or chronically active. The calculated mean (se) volume of 10 active lymph nodes was 17.4 (6.9) cm³, and that of three chronically active lymph nodes was 10.6 (1.0) cm³, whereas the mean volume of 17 inactive lymph nodes was 3.1 (0.6) cm³. The presence of lymph node tissue in samples obtained by ultrasound-guided biopsy from three animals that were maintained under conditions that allowed for additional sampling was confirmed histologically. The dna extracted from the lymphoid tissue and the whole blood of all the elephants was negative for endotheliotropic herpesvirus by PCR.

Descriptors: DNA viral isolation and purification, herpesviridae isolation and purification, herpesviridae infections, lymph nodes pathology, zoo animals, fine needle biopsy methods, disease reservoirs, disease reservoirs virology, Herpesviridae pathogenicity, Herpesviridae infections epidemiology, Herpesviridae infections pathology, lymph nodes ultrasonography, lymph nodes virology, polymerase chain reaction, prevalence, virus latency.

Kajaysri, J., S. Huayjunteuk, S. Reunpech, C. Thammakarn, N. Warrasuth, and S. Eardmusic (2003). **The condition of paper thin bone layer and fracture by metabolic bone disease in an orphan elephant.** *Proceedings of 41st Kasetsart University Annual Conference, Subject: Animals and Veterinary Medicine, February 3, 2003-February 7,*

2003, Bangkok, Thailand: Kasetsart University, Kasetsart University: Bangkok, Thailand, p. 508-515.

Descriptors: Asian elephant, metabolic bone diseases, bone layer, fracture, case reports, clinical aspects, diagnosis, treatment, fracture fixation, *Elephas maximus*.

Language of Text: Thai, with English summary.

Kongsila, A., N. Thongtip, and N. Yatbantung (2003). **Oesophageal obstruction (choke) in Asiatic elephant (*Elephas maximus*): case report.** *Proceedings of 41st Kasetsart University Annual Conference, Subject: Animals and Veterinary Medicine, February 3, 2003-February 7, 2003, Bangkok, Thailand: Kasetsart University, Kasetsart University: Bangkok, Thailand, p. 678-683.*

Descriptors: Asian elephant, choke, esophageal obstruction, case report, clinical signs, diagnosis, treatment, *Elephas maximus*.

Language of Text: Thai, with English summary.

Lewerin, S.S., S.L. Olsson, K. Eld, B. Roken, S. Ghebremichael, T. Koivula, G. Kallenius, and G. Bolske (2005). **Outbreak of *Mycobacterium tuberculosis* infection among captive Asian elephants in a Swedish zoo.** *Veterinary Record* 156(6): 171-5.

NAL Call Number: 41.8 V641

Abstract: Between 2001 and 2003, there was an outbreak of tuberculosis in a Swedish zoo which involved elephants, giraffes, rhinoceroses and buffaloes. Cultures of trunk lavages were used to detect infected elephants, tuberculin testing was used in the giraffes and buffaloes, and tracheal lavage and tuberculin testing were used in the rhinoceroses. The bacteria isolated were investigated by spoligotyping and restriction fragment length polymorphism. Five elephants and one giraffe were found to have been infected by four different strains of *Mycobacterium tuberculosis*.

Descriptors: disease outbreaks, *Mycobacterium tuberculosis* isolation and purification, tuberculosis, zoo animals *Mycobacterium tuberculosis* classification, *Mycobacterium tuberculosis* pathogenicity, polymorphism, restriction fragment length, Sweden epidemiology, tuberculosis diagnosis, tuberculosis epidemiology.

Liu, C.H., C.H. Chang, S.C. Chin, P.H. Chang, Y.X. Zhuo, and C.C. Lee (2004). **Fibrosarcoma with lung and lymph node metastases in an Asian elephant (*Elephas maximus*).** *Journal of Veterinary Diagnostic Investigation* 16(5): 421-3.

NAL Call Number: SF774.J68

Abstract: A case of fibrosarcoma with lung and lymph node metastases in a 54-year-old female Asian elephant (*Elephas maximus*) is described. After pododermatitis of 2 years duration in the right forefoot, a mass developed in the lateral toenail. At postmortem, metastasis to the right axillary lymph node and both lungs was noted. Microscopic examination of primary and metastatic sites revealed infiltrating bundles of spindle cells, with fairly distinct cell borders, variable amounts of eosinophilic cytoplasm, and elongate or oval nuclei. Tumor cells were often arranged in interwoven bundles and herringbone patterns. Mitotic figures were numerous and frequently bizarre. The diagnosis of fibrosarcoma with lung and lymph node metastases was made on the basis of histologic features and positive immunohistochemical staining for vimentin.

Descriptors: zoo animals, fibrosarcoma, secondary lung neoplasms, lung neoplasms, lymph nodes pathology, skin neoplasms, biopsy, fatal outcome, fibrosarcoma secondary, immunohistochemistry, skin neoplasms pathology.

Manna, S. (2003). **Enteritis and it's treatment in an Asian elephant.** *Zoos' Print Journal* 18(6): 1130. ISSN: 0971-6378.

Descriptors: Asian elephant, atropine, clinical aspects, diagnosis, diarrhea, drug therapy, enteritis, oxytetracycline, zoo elephant, *Elephas maximus*.

Manohar, B.M., J. Selvaraj, S.M. Sakthivelan, W.M. Paul, M.G. Jayathangaraj, K.S. Kumar, and Koteeswaran (2004). **Pododermatitis in an elephant calf.** *Indian Veterinary Journal* 81(1): 107-108. ISSN: 0019-6479.

NAL Call Number: 41.8 IN2

Descriptors: Asian elephant, calf, pododermatitis, infection.

Maslow, J.N., S.K. Mikota, M. Zhu, R. Isaza, L.R. Peddie, F. Dunker, J. Peddie, H. Riddle, and C.A. Peloquin (2005). **Population pharmacokinetics of isoniazid in the treatment of *Mycobacterium tuberculosis* among Asian and African elephants (*Elephas maximus* and *Loxodonta africana*).** *Journal of Veterinary Pharmacology and Therapeutics* 28(1): 21-7.

NAL Call Number: SF915.J63

Abstract: We recently described the clinical presentation and treatment of 18 elephants from six herds infected with TB. Treatment protocols and methods varied between herds to include both oral and rectal dosing using multiple drug doses and formulations. In this paper we present information regarding the pharmacokinetics (PK) of isoniazid (INH) in elephants and provide suggestions regarding initial treatment regimens. Forty-one elephants received INH daily by either oral or rectal administration with different formulations. Population PK analysis was performed using Non-linear Mixed Effect Modeling (NONMEM). Results of oral administration indicated that compared with premixed INH solution, the drug exposure was highest with a suspension prepared freshly

with INH powder. When INH was concomitantly given as an admixture over food, T_{max} was delayed and variability in drug absorption was significantly increased. Compared with oral administration, similar drug exposures were found when INH was dosed rectally. The data generated suggest that a starting dose of 7.5 mg/kg of INH is appropriate for initial TB treatment in elephants when premixed solution is administered directly into the oropharynx or rectal vault and 4 mg/kg are when INH is administered following immediate suspension from powdered form.

Descriptors: antitubercular agents pharmacokinetics, metabolism, isoniazid pharmacokinetics, oral administration, rectal administration, administration and dosage of antitubercular agents, antitubercular agents in blood, therapeutic use of antitubercular agents, area under curve, isoniazid administration and dosage, isoniazid in blood, therapeutic use of isoniazid, *Mycobacterium tuberculosis*, tuberculosis drug therapy, tuberculosis.

Nath, I., V.S.C. Bose, S.K. Panda, B.C. Das, and L.K. Singh (2003). **A case of multiple abscesses in a baby elephant.** *Zoos' Print Journal* 18(11): 1270.

Descriptors: baby elephant, abscesses, multiple, disease, infection.

Nath, I., N. Sahoo, D.N. Mohanty, S.N. Mohapatra, S.K. Panda, V.S.C. Bose, and K.L. Purohit (2006). **Foreign body obstruction of pharynx in an Asian elephant *Elephas maximus*.** *Zoos' Print Journal* 21(10): 2441. ISSN: 0971-6378.

Abstract: This article reports on a case of transverse obstruction of the pharynx due to an intake of sugarcane by an adult free living cow elephant *E. maximus* in a forest near the Nandankanan Zoo in India. The highlight of the report focused on the diagnosis and treatment of the elephant. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, case reports, foreign bodies, histopathology, medical treatment, obstruction, pharynx, postmortem examinations, sugarcane.

Oni, O., K. Sujit, S. Kasemsuwan, T. Sakpuaram, and D.U. Pfeiffer (2007). **Seroprevalence of leptospirosis in domesticated Asian elephants (*Elephas maximus*) in north and west Thailand in 2004.** *Veterinary Record* 160(11): 368-371. ISSN: 0042-4900.

Abstract: Serum samples from Asian elephants (*Elephas maximus*) in the Kanchanaburi, Chiang Mai and Lampang provinces of Thailand were tested using the microscopic agglutination test against 22 serovars of *Leptospira interrogans*. A titre of more than 1:100 was used as evidence of infection. In northern Thailand, the seroprevalence was 58 per cent and the prevalent serovars were *Leptospira interrogans serovar Sejroe*, *Leptospira interrogans serovar Tarassovi*, *Leptospira interrogans serovar Ranarum* and *Leptospira interrogans serovar Shermani*. In western Thailand, the seroprevalence was 57 per cent and the prevalent serovars were *L Tarassovi*, *L Sejroe*, *L Ranarum*, *Leptospira interrogans serovar Bataviae* and *L Shermani*. These results were similar to studies in domestic livestock and stray dogs in the Bangkok district. Among the elephants from Kanchanaburi there were significant associations between seropositivity and between the camp and between the prevalent serovars and the camp. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, epidemiology, leptospirosis, seroprevalence, *Leptospira interrogans*.

Oni, O., W. Wajjwalku, O. Boodde, and W. Chumsing (2006). **Canine distemper virus antibodies in the Asian elephant (*Elephas maximus*).** *Veterinary Record Journal of the British Veterinary Association* 159(13): 420-421. ISSN: 0042-4900.

NAL Call Number: 41.8 V641

Descriptors: Asian elephant, *Elephas maximus*, Canine distemper virus, seroprevalence, Thailand.

Pucher, H.E., C. Stremme, and F. Schwarzenberger (2003). **Priapism in a semiwild Asian elephant (*Elephas maximus*) in Vietnam.** *Veterinary Record* 153(23): 717-718. ISSN: 0042-4900.

NAL Call Number: 41.8 V641

Descriptors: *Elephas maximus*, penis, case studies, chronic diseases, males, adult animals, male genital diseases, necrosis, medical treatment, sulfonamides, Vietnam, priapism.

Ratanakorn, P. (2006). **Warning: fatal viral disease in Asian elephant found in South East Asia.** *Tigerpaper* 33(2): 25. ISSN: 1014-2789.

Abstract: This article discusses the risk of transmission of Elephant epitheliotropic herpesvirus (EEHV) between domestic and wild elephants (*Elephas maximus*) in Thailand, and the establishment of a reference laboratory for the diagnosis of the disease. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, Indian elephant, Elephant epitheliotropic herpesvirus (EEHV), diagnosis and disease transmission, endangered species, epidemiology.

Reid, C.E., N. Marx, J. Fickel, F. Goritz, M. Hunt, N. Thy, J.M. Reynes, W. Schaftenaar, and T.B. Hildebrandt (2005). **Endotheliotropic herpes in Asia: the impact on captive and**

wild Asian elephant populations. *Proceedings of the Institute for Zoo and Wildlife Research, Berlin*(6): 273. ISSN: 1431-7338.

Descriptors: Asian elephant, *Elephas maximus*, herpes, latent infections, mortality, viral diseases.

Sarma, K.K., A. Bhawal, V.K. Yadav, G. Saikia, and Jogiraj Das. (2006). **Investigation of tuberculosis in captive Asian elephants of Assam vis a vis its cross infections with the handlers.** *Intas Polivet* 7(2): 269-274. ISSN: 0972-1738.

Abstract: This study was conducted to screen selected captive elephants in Assam for tuberculosis. Cross infections with handlers were also investigated. 88 adult captive elephants from different locations in Assam were included in this study. Serum samples were subjected to indirect haemagglutination test (IHA). The animals seropositive in the IHA test were again examined by single intradermal tuberculin test using purified protein derivative and Trunk wash method. 36 elephants were serologically positive. Out of the 36 suspected animals subjected to the single intradermal tuberculin and Trunk wash tests, 7 were highly suspected. Only 2 cases could be positively diagnosed as infected with Mycobacterium based on the colony and staining characteristics. The positive animals were treated with a combination of 5 mg/kg body weight isoniazid (Solonex-DT) and 4.5 g/t body weight streptomycin (Ambistryn-S). An improvement in the general appearance of the animals was observed after one month of treatment. Mahouts and elephant keepers whose elephants were found to be seropositive were subjected to Mountex test, estimation of ESR and chest radiography. None of the mahouts suffered from the active form of tuberculosis. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, clinical aspects, cross infection, diagnostic techniques, disease control, disease prevention, drug therapy, epidemiology, isoniazid, streptomycin, tuberculosis.

Shimada, Y., N. Hama, M. Ashida, K. Ishikawa, Y. Matsuo, A. Yamada, A. Noda, K. Murata, and K. Okuno (2005). **Pregnancy and stillbirth of an Asian elephant, *Elephas maximus*.** *Journal of Japanese Association of Zoos and Aquariums* 46(2): 41-49. ISSN: 0386-7498.

NAL Call Number: QL77.5.D63

Descriptors: Asian elephant, stillbirth, clinical aspects, prevalence, fetal death, pregnancy, *Elephas maximus*.

Language of Text: Japanese.

Thitaram, C., P. Pongsopawijit, N. Thongtip, T. Angkavanich, S. Chansittivej, W. Wongkalasin, C. Somgird, N. Suwankong, W. Prachsilpchai, and K. Suchit (2006). **Dystocia following prolonged retention of a dead fetus in an Asian elephant (*Elephas maximus*).** *Theriogenology* 66(5): 1284-1291. ISSN: 0093-691X.

Online: <http://dx.doi.org/10.1016/j.theriogenology.2006.04.020>

NAL Call Number: QP251.A1T5

Abstract: A 32-year-old nulliparous female Asian elephant (*Elephas maximus*) showed signs of parturition 8 months later than predicted from the breeding records. However, while serosanguineous fluid, necrotic tissue and pieces of amnion were expelled, second-stage labor did not progress. Since the fetus was not found during an endoscopic examination of the vestibule, it was assumed that the elephant had calved unseen and she was returned to the forest to recuperate. Twelve months later, the elephant showed clear signs of second-stage labor accompanied by a bulge in the perineum and passage of keratinized nail through the vulva. A 35 cm episiotomy incision was made in the perineum just below the anus, via which chains were attached to the forelimbs of the fetus. Traction on the forelimbs alone proved insufficient to achieve delivery because the fetal head kept rotating and impacting in the pelvis. However, traction applied via a hook inserted behind the mandibular symphysis allowed the head to be elevated and extended, and the fetus to be delivered. The episiotomy wound was sutured in two layers and although the skin did not heal during primary closure it subsequently healed uneventfully by second intention. Retrospective evaluation of the elephant's serum progestagens profile demonstrated a fall to baseline at the suspected onset of parturition, supporting the supposition that the fetus was retained in the uterus for 12 months after parturition began. It is suggested that serum progestagens concentrations should be monitored regularly in mated elephant cows to verify the establishment of pregnancy and to better estimate the expected timing, and the onset of calving. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, case studies, females, fetal death, dystocia, postoperative care, Thailand.

Vodicka, R. (2008). **Trunk pyoderma in a male Ceylon elephant (*Elephas maximus maximus*).** *Acta Veterinaria Brno* 77(1): 127-131. ISSN: 0001-7213.

Abstract: The study describes the therapy of purulent trunk dermatitis in an aggressive male Ceylon elephant (*Elephas maximus maximus*). The elephant was immobilized 4 times with 1.7 ml Large Animal (LA) Immobilon i.m. within 50 days. The anesthetic action was antagonised with 1.7 ml LA Revivon+8.0 ml Naloxone i.v. and 0.5 ml LA Revivon+6.0 ml Naloxone i.m. From skin lesions the following pathogens were isolated: *Staphylococcus* spp., *Streptococcus* spp. and *Candida tropicalis*. Local therapy consisted of the debridement of the affected skin, application of antibiotics and skin antiseptics. Depot penicillin, vitamins, probiotics and autogenous yeast vaccine were administered generally.

In hematological indicators the biggest changes were found in the numbers of white blood cells and segmented neutrophils. Markedly low zinc concentrations were found repeatedly. Despite the non-standard steps we took (repeated anesthesia during a short time, non-compliance with the recommendations for the administration of some drugs, etc.) and difficult handling (aggressive, uncontrollable elephant, no restraint chute), it proved possible to treat such a case in this manner. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, case report, dermatitis, skin diseases, *Candida tropicalis*, Staphylococcus, Streptococcus.

Language of Text: Slovakian.

Vodicka, R. and J. Kral (2003). **Purulent trunk dermatitis in a male Ceylon elephant (*Elephas maximus maximus*)**. In: *Erkrankungen der Zootiere: Verhandlungsbericht des 41 Internationalen Symposiums über die Erkrankungen der Zoo und Wildtiere, May 1, 1928-June 1, 2003, Rome, Italy*, Vol. 5, p. 151-153.

NAL Call Number: SF996.15

Descriptors: Asian elephant, trunk, purulent dermatitis, pyoderma, skin diseases, treatment, aggressive male, anesthesia, handling, *Elephas maximus*.

Wanke, R., N. Herbach, and T. Haenichen (2005). **Metastasising granulosa cell tumour in an Asian elephant (*Elephas maximus*)**. *Proceedings of the Institute for Zoo and Wildlife Research, Berlin*(6): 308. ISSN: 1431-7338.

Descriptors: Asian elephant, *Elephas maximus*, animal pathology, case report, granulosa cells, histopathology, metastasis, neoplasms, uterine diseases.

Zhu, M., J.N. Maslow, S.K. Mikota, R. Isaza, F. Dunker, H. Riddle, and C.A. Peloquin (2005).

Population pharmacokinetics of pyrazinamide in elephants. *Journal of Veterinary Pharmacology and Therapeutics* 28(5): 403-9.

NAL Call Number: SF915.J63

Abstract: This study was undertaken to characterize the population pharmacokinetics (PK), therapeutic dose, and preferred route of administration for pyrazinamide (PZA) in elephants. Twenty-three African (*Loxodonta africana*) and Asian (*Elephas maximus*) elephants infected with or in contact with others culture positive for *Mycobacterium tuberculosis* were dosed under treatment conditions. PZA was dosed daily at 20-30 mg/kg via oral (fasting or nonfasting state) or rectal (enema or suppository) administration. Blood samples were collected 0-24 h postdose. Population PK was estimated using nonlinear mixed effect modeling. Drug absorption was rapid with T(max) at or before 2 h regardless of the method of drug administration. C(max) at a mean dose of 25.6 (+/-4.6) mg/kg was 19.6 (+/-9.5 microg/mL) for PZA given orally under fasting conditions. Under nonfasting conditions at a mean dose of 26.1 +/- 4.2 mg/kg, C(max) was 25% (4.87 +/- 4.89 microg/mL) and area under concentration curve (AUC) was 30% of the values observed under fasting conditions. Mean rectal dose of 32.6 +/- 15.2 mg/kg yielded C(max) of 12.3 +/- 6.3 microg/mL, but comparable AUC to PZA administered orally while fasting. Both oral and rectal administration of PZA appeared to be acceptable and oral dosing is preferred because of the higher C(max) and lower inter-subject variability. A starting dose of 30 mg/kg is recommended with drug monitoring between 1 and 2 h postdose. Higher doses may be required if the achieved C(max) values are below the recommended 20-50 microg/mL range.

Descriptors: antitubercular agents pharmacokinetics, metabolism, pyrazinamide pharmacokinetics, pulmonary tuberculosis, oral administration, rectal administration, antitubercular agents administration and dosage, antitubercular agents therapeutic use, area under curve, *Mycobacterium tuberculosis* pathogenicity, pyrazinamide administration and dosage, pyrazinamide therapeutic use, tuberculosis, pulmonary blood, pulmonary drug therapy.

[Back to Top](#)

[<< Table of Contents](#)

[<< Previous](#) | [Next >>](#)

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[<< Table of Contents](#)[>> Previous](#) | [Next >>](#)

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- [Anatomy / Histology / Physiology](#)
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- [Digestive / Food / Nutrition](#)
- [Diseases / Conditions](#)
- [Genetics / DNA](#)
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Genetics / DNA

Faust, L.J., S.D. Thompson, J.M. Earnhardt (2006). **Is reversing the decline of Asian elephants in North American zoos possible? An individual-based modeling approach.** *Zoo Biology* 25(3): 201-218. ISSN: 0733-3188.

Online: <http://dx.doi.org/10.1002/zoo.20054>

NAL Call Number: QL77.5.Z6

Descriptors: *Elephas maximus*, zoo animals, population dynamics, population structure, simulation models, stochastic processes, mortality, fecundity, animal reproduction, animal husbandry, North America, captive elephants, population decline, demographic models, individual based stochastic models.

Fernando, P., T.N. Vidya, J. Payne, M. Stuewe, G. Davison, R.J. Alfred, P. Andau, E. Bosi, A. Kilbourn, and D.J. Melnick (2003). **DNA analysis indicates that Asian elephants are native to Borneo and are therefore a high priority for conservation.** *PLoS Biology* 1(1): E6.

NAL Call Number: QH301.P56

Abstract: The origin of Borneo's elephants is controversial. Two competing hypotheses argue that they are either indigenous, tracing back to the Pleistocene, or were introduced, descending from elephants imported in the 16th-18th centuries. Taxonomically, they have either been classified as a unique subspecies or placed under the Indian or Sumatran subspecies. If shown to be a unique indigenous population, this would extend the natural species range of the Asian elephant by 1300 km, and therefore Borneo elephants would have much greater conservation importance than if they were a feral population. We compared DNA of Borneo elephants to that of elephants from across the range of the Asian elephant, using a fragment of mitochondrial DNA, including part of the hypervariable d-loop, and five autosomal microsatellite loci. We find that Borneo's elephants are genetically distinct, with molecular divergence indicative of a Pleistocene

colonisation of Borneo and subsequent isolation. We reject the hypothesis that Borneo's elephants were introduced. The genetic divergence of Borneo elephants warrants their recognition as a separate evolutionary significant unit. Thus, interbreeding Borneo elephants with those from other populations would be contraindicated in ex situ conservation, and their genetic distinctiveness makes them one of the highest priority populations for Asian elephant conservation.

Descriptors: conservation of natural resources methods, alleles, Borneo, DNA chemistry, mitochondrial DNA chemistry, molecular evolution, gene frequency, population genetics, genotype, geography, haplotypes, microsatellite repeats, statistical models, molecular sequence data, phylogeny, polymerase chain reaction, DNA sequence analysis, species specificity, variation genetics.

Rautian, G.S. and I.A. Dubrovo (2003). **Data on DNA give evidence for parallel development in mammoths and elephants.** *Deinsea* 9: 381-394. ISSN: 0923-9308.

Descriptors: *Elephas maximus*, *Loxodonta africana*, *Mammuthus primigenius*, Elephantidae, *Mammuth americanus*, Mammuthidae, nucleic acids, molecular genetics, DNA, parallel evolution, genetic data, phylogeny.

Roca, A.L. and S.J. O'Brien (2005). **Genomic inferences from Afrotheria and the evolution of elephants.** *Current Opinion in Genetics and Development* 15(6): 652-659.

NAL Call Number: QH426.C88

Abstract: Recent genetic studies have established that African forest and savanna elephants are distinct species with dissociated cytonuclear genomic patterns, and have identified Asian elephants from Borneo and Sumatra as conservation priorities. Representative of Afrotheria, a superordinal clade encompassing six eutherian orders, the African savanna elephant was among the first mammals chosen for whole-genome sequencing to provide a comparative understanding of the human genome. Elephants have large and complex brains and display advanced levels of social structure, communication, learning and intelligence. The elephant genome sequence might prove useful for comparative genomic studies of these advanced traits, which have appeared independently in only three mammalian orders: primates, cetaceans and proboscideans.

Descriptors: evolution, genetics, DNA, African elephants, Asian elephants, genomic patterns.

Thitaram, C., N. Thongtip, C. Somgird, B. Colenbrander, D.C.J. van Boxtel, F. van Steenbeek, and J.A. Lenstra (2008). **Evaluation and selection of microsatellite markers for an identification and parentage test of Asian elephants (*Elephas maximus*).**

Conservation Genetics 9(4): 921-925. ISSN: 1566-0621.

Online: <http://dx.doi.org/10.1007/s10592-007-9406-z>

Abstract: Numbers of the Asian elephants (*Elephas maximus*) population are declining due to poaching, human-elephant conflicts, capture of wild calves for tourism and export and habitat destruction, which also may cause inbreeding in fragmented populations. In order to contribute to a reversal of this trend, we have developed an identification and parentage test by evaluation and selection of markers from 43 microsatellite loci that have been previously described for Asian or African elephants. Testing these markers on a panel of 169 Asian elephants comprising the 23 mother-offspring, 13 father-offspring and 13 parents-offspring pairs yielded 26 polymorphic markers. However, only 14 of these were found to be suitable for an analysis of molecular diversity, 12 of which will be implemented for an identification and parentage test to control the capture of wild calves in Thailand and neighboring countries. Reproduced with Permission from CAB Abstracts.

Descriptors: Asian elephant, *Elephas maximus*, genetic markers, genetic polymorphism, microsatellites, parentage.

Vidya, T.N., P. Fernando, D.J. Melnick, and R. Sukumar (2005). **Population differentiation within and among Asian elephant (*Elephas maximus*) populations in southern India.** *Heredity* 94(1): 71-80.

NAL Call Number: 443.8 H42

Abstract: Southern India, one of the last strongholds of the endangered Asian elephant (*Elephas maximus*), harbours about one-fifth of the global population. We present here the first population genetic study of free-ranging Asian elephants, examining within- and among-population differentiation by analysing mitochondrial DNA (mtDNA) and nuclear microsatellite DNA differentiation across the Nilgiris-Eastern Ghats, Anamalai, and Periyar elephant reserves of southern India. Low mtDNA diversity and 'normal' microsatellite diversity were observed. Surprisingly, the Nilgiri population, which is the world's single largest Asian elephant population, had only one mtDNA haplotype and lower microsatellite diversity than the two other smaller populations examined. There was almost no mtDNA or microsatellite differentiation among localities within the Nilgiris, an area of about 15,000 km². This suggests extensive gene flow in the past, which is compatible with the home ranges of several hundred square kilometres of elephants in southern India. Conversely, the Nilgiri population is genetically distinct at both mitochondrial and microsatellite markers from the two more southerly populations, Anamalai and Periyar, which in turn are not genetically differentiated from each other. The more southerly populations are separated from the Nilgiris by only a 40-km-wide stretch across a gap in the Western Ghats mountain range. These results variably indicate the importance of population bottlenecks, social organization, and biogeographic barriers in shaping the

distribution of genetic variation among Asian elephant populations in southern India.

Descriptors: mitochondrial DNA genetics, population genetics, microsatellite repeats, variation genetics, cell nucleus genetics, elephant classification, molecular evolution, geography, haplotypes, India, phylogeny, genetic polymorphism.

Vidya, T.N.C. and R. Sukumar (2005). **Social organization of the Asian elephant (*Elephas maximus*) in southern India inferred from microsatellite DNA.** *Journal of Ethology* 23(2): 205-210. ISSN: 0289-0771.

NAL Call Number: QL750.J68

Descriptors: Asian elephant, social organization, dung, extracted DNA, families, males, matriarchal groups, dispersal, microsatellite, India.

Vidya, T.N.C., R. Sukumar, and D.J. Melnick (2009). **Range wide mtDNA phylogeography yields insights into the origins of Asian elephants.** *Proceedings of the Royal Society of London Series B, Biological Sciences* 276(1658): 893-902. ISSN: 0962-8452.

Online: <http://dx.doi.org/10.1098/rspb.2008.1494>

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. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, endangered species, mitochondrial DNA, nucleotide sequences, population genetics.

Vidya, T.N.C., Surendra Varma, N.X. Dang, T.v. Thanh, and R. Sukumar (2007). **Minimum population size, genetic diversity, and social structure of the Asian elephant in Cat Tien National Park and its adjoining areas, Vietnam, based on molecular genetic analyses.** *Conservation Genetics* 8(6): 1471-1478. ISSN: 1566-0621.

Online: <http://dx.doi.org/10.1007/s10592-007-9301-7>

Abstract: Vietnam's elephant population that has suffered severe declines during the past three decades is now believed to number 60-80 individuals in the wild. Cat Tien National Park is thought to be one of the key areas for the recovery of Vietnam's elephants. We carried out a molecular genetic study of elephants in Cat Tien National Park and its adjoining areas with the objectives of estimating minimum population size, assessing genetic diversity, and obtaining insights into social organization. We obtained a minimum population size of 11 elephants based on a combination of unique nuclear microsatellite genotypes and mitochondrial haplotypes. While mitochondrial diversity based on a 600-base pair segment was high in this small sample of individuals, the six microsatellite loci examined showed low diversity and the signature of a recent population bottleneck. Along with nuclear genetic depauperation of Cat Tien's elephants, we also report disruption of normal social organization, with different matrilineal groups having coalesced into a single social group because of anthropogenic disturbance. The results emphasize the critical condition of this elephant population and the need for urgent conservation measures if this population is to be saved. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, endangered species, genetic diversity, population genetics.

Vidya, T., P. Fernando, D. Melnick, and R. Sukumar (2005). **Population genetic structure and conservation of Asian elephants (*Elephas maximus*) across India.** *Animal Conservation* 8(4): 377-388. ISSN: 1367-9430.

NAL Call Number: QH75.A1

Descriptors: Asian elephant, *Elephas maximus*, conservation measures, population genetics, genetic structure, nuclear microsatellite, mtDNA marker study, phylogeny variation, social organization, India, mitochondrial DNA, allele frequencies, haplotypes.

Vidya, T. and R. Sukumar (2005). **Amplification success and feasibility of using**

microsatellite loci amplified from dung to population genetic studies of the Asian elephant (*Elephas maximus*). *Current Science (Bangalore)* 88(3): 489-492. ISSN: 0011-3891.

NAL Call Number: 475 SCI23

Descriptors: Asian elephant, *Elephas maximus*, population genetics, nucleic acids, feces, molecular genetics, microsatellite DNA, India, fecal microsatellite DNA samples, dung samples, population genetics analysis, evaluation.

[Back to Top](#)

[<< Table of Contents](#)

[<< Previous](#) | [Next >>](#)

Last Modified: Jan 23, 2014

[AWIC Home](#) | [NAL Home](#) | [USDA](#) | [AgNIC](#) | [ARS](#) | [Web Policies and Important Links](#) | [RSS Feeds](#) | [Site Map](#)
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- ▷ Government and Professional Resources
- ▷ Alternatives
- ▷ Literature Searching and Databases
- ▷ Pain and Distress
- ▷ Humane Endpoints and Euthanasia

 You are here: [Home](#) / [Publications](#) / [Bibliographies and Resource Guides](#) / [Information Resources on Elephants](#) / [Asian Elephants - Parasites](#)
 Printer Friendly Page

Publications

Information Resources on Elephants

[<< Table of Contents](#)
[<< Previous](#) | [Next >>](#)

Asian Elephants

- [Anatomy / Histology / Physiology](#)
- [Anesthesia / Analgesia / Sedation / Capture](#)
- [Behavior / Care / Enrichment / Handling / Training](#)
- [Blood / Circulation / Cardiac / Hematology](#)
- [Communication / Vocal / Hearing](#)
- [Digestive / Food / Nutrition](#)
- [Diseases / Conditions](#)
- [Genetics / DNA](#)
- [Parasites](#)
- [Reproductive](#)
- [Research](#)
- [Veterinary](#)

Parasites

Agatsuma, T., R. Rajapakse, V. Kuruwita, M. Iwagami, and R. Rajapakse (2004). **Molecular taxonomic position of the elephant schistosome, *Bivitellobilharzia nairi*, newly discovered in Sri Lanka.** *Parasitology International* 53(1): 69-75. ISSN: 1383-5769. NAL Call Number: QL757.P3747

Descriptors: *Bivitellobilharzia nairi*, molecular genetics, phylogeny, Asian elephant, parasites, hosts, *Elephas maximus*, Sri Lanka, adult worm, schistosome.

Dangolla, A., D.K. Ekanayake, R.P. Rajapakse, J.P. Dubey, and I.D. Silva (2006). **Seroprevalence of *Toxoplasma gondii* antibodies in captive elephants (*Elephas maximus maximus*) in Sri Lanka.** *Veterinary Parasitology* 137(1-2): 172-4. NAL Call Number: SF810.V4

Abstract: Serum samples collected during August 2003-June 2004 from 45 privately owned captive and 8 elephants from the Pinnawala Elephant Orphanage were tested for the presence of antibodies against *Toxoplasma gondii* using the direct modified agglutination test (MAT). Antibodies were found in sera of 14 of 45 (32%) privately owned elephants with titers of 1:25 in three, 1:50 in three, 1:100 in three, 1:200 in three, and 1:400 in three elephants. The elephants from Pinnawala Elephant Orphanage were seronegative. This is the first report of *T. gondii* seroprevalence in elephants in Sri Lanka.

Descriptors: Toxoplasma, seroprevalence, antibodies, captive elephants, Sri Lanka, serum, modified agglutination test, MAT.

Jani, R.G. (2008). **Prevalence and hemato biochemical studies of gastrointestinal parasites of Indian elephants (*Elephas maximus*).** *Veterinary World* 1(10): 296-298. ISSN: 0972-8988.

Abstract: Fecal samples were collected from 40 Indian elephants (*Elephas maximus*). The

examination revealed a 62.5% prevalence of parasites in the elephants. Among the single infection with parasites, a high prevalence of *Fasciola* spp. (15.00%) was observed followed by mixed infections. The elephants harbouring parasites were clinically dull, depressed and lethargic. About 48% of the elephants manifested dehydration and loose feces as well as the habit of soil licking. The hematological studies of elephants harboring parasites revealed mild anaemia and eosinophilia, whereas biochemical studies revealed insignificant hypoproteinaemia. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, anemia, blood chemistry, dehydration, hypoproteinaemia, infections, parasitoses.

McAloon, F.M. (2004). **Oribatid mites as intermediate hosts of *Anoplocephala manubriata*, cestode of the Asian elephant in India.** *Experimental and Applied Acarology* 32(3): 181-5.

NAL Call Number: SB940 .E9

Abstract: *Anoplocephala manubriata* (Cestoda: Anoplocephalidae) is a tapeworm that parasitizes both African (*Loxodonta africana*) and Asian (*Elephas maximus*) elephants. Its life cycle has not yet been completely elucidated nor have intermediate hosts been previously reported. Soil and substrate was collected in the Kodanadu Forest Range, Ernakulum District and Guruvayur Devaswom Temple grounds, Thrissur District, in Kerala, India. Oribatid mites (Acari: Oribatida) were collected from dung piles near captive elephants' bedding and examined for immature stages of the tapeworm. Five species of oribatids were found to contain at least one immature life stage of *A. manubriata*: *Galumna flabellifera orientalis* Hammer 1958, *Scheloribates latipes* (C.L. Koch 1844), *S. praeincisus* (Berlese 1913), *Protoribates seminudus* (Hammer 1971), and *P. triangularis* (Hammer 1971).

Descriptors: Cestoda growth and development, cestode infections, mites parasitology, cestode infections parasitology, cestode infections transmission, India, mite infestations parasitology, mite infestations.

Saseendran, P.C., S. Rajendran, R. Subramanian, M. Sasikumar, G. Vivek, and K.S. Anil (2004). **Incidence of helminthic infection among annually dewormed captive elephants.** *Zoos' Print Journal* 19(3): 1422.

Descriptors: captive elephants, helminthic infection, dewormed, incidence.

[Back to Top](#)

[<< Table of Contents](#)

[<< Previous](#) | [Next >>](#)

Last Modified: Jan 23, 2014

[Home](#)[About AWIC](#)[Publications](#)[Workshops](#)[Services](#)[News and Events](#)[Help](#)[Contact Us](#)

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- ▷ Research Animals
- ▷ Farm Animals
- ▷ Zoo, Circus and Marine Animals
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- ▷ Government and Professional Resources
- ▷ Alternatives
- ▷ Literature Searching and Databases
- ▷ Pain and Distress
- ▷ Humane Endpoints and Euthanasia

You are here: [Home](#) / [Publications](#) / [Bibliographies and Resource Guides](#) / [Information Resources on Elephants](#) / [Asian Elephants - Reproductive](#)

 [Printer Friendly Page](#)

Publications

Information Resources on Elephants

[<< Table of Contents](#)
[<< Previous](#) | [Next >>](#)

Asian Elephants

- [Anatomy / Histology / Physiology](#)
- [Anesthesia / Analgesia / Sedation / Capture](#)
- [Behavior / Care / Enrichment / Handling / Training](#)
- [Blood / Circulation / Cardiac / Hematology](#)
- [Communication / Vocal / Hearing](#)
- [Digestive / Food / Nutrition](#)
- [Diseases / Conditions](#)
- [Genetics / DNA](#)
- [Parasites](#)
- [Reproductive](#)
- [Research](#)
- [Veterinary](#)

Reproductive

Agnew, D.W., L. Munson, and E.C. Ramsay (2004). **Cystic endometrial hyperplasia in elephants.** *Veterinary Pathology* 41(2): 179-83.

NAL Call Number: 41.8 P27

Abstract: Most captive female elephants are nulliparous and aged and many have endometrial disease, factors that may hinder fertility. This study characterized the pathologic features and demographic distribution of endometrial lesions from 27 captive Asian (*Elephas maximus*) and 13 African elephants (*Loxodonta africanus*), 12- to 57-years of age. The principal lesion was marked cystic and polypoid endometrial hyperplasia (CEH), present in 67% of Asian and 15% of African elephants ranging from 26 to 57 years. The lower prevalence in African elephants likely reflects their younger age range in this study. Fourteen of 15 affected elephants with breeding information were nulliparous. These results suggest that CEH and polyps are common in aged nulliparous elephants, and the severity of these lesions may impair fertility. These findings will be useful in the interpretation of ultrasonographic findings during reproductive examinations of potential breeding cows. Also, breeding programs should focus on younger animals.

Descriptors: zoo animals, endometrial hyperplasia, endometrium pathology, fertility physiology, polyps, endometrial hyperplasia pathology, histological techniques, polyps pathology, species specificity.

Ball, R.L., J.L. Brown, J. Meyer, J. St. Leger, and J.H. Olsen (2004). **Treatment of anestrus due to hyperprolactinemia with cabergoline in a captive Asian elephant (*Elephas maximus*).** *Proceedings: American Association of Zoo Veterinarians, American Association of Wildlife Veterinarians, Wildlife Disease Association: Health and Conservation of Captive and Free-Ranging Wildlife. Joint Conference, August 28, 2004-September 3, 2004, San Diego, California, American Association of Zoo Veterinarians:* p. 363-365. 660 p.

Descriptors: Asian elephant, anestrus, treatment, hyperprolactinemia, *Elephas maximus*, cabergoline, plasma, serum prolactin levels, hormones, prolactin, ovary.

- Belterman, R., T. Dorresteyn and M. van Wees (Editors) (2005). **Asian Elephant Studbook *Elephas Maximus. Europe Regional EAZA - EEP***, Rotterdam Zoo: Rotterdam, 76 p.
Descriptors: Asian elephant, *Elephas maximus*, Europe, studbook.
- Brown, J.L., F. Goritz, N. Pratt Hawkes, R. Hermes, M. Galloway, L.H. Graham, C. Gray, S.L. Walker, A. Gomez, and R. Moreland (2004). **Successful artificial insemination of an Asian elephant at the National Zoological Park**. *Zoo Biology* 23(1): 45-63. ISSN: 0733-3188.
NAL Call Number: QL77.5.Z6
Descriptors: Asian elephant, successful artificial insemination, National Zoo, reproduction.
- Brown, J.L., D. Olson, M. Keele, and E.W. Freeman (2004). **Survey of the reproductive cyclicity status of Asian and African elephants in North America**. *Zoo Biology* 23(4): 309-321. ISSN: 0733-3188.
NAL Call Number: QL77.5.Z6
Descriptors: reproductive cyclicity, status, survey, African elephant, Asian elephant, North America.
- Brown, J.L., S.L. Walker, and T. Moeller (2004). **Comparative endocrinology of cycling and non-cycling Asian (*Elephas maximus*) and African (*Loxodonta africana*) elephants**. *General and Comparative Endocrinology* 136(3): 360-70.
NAL Call Number: 444.8 G28
Abstract: Up to 14% of Asian and 29% of African elephants in captivity are not cycling normally or exhibit irregular cycles based on progesterin profiles. To determine if ovarian acyclicity is related to other disruptions in endocrine activity, serum pituitary, thyroid, adrenal, and ovarian hormones in weekly samples collected for 6-25 months were compared between normal cycling (n=22 each species) and non-cycling (n=6 Asian; n=30 African) elephants. A subset of cycling females (n=4 Asian, 7 African) also were blood sampled daily during the follicular phase to characterize the peri-ovulatory period. In normal cycling females, two luteinizing hormone (LH) surges were observed 3 weeks apart during a normal follicular phase, with the second inducing ovulation (ovLH). Serum FSH concentrations were highest at the beginning of the non-luteal phase, declining to nadir concentrations within 4 days of the ovLH surge. FSH remained low until after the ovLH surge and then increased during the luteal phase. A species difference was noted in prolactin secretion. In the African elephant, prolactin was increased during the follicular phase, but in Asian elephants concentrations remained stable throughout the cycle. Patterns of thyroid hormones (thyroid-stimulating hormone, TSH; free and total thyroxine, T4; free and total triiodothyronine, T3) and cortisol secretion were not affected by estrous cycle stage or season in cycling elephants. In non-cycling elephants, there were no fluctuating patterns of LH, FSH, or prolactin secretion. Overall mean concentrations of all hormones were similar to those in cycling animals, with the exception of FSH, prolactin, and estradiol. Mean serum FSH concentrations were lower due to females not exhibiting normal cyclic increases, whereas serum estradiol was higher overall in most acyclic females. Prolactin concentrations were significantly increased in 11 of 30 non-cycling females, all of which were African elephants. In sum, while there were no consistent endocrine anomalies associated with ovarian acyclicity, hyperprolactinemia may be one cause of ovarian dysfunction. The finding of elevated estrogens in some acyclic females also deserves further investigation, especially determining how it relates to reproductive tract pathologies.
Descriptors: physiology, estrous cycle physiology, ovary physiology, blood, estradiol blood, estrous cycle blood, follicle stimulating hormone blood, hydrocortisone blood, luteinizing hormone blood, prolactin blood, seasons, species specificity, thyrotropin blood, thyroxine blood, triiodothyronine blood.
- Brown, J.L. and T.B. Hildebrandt (2003). **The science behind elephant artificial insemination**. *Biology of Reproduction* 68(Supplement 1): 95-96. ISSN: 0006-3363.
NAL Call Number: QL876.B5
Descriptors: reproduction, artificial insemination, clinical techniques, captive breeding, sperm cryopreservation, transrectal ultrasound, diagnostic techniques, imaging, estrous cycle, ovulation, parturition, pregnancy.
- Czekala, N.M., E.A. MacDonald, K. Steinman, S. Walker, N.W.I. Garrigues, D. Olson, and J.L. Brown (2003). **Estrogen and LH dynamics during the follicular phase of the estrous cycle in the Asian elephant**. *Zoo Biology* 22(5): 443-454. ISSN: 0733-3188.
NAL Call Number: QL77.5.Z6
Descriptors: Asian elephant, estrogen, LH, dynamics, follicular phase, estrus cycle, reproduction.
- Dahl, N.J., D. Olson, D.L. Schmitt, D.R. Blasko, R.S. Kristipati, and J.F. Roser (2004). **Development of an enzyme-linked immunosorbent assay (ELISA) for luteinizing hormone (LH) in the elephant (*Loxodonta africana* and *Elephas maximus*)**. *Zoo*

Biology 23(1): 65-78. ISSN: 0733-3188.

NAL Call Number: QL77.5.Z6

Descriptors: African elephant, Asian elephant, ELISA, luteinizing hormone, enzyme-linked immunosorbent assay, LH, development.

Dahl, N.J., D.L. Schmitt, D.R. Blasko, and J.F. Roser (2004). **A progesterone (p4) rise prior to and during the ovulatory luteinizing hormone (ovlh) peak may facilitate fertile ovulations in the African and Asian elephant (*Loxodonta africana* and *Elephas maximus*).** *Biology of Reproduction*(Special Issue): 102-103. ISSN: 0006-3363.

NAL Call Number: QL876.B5

Descriptors: reproduction, infertility, disease, reproductive system disease, fertile, ovulation, progesterone rise, ovulatory luteinizing hormone, peak.

Dehnhard, M., J.M. Hatt, K. Eulenberger, A. Ochs, and G. Strauss (2003). **Headspace solid-phase microextraction (SPME) and gas chromatography-mass spectrometry (GC-MS) for the determination of 5alpha-androst-2-en-17-one and -17beta-ol in the female Asian elephant: application for reproductive monitoring and prediction of parturition.** *Journal of Steroid Biochemistry and Molecular Biology* 84(2-3): 383-91.

NAL Call Number: QD426.A1J6

Abstract: Asian elephants are not self-sustaining in captivity. The main reasons for this phenomenon are a low birth rate, an aging population, and poor calf-rearing. Therefore, it is essential that reproductive rates had to be improved and there is need for rapid quantitative measures to monitor reproductive functions focussing on estrous detection and the prediction of the period of parturition. The objective of this study was to develop a method which combines headspace solid-phase microextraction (SPME) and gas chromatography-mass spectrometry (GC-MS) for analyses of 5alpha-androst-2-en-17beta-ol and -17-one to prognose estrous and to predict the period of parturition. SPME was carried out with a CTC Combi Pal system. The course of the luteal phase-specific substance 5alpha-androst-2-en-17beta-ol and -17-one followed a cyclic pattern in which the follicular and luteal phases could be clearly distinguished (mean estrous cycle length, 15 +/- 1.4 weeks). Based on daily urine samples, estrous prognosis might be possibly based on the initial 5alpha-androst-2-en-17beta-ol increase at the end of the follicular phase. Parturition prognosis was performed in three elephant cows based on the 5alpha-androst-2-en-17beta-ol drop to baseline levels 5-4 days prior parturition. Experiments revealed that 5alpha-androst-3alpha-ol-17-one and probably 5alpha-androst-3alpha-ol-17beta-ol are generated from sulfate conjugates by a thermal process.

Descriptors: androstane 3,17 diol blood, androsterone blood, chemistry, clinical methods, mass fragmentography methods, parturition blood, chromatography, gas, estrous cycle, pregnancy, animal blood, temperature, time factors.

Duer, C., M. Carden, and T. Tomasi (2007). **Detection of fetal gender differences in maternal serum progesterone concentrations of Asian elephants (*Elephas maximus*).** *Animal Reproduction Science* 97(3/4): 278-283. ISSN: 0378-4320.

Abstract: Previous studies have analysed total testosterone concentrations in maternal serum for a reliable method of fetal gender determination in Asian elephants (*Elephas maximus*). The present study investigated the possibility that progesterone concentrations in maternal serum may reflect these testosterone patterns. Weekly serum samples were collected from 17 pregnancies in captive Asian elephants and analysed via radioimmunoassay (RIA) for progesterone concentrations. Nine and eight cows carried male and female calves, respectively. Mean progesterone concentrations in maternal serum of elephants carrying male calves were greater than in those carrying female calves (P<0.01). Mean progesterone concentrations (based on 5-week means) in maternal serum were greater at weeks 20-55 (P<0.01) and 60-65 (P<0.05) for elephants carrying male calves. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, pregnancy, progesterone, sex determination, sex differences, testosterone.

Freeman, E.W., E. Weiss, and J.L. Brown (2004). **Examination of the interrelationships of behavior, dominance status, and ovarian activity in captive Asian and African elephants.** *Zoo Biology* 23(5): 431-448. ISSN: 0733-3188.

NAL Call Number: QL77.5.Z6

Descriptors: ovarian activity, Asian elephants, African elephants, dominance status, behavior, interrelationships.

Graham, L.H., J. Bando, C. Gray, and M.M. Buhr (2004). **Liquid storage of Asian elephant (*Elephas maximus*) sperm at 4 degrees C.** *Animal Reproduction Science* 80(3-4): 329-40.

NAL Call Number: QP251.A5

Abstract: The Asian elephant (*Elephas maximus*) population in the wild has been in decline for several decades and breeding in captivity has not been self-sustaining. The use of artificial insemination (AI) can help overcome many of the difficulties associated with breeding elephants in captivity; however, the ability to store semen for extended periods of time is critical to the successful application of AI to elephants. The objective of the present study was to assess the effects of four different semen extenders and the presence of egg yolk on the viability and motility of Asian elephant semen stored at 4

degrees C. High quality ejaculates (n=4) were collected from two Asian elephant bulls by rectal massage. Aliquots of each ejaculate were extended in four different diluents (Beltsville thawing solution (BTS); Tris-citric acid (TCA)/fructose-based; Beltsville F5 (BF5); dextrose-supplemented phosphate-buffered saline (PBS)) with or without egg yolk then cooled and stored at 4 degrees C. The percentages of viable (viability) and motile (motility) sperm were evaluated at 8, 24 and 48 h following collection. The addition of egg yolk significantly reduced the percentage loss in viability from initial collection to 48 h compared to extenders without egg yolk (17.0 +/- 8.2 versus 32.6 +/- 8.9 decline in percent viable sperm in the population, respectively; P<0.05). Extender and egg yolk affected (P<0.005) total motility and percent progressively motile sperm at all evaluation times during incubation. TCA + egg yolk maintained higher (P<0.05) levels of progressive motility compared to other extenders supplemented with egg yolk. These results indicate that Asian elephant semen extended in TCA diluent supplemented with egg yolk can maintain at least 50% viability and motility when stored at 4 degrees C for 48 h.

Descriptors: semen preservation, spermatozoa physiology, breeding, buffers, cell survival, cold, egg yolk, ejaculation, artificial insemination, semen preservation methods, sperm motility, tissue and organ harvesting methods.

Graham, L.H., C. Gray, and M.M. Buhr (2004). **Influence of cryoprotectant type and concentration on post-thaw characteristics of cryopreserved Asian elephant (*Elephas maximus*) semen.** *Biology of Reproduction*(Special Issue): 236. ISSN: 0006-3363.

NAL Call Number: QL876.B5

Descriptors: semen, cryopreservation, Asian elephant, post thaw, characteristics, cryoprotectant, influence.

Hama, N., A. Yamada, A. Noda, K. Murata, Y. Shimada, M. Ashida, K.M.Y. Ishikawa, and K. Okuno (2003). **Serum hormonal changes in a female Asian elephant (*Elephas maximus*) with stillbirth.** *Japanese Journal of Zoo and Wildlife Medicine* 8(2): 109-113. ISSN: 1342-6133.

Descriptors: Asian elephant, female, hormonal changes, seasonal, stillbirth, serum, progesterone, estradiol, prolactin, radioimmunoassay, RIA.

Language of Text: Japanese, with English summary.

Hermes, R., B. Behr, T.B. Hildebrandt, S. Blottner, B. Sieg, A. Frenzel, A. Knieriem, J. Saragusty, and D. Rath (2009). **Sperm sex-sorting in the Asian elephant (*Elephas maximus*).** *Animal Reproduction Science* 112(3/4): 390-396. ISSN: 0378-4320.

Online: <http://dx.doi.org/10.1016/j.anireprosci.2008.05.007>

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+or-0.7% at an average sort rate of 1945.5+or-187.5 spermatozoa per second. Sperm integrity, progressive and total motility were 42.6+or-3.9%, 48.1+or-3.3%, 59.4+or-3.8% after DNA labelling, and 64.8+or-3.2%, 58.0+or-5.0%, 70.8+or-4.4% after sorting, respectively. After liquid storage of sorted spermatozoa for 12 h at 4 degrees C, sperm integrity, progressive and total motility were 46.4+or-5.2%, 32.2+or-4.2% and 58.2+or-3.9%, respectively. The obtained results provide a promising base to inseminate Asian elephants with sexed semen. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, artificial insemination, bulls, semen, sexual reproduction, spermatozoa, storage.

Kirtland, J. (2003). **Dreams and false promises: Asian elephant reproduction in North America.** *American Zoo and Aquarium Association Annual Conference Proceedings* 2003: 49-54.

NAL Call Number: QL76.5.U6A472

Descriptors: Asian elephant, *Elephas maximus*, breeding programs, North America, reproduction.

Lazar, J., L.E. Rasmussen, D.R. Greenwood, I.S. Bang, and G.D. Prestwich (2004). **Elephant albumin: a multipurpose pheromone shuttle.** *Chemistry and Biology* 11(8): 1093-100.

Abstract: (Z)-7-dodecenyl acetate (Z7-12:Ac) is present in the urine of female Asian elephants (*Elephas maximus*) approaching ovulation and functions as a female-to-male sex pheromone. Here we show that a significant fraction of the pheromone in the urine is bound to a protein, elephant serum albumin (ESA), and provide evidence for key physiological functions of urinary ESA. Our biochemical and behavioral experiments

suggest a three-fold role of ESA in pheromone signaling: (1) transporting Z7-12:Ac from serum into urine; (2) extending the presence of the pheromone in the environment without hampering detection; and (3) targeting pheromone delivery to chemosensory organs through localized release of the ligand induced by a pH change. The exploitation of albumin in pheromone transport clearly distinguishes the elephant from other mammals studied, and complements the uniqueness of elephant anatomy, physiology, and behavior.

Descriptors: acetates metabolism, albumins metabolism, pheromones metabolism, acetates urine, albumins chemistry, albumins genetics, biological availability, biological transport, cloning, molecular, hydrogen ion concentration, molecular structure, pheromones urine, substrate specificity, time factors, urine chemistry.

Meyer, J.M., S.L. Walker, E.W. Freeman, B.G. Steinetz, and J.L. Brown (2004). **Species and fetal gender effects on the endocrinology of pregnancy in elephants.** *General and Comparative Endocrinology* 138(3): 263-270.

NAL Call Number: 444.8 G28

Abstract: Quantitative and temporal progestin profiles vary during gestation in the elephant, sometimes making it difficult to determine if a pregnancy is progressing normally. The aim of the present study was to determine if circulating progestin variability was related to species or fetal gender effects. A similar comparison also was conducted for secretory profiles of prolactin, relaxin, and cortisol. Overall mean progestin concentrations during gestation in Asian (n = 19) and African (n = 8) elephants were similar; however, the temporal profiles differed (P < 0.001). Concentrations were higher in African elephants during the first half of pregnancy, but then declined to levels below those observed in Asian elephants (P < 0.05). There also was a fetal gender effect in Asian, but not African elephants. Progestin concentrations were higher in Asian cows carrying male calves (n = 9) as compared to those carrying females (n = 10) (P < 0.001). Overall prolactin concentrations were higher in Asian than in African elephants between 8 and 15 months of gestation (P < 0.001). There were no species differences in the secretory patterns of relaxin. Cortisol was relatively stable until the end of gestation when significant surges were observed, mainly between 8 and 11 days before parturition, and again on the day of birth. In sum, a comparison of progestin patterns between Asian and African elephants identified notable differences related to species and fetal gender. A role for cortisol in the initiation of parturition also was inferred from these data. From a practical standpoint, understanding the factors affecting gestational hormone characteristics and recognizing what the species differences are will help ensure that data used in diagnosing and monitoring elephant pregnancies are properly interpreted.

Descriptors: blood, embryology, hydrocortisone in blood, maternal fetal exchange physiology, pregnancy, progestins in blood, analysis of variance, fetus, prolactin in blood, relaxin in blood, sex factors, species specificity.

Oliveira, C.A., E.C.G. Felipe, and M.O.M. Chelini (2008). **Serum cortisol and progestin concentrations in pregnant and non-pregnant Asian elephants (*Elephas maximus*).** *Research in Veterinary Science* 84(3): 361-363. ISSN: 0034-5288.

Online: <http://dx.doi.org/10.1016/j.rvsc.2007.05.009>

Abstract: Blood samples were collected during the estrous cycle (n=3), throughout gestation (n=3), and during the periparturient period (n=11) to assess serum concentrations of cortisol in pregnant and non-pregnant Asian elephants whose reproductive status was being monitored by serum progestin determination. While serum cortisol concentrations remained constant throughout gestation, progestin concentrations decreased significantly (p<0.05) in the second half of pregnancy, declining to undetectable levels by 3 days before calving. During the non-luteal phase of the estrous cycle serum progestins varied from undetectable levels to 100 pg/ml (53+or-10.7 pg/ml) then increased steadily during the luteal phase (322+or-207.5 pg/ml). There were no significant differences between serum cortisol concentrations during the luteal and those of the non-luteal phase (p>0.05). The mean cortisol concentration during the estrous cycle was about twice that during pregnancy (p>0.05). No substantial changes in maternal cortisol were found during the course of pregnancy or the periparturient period. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, blood chemistry, circus animals, hydrocortisone, estrous cycle, pregnancy, progesterone.

Portas, T.J., B.R. Bryant, F. Goritz, R. Hermes, T. Keeley, G. Evans, W.M.C. Maxwell, and T.B. Hildebrandt (2007). **Semen collection in an Asian elephant (*Elephas maximus*) under combined physical and chemical restraint.** *Australian Veterinary Journal* 85(10): 425-427. ISSN: 1751-0813.

Online: <http://dx.doi.org/10.1111/j.1751-0813.2007.00207.x>

Abstract: This article describes technique of manual stimulation for semen collection in a captive 50-year-old male Asian elephant (*Elephas maximus*) in New South Wales, Australia, physically restrained in a restraint chute and anesthetized with a combination of xylazine (Xylazil-100) and butorphanol (Torbugesic). This technique was effective for semen collection on the same animal for three occasions, but cannot be recommended for routine and repeated use due to the potential risk associated with anesthesia. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, anesthesia, anesthetics, butorphanol,

restraint of animals, semen, techniques, xylazine, zoo animals.

Rasmussen, L., V. Krishnamurthy, and R. Sukumar (2005). **Behavioural and chemical confirmation of the preovulatory pheromone, (Z) -7-dodecenyl acetate, in wild Asian elephants: its relationship to musth.** *Behaviour* 142(3): 351-396. ISSN: 0005-7959.

NAL Call Number: 410 B393

Descriptors: Asian elephant, *Elephas maximus*, age, reproductive behavior, musth, mating strategies, female preovulatory hormone, pheromones, preovulatory urinary hormone, social behavior, India, preovulatory hormone identification, male chemosensory responses.

Rees, P.A. (2004). **Some preliminary evidence of the social facilitation of mounting behavior in a juvenile bull Asian elephant (*Elephas maximus*).** *Journal of Applied Animal Welfare Science* 7(1): 49-58.

NAL Call Number: HV4701.J68

Abstract: This study recorded sexual behavior within a captive herd of 8 Asian elephants for approximately 230 hr on 50 days over a period of 10 months. The study observed a single adult and a single juvenile bull mounting cows more than 160 times. When the juvenile bull was between 4 years, 2 months and 4 years, 8 months old, he exhibited mounting behavior only on days when adult mounting occurred. Adult mounting always occurred first. Beyond the age of 4 years, 8 months, the juvenile bull exhibited spontaneous mounting behavior in the absence of adult mounting. This suggests that mounting behavior may develop because of social facilitation. Determining the significance of the presence of sexually active adults in the normal development of sexual behavior in juveniles will require further studies. Encouraging the establishment of larger captive herds containing adults and calves of both sexes-if their presence is important-would improve the welfare of elephants in zoos and increase their potential conservation value.

Descriptors: sex behavior, social environment, zoo animals.

Sa Ardit, M., J. Saikhun, N. Thongtip, M. Damyang, S. Mahasawangkul, T. Angkawanish, S. Jansittiwate, T. Faisaikarm, Y. Kitiyanant, K. Pavasuthipaisit, and A. Pinyopummin (2006). **Ultrastructural alterations of frozen-thawed Asian elephant (*Elephas maximus*) spermatozoa.** *International Journal of Andrology* 29(2): 346-52.

NAL Call Number: QP251.I55

Abstract: Intact plasma and acrosome membranes and functional mitochondria following cryopreservation are important attributes for the fertilizing ability of spermatozoa. In the present study, functional and ultrastructural changes of Asian elephant spermatozoa after cryopreservation either in TEST + glycerol or HEPT + dimethyl sulphoxide (DMSO) were evaluated by fluorescent techniques and electron microscopy. Sperm frozen in TEST + glycerol had higher proportion of sperm with intact plasma (49.1 +/- 9.2% vs. 30.9 +/- 3.9%) and acrosomal (53.7 +/- 4.9% vs. 35.8 +/- 6.1%) membranes, as well as active mitochondria (57.0 +/- 7.2% vs. 42.0 +/- 5.0%) than those cryopreserved in HEPT + DMSO. The results obtained from electron microscopy were similar to those obtained by fluorescence microscopy. The percentage of normal spermatozoa was higher when spermatozoa were frozen in TEST + glycerol than those frozen in HEPT + DMSO (31.8 +/- 5.6 vs. 28.5 +/- 6.4). The ultrastructural alterations revealed by transmission electron microscopy could be classified as (i) distension of plasma membrane, while the acrosome was swollen; (ii) disruption or loss of plasma membrane, while acrosome was swollen with distended outer acrosomal membrane; (iii) disruption or loss of plasma and outer acrosomal membrane with leakage of acrosome content; (iv) extensive vesiculation of plasma and outer acrosomal membrane and leakage of acrosome content; (v) a complete loss of both plasma membrane and outer acrosomal membrane; and (vi) swelling of mitochondria. These findings suggest that the freezing and thawing procedure caused structural damage to elephant spermatozoa, especially in the plasma membrane, acrosome and mitochondria. Fluorescence and electron microscopic evaluations are potentially a powerful tool in the analysis of elephant spermatozoa after freezing and thawing.

Descriptors: Asian elephant, spermatozoa, frozen, thawed, ultrastructural, alterations, cryopreservation, fertilizing ability.

Saragusty, J., T.B. Hildebrandt, B. Behr, A. Knieriem, J. Kruse, and R. Hermes (2009). **Successful cryopreservation of Asian elephant (*Elephas maximus*) spermatozoa.** *Animal Reproduction Science* 115(1/4): 255-266. ISSN: 0378-4320.

Online: <http://dx.doi.org/10.1016/j.anireprosci.2008.11.010>

Abstract: Reproduction in captive elephants is low and infant mortality is high, collectively leading to possible population extinction. Artificial insemination was developed a decade ago; however, it relies on fresh-chilled semen from just a handful of bulls with inconsistent sperm quality. Artificial insemination with frozen-thawed sperm has never been described, probably, in part, due to low semen quality after cryopreservation. The present study was designed with the aim of finding a reliable semen freezing protocol. Screening tests included freezing semen with varying concentrations of ethylene glycol, propylene glycol, trehalose, dimethyl sulfoxide and glycerol as cryoprotectants and assessing cushioned centrifugation, rapid chilling to suprazero temperatures, freezing

extender osmolarity, egg yolk concentration, post-thaw dilution with cryoprotectant-free BC solution and the addition of 10% (v/v) of autologous seminal plasma. The resulting optimal freezing protocol uses cushioned centrifugation, two-step dilution with isothermal 285 m Osm/kg Berliner Cryomedium (BC) with final glycerol concentration of 7% and 16% egg yolk, and freezing in large volume by the directional freezing technique. After thawing, samples are diluted 1:1 with BC solution. Using this protocol, post-thaw evaluations results were: motility upon thawing: 57.2+or-5.4%, motility following 30 min incubation at 37 degrees C: 58.5+or-6.0% and following 3 h incubation: 21.7+or-7.6%, intact acrosome: 57.1+or-5.2%, normal morphology: 52.0+or-5.8% and viability: 67.3+or-6.1%. With this protocol, good quality semen can be accumulated for future use in artificial inseminations when and where needed. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, artificial insemination, bulls, chilling, cryopreservation, cryoprotectants, dimethyl sulfoxide, egg yolk, eggs, endangered species, ethylene glycol, freezing, gametes, genomes, glycerol, incubation, infant mortality, insemination, mortality, propylene glycol, seminal plasma, sexual reproduction, spermatozoa, thawing.

Saragusty, J., T.B. Hildebrandt, Y. Natan, R. Hermes, S. Yavin, F. Goeritz, and A. Arav (2005). **Effect of egg-phosphatidylcholine on the chilling sensitivity and lipid phase transition of Asian elephant (*Elephas maximus*) spermatozoa.** *Zoo Biology* 24(3): 233-245. ISSN: 0733-3188.

NAL Call Number: QL77.5.Z6

Descriptors: semen extenders, cooling, liposomes artificial, cryopreservation, cryoprotectants, spermatazoa.

Saragusty, J., T.B. Hildebrandt, B. Behr, A. Knieriem, J. Kruse, and R. Hermes (2009). **Successful cryopreservation of Asian elephant (*Elephas maximus*) spermatozoa.** *Animal Reproduction Science* 115(1-4): 255-266. ISSN: 0378-4320.

Online: <http://dx.doi.org/10.1016/j.anireprosci.2008.11.010>

NAL Call Number: QP251.A5

Abstract: Reproduction in captive elephants is low and infant mortality is high, collectively leading to possible population extinction. Artificial insemination was developed a decade ago; however, it relies on fresh-chilled semen from just a handful of bulls with inconsistent sperm quality. Artificial insemination with frozen-thawed sperm has never been described, probably, in part, due to low semen quality after cryopreservation. The present study was designed with the aim of finding a reliable semen freezing protocol. Screening tests included freezing semen with varying concentrations of ethylene glycol, propylene glycol, trehalose, dimethyl sulfoxide and glycerol as cryoprotectants and assessing cushioned centrifugation, rapid chilling to suprazero temperatures, freezing extender osmolarity, egg yolk concentration, post-thaw dilution with cryoprotectant-free BC solution and the addition of 10% (v/v) of autologous seminal plasma. The resulting optimal freezing protocol uses cushioned centrifugation, two-step dilution with isothermal 285mOsm/kg Berliner Cryomedium (BC) with final glycerol concentration of 7% and 16% egg yolk, and freezing in large volume by the directional freezing technique. After thawing, samples are diluted 1:1 with BC solution. Using this protocol, post-thaw evaluations results were: motility upon thawing: 57.2±5.4%, motility following 30min incubation at 37°C: 58.5±6.0% and following 3h incubation: 21.7±7.6%, intact acrosome: 57.1±5.2%, normal morphology: 52.0±5.8% and viability: 67.3±6.1%. With this protocol, good quality semen can be accumulated for future use in artificial inseminations when and where needed. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, spermatozoa, cryopreservation, artificial insemination, reproduction.

Slade, B.E., B. Schulte, and L.E.L. Rasmussen (2003). **Oestrous state dynamics in chemical communication by captive female Asian elephants.** *Animal Behaviour* 65(4): 813-819. ISSN: 0003-3472.

NAL Call Number: Film S-1802

Descriptors: reproductive status, urine, estrus, female, Asian elephants, chemical communication, social group dynamics, chemosensory responses.

Slade Cain, B.E., L.E.L. Rasmussen, and B.A. Schulte (2008). **Estrous state influences on investigative, aggressive, and tail flicking behavior in captive female Asian elephants.** *Zoo Biology* 27(3): 167-180. ISSN: 0733-3188.

Online: <http://dx.doi.org/10.1002/zoo.20181>

NAL Call Number: QL77.5.Z6

Abstract: Females of species that live in matrilineal hierarchies may compete for temporally limited resources, yet maintain social harmony to facilitate cohesion. The relative degree of aggressive and nonaggressive interactions may depend on the reproductive condition of sender and receiver. Individuals can benefit by clearly signaling and detecting reproductive condition. Asian elephants (*Elephas maximus*) live in social matrilineal herds. Females have long estrous cycles (14-16 weeks) composed of luteal (8-12 weeks) and follicular (4-8 weeks) phases. In this study, we observed the behavior of four captive Asian elephant females during multiple estrous cycles over 2 years. We evaluated whether investigative, aggressive, and tail flicking behaviors were related to

reproductive condition. Investigative trunk tip contacts showed no distinct pattern by senders, but were more prevalent toward female elephants that were in their follicular compared with their luteal phase. The genital area was the most frequently contacted region and may release reproductively related chemosignals. Aggression did not differ significantly with estrus; however, rates of aggression were elevated when senders were approaching ovulation and receivers were in the luteal phase. Females in the follicular phase may honestly advertise their condition. Contacts by conspecifics may serve to assess condition and reduce aggression. A behavior termed "tail flicking" was performed mainly during the mid-follicular phase when estrogen and luteinizing hormone levels are known to spike. Tail flicking may disperse chemical signals in urine or mucus as well as act as a tonic signal that could provide a means of anticipating forthcoming ovulation by elephants and also for human observers and caretakers. Reproduced with Permission from CAB Abstracts.

Descriptors: Asian elephant, *Elephas maximus*, estrous cycle, estrus, ovulation, animal behavior, social behavior, aggression, tail, touch, animal communication, zoo animals, follicular phase, luteal phase, female behavior, investigative behavior, tactile behavior.

Teng MingSheng, Yang XiaoLi, and Wu DengHu (2003). **Characteristics of reproductive biology of Asian elephants.** *Chinese Journal of Zoology* 38(6): 86-90. ISSN: 0250-3263.

NAL Call Number: QL1.T8

Descriptors: reproductive biology, characteristics, Asian elephant, mating, estrus, parturition, pregnancy, reproduction, *Elephas maximus*, fetuses, gestation.

Language of Text: Chinese, with English summary.

Thitaram, C., J.L. Brown, P. Pongsopawijit, S. Chansitthiwet, W. Wongkalasin, P. Daram, R. Roongsri, A. Kalmapijit, S. Mahasawangkul, and S. Rojansthien (2008). **Seasonal effects on the endocrine pattern of semi-captive female Asian elephants (*Elephas maximus*): Timing of the anovulatory luteinizing hormone surge determines the length of the estrous cycle.** *Theriogenology* 69(2): 237-244. ISSN: 0093-691X.

Online: <http://dx.doi.org/10.1016/j.theriogenology.2007.09.018>

NAL Call Number: QP251.A1T5

Abstract: Better breeding strategies for captive Asian elephants in range countries are needed to increase populations; this requires a thorough understanding of their reproductive physiology and factors affecting ovarian activity. Weekly blood samples were collected for 3.9 years from 22 semi-captive female Asian elephants in Thai elephant camps to characterize LH and progesterone patterns throughout the estrous cycle. The duration of the estrous cycle was 14.6 ± 0.2 weeks (mean ± S.E.M.; n = 71), with follicular and luteal phases of 6.1 ± 0.2 and 8.5 ± 0.2 weeks, respectively. Season had no significant effect on the overall length of the estrous cycle. However, follicular and luteal phase lengths varied among seasons and were negatively correlated (r = -0.658; P < 0.01). During the follicular phase, the interval between the decrease in progesterone concentrations to baseline and the anovulatory LH (anLH) surge varied in duration (average 25.9 ± 2.0 days, range 7-41, n = 23), and was longer in the rainy season (33.4 ± 1.8 days, n = 10) than in both the winter (22.2 ± 4.5 days, n = 5; P < 0.05) and summer (18.9 ± 2.6 days, n = 8; P < 0.05). By contrast, the interval between the anLH and ovulatory LH (ovLH) surge was more consistent (19.0 ± 0.1 days, range 18-20, n = 14). Thus, seasonal variation in estrous cycle characteristics were mediated by endocrine events during the early follicular phase, specifically related to timing of the anLH surge. Overall reproductive hormone patterns in Thai camp elephants were not markedly different from those in western zoos. However, this study was the first to more closely examine how timing of the LH surges impacted estrous cycle length in Asian elephants. These findings, and the ability to monitor reproductive hormones in range countries (and potentially in the field), should improve breeding management of captive and semi-wild elephants. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, anovulation, luteinizing hormone, progesterone hormones, hormone secretion, temporal variation, seasonal variation, estrous cycle, duration, Thailand, follicular phase, luteal phase.

Thitaram, C., P. Pongsopawijit, S. Chansitthiwet, J.L. Brown, K. Nimtragul, K. Boonprasert, P. Homkong, S. Mahasawangkul, S. Rojanasthien, B. Colenbrander, G.C. van derWeijden, and F.J.C.M. van Eerdenburg (2009). **Induction of the ovulatory LH surge in Asian elephants (*Elephas maximus*): a novel aid in captive breeding management of an endangered species.** *Reproduction, Fertility and Development* 21(5): 672-678. ISSN: 1031-3613.

Online: <http://dx.doi.org/10.1071/RD08296>

Abstract: A unique feature of the reproductive physiology of Asian elephants (*Elephas maximus*) is the occurrence of two LH surges before ovulation, instead of one. An anovulatory LH (anLH) surge, the function of which is unknown, occurs consistently 3 weeks before the ovulatory LH (ovLH) surge that induces ovulation. Thus, the ability to induce an ovLH surge would be useful for scheduling natural mating or artificial insemination. The present study tested the efficacy of a gonadotrophin-releasing hormone agonist (GnRH-Ag) to induce LH surges during the follicular phase of the estrous cycle, which resulted in varied LH responses, but generally none were as high as previously documented natural surges. Thus, for the ovulation-induction trials, nine females were

administered 80 micro g GnRH-Ag intravenously at three time periods during the estrous cycle, namely the anovulatory follicular phase, the ovulatory follicular phase and the luteal phase. During the late anovulatory follicular phase, nine of 10 females (90%) responded with an immediate LH surge followed 15-22 days later by an ovLH surge or a post-ovulatory increase in progesteragens. In contrast, despite responding to the GnRH-Ag with an immediate increase in LH, none of the females treated during other periods of the estrous cycle exhibited subsequent ovLH surges. One cow got pregnant from natural mating following the induced ovLH surge. In conclusion, ovLH induction is possible using a GnRH-Ag, but only during a specific time of the anovulatory follicular phase. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, animal breeding, breeding programmes, endangered species, gonads, estrous cycle, Hollyhock leaf crumple virus.

Thitaram, C., S. Chansitthiwet, P. Pongsopawijit, J.L. Brown, W. Wongkalasin, P. Daram, R. Roongsri, A. Kalmapijit, S. Mahasawangkul, S. Rojanasthien, B. Colenbrander, G.C. van der Weijden, and F.J.C.M. van Eerdenburg (2009). **Use of genital inspection and female urine tests to detect estrus in captive Asian elephants.** *Animal Reproduction Science* 115(1-4): 267-278. ISSN: 0378-4320.

Online: <http://dx.doi.org/10.1016/j.anireprosci.2008.11.017>

NAL Call Number: QP251.A5

Abstract: Captive Asian elephant (*Elephas maximus*) populations are decreasing due to low birth rates compared to wild elephants. Improving estrous detection in female elephants is required to ensure successful mating in captive and semi-captive herds. Responsive behaviours of eight semi-captive bull elephants to the uro-genital area (genital inspection test) or urinary pheromones (urine test) of 14 female elephants throughout the estrous cycle were evaluated. Weekly blood samples were collected for 27 consecutive months (14 months for the genital inspection test and 13 months for the urine test) from female elephants to characterize the patterns of circulating progesteragen. Responsive behaviours of bulls were compared between females in the follicular versus the luteal phase of the cycle. The sensitivity and specificity of the genital inspection test were 65% and 68%, while those of the urine test were 52% and 61%, respectively. The bulls showed significantly higher genital inspection, flehmen from genital area and trunk on back behaviours during the genital inspection test, and flehmen behaviours during the urine test in oestrous than in non-estrous females. In sum, this study showed that monitoring sexual behaviours of Asian elephant bulls towards females or their urine can be used to detect the estrous period. Although the sensitivity and specificity of both tests were not as high as expected, still, these methods appear to be more efficient at detecting estrous than traditional methods based on mahout estimations of female receptivity. The use of genital inspection and urine tests may lead to more successful matings and thus to creating self-sustaining populations of captive elephants in range countries. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, genital inspection, urine tests, estrus detection, female, captive, matings.

Thongtip, N., M. Damyang, S. Mahasawangkul, A. Kongsila, T. Angkawanich, S. Jansittiwate, C. Thitaram, and P. Phongsopawijit (2003). **Frozen semen artificial insemination in Asian elephants (*Elephas maximus*) using endoscope and ultrasound guide.** *Proceedings of 41st Kasetsart University Annual Conference, Subject: Animals and Veterinary Medicine, February 3, 2003-February 7, 2003, Bangkok, Thailand: Kasetsart University, Bangkok, Thailand, p. 652-657.*

Descriptors: Asian elephant, frozen semen, artificial insemination, endoscopy, cervix, thawed semen, ultrasonography, *Elephas maximus*.

Language of Text: Thai, with English summary.

Thongtip, N., J. Saikhun, M. Damyang, S. Mahasawangkul, P. Suthunmapinata, M. Yindee, A. Kongsila, T. Angkawanish, S. Jansittiwate, and W. Wongkalasin (2004). **Evaluation of post-thaw Asian elephant (*Elephas maximus*) spermatozoa using flow cytometry: the effects of extender and cryoprotectant.** *Theriogenology* 62(3-4): 748-760. ISSN: 0093-691X.

NAL Call Number: QP251.A1T5

Abstract: Although the development of semen cryopreservation in the African elephants (*Loxodonta africana*) has been accomplished, effective procedures for cryopreservation of Asian elephant (*Elephas maximus*) spermatozoa have not been established. In the present study, we investigate the freezing methods for conservation of Asian elephant spermatozoa under field conditions and identify the most suitable freezing protocols which provide acceptable post-thaw semen quality. Semen was collected from two Asian elephant bulls (EM1 and EM2, 10 ejaculates from each bull) by manual manipulation and were assessed for volume, pH, sperm cell concentration, and progressive motility. Eight out of 20 ejaculates were of acceptable quality (progressive motility greater than or equal to 60%), and were used for cryopreservation studies. Semen were frozen in TEST+glycerol, TEST+DMSO, HEPT+glycerol, or HEPT+DMSO. The post-thaw progressive sperm motilities were assessed, and sperm cells were stained with PI and FITC-PNA for membrane and acrosomal integrity assessment using flow cytometry. Post-thaw progressive motility of spermatozoa (EM1: 42.0±4.3%; EM2: 26.0±17.3%) and the percentage of membrane and acrosome intact spermatozoa (EM1: 55.5±8.1%; EM2:

46.3±6.4%) cryopreserved in TEST+glycerol were significantly higher than (P<0.05) those frozen in the other medium investigated choices for cryopreservation of Asian elephant spermatozoa. The data support the use of TEST+glycerol as an acceptable cryopreservation media of Asian elephant semen for the establishment of sperm banks.

Descriptors: *Elephas maximus*, spermatozoa, cryopreservation, semen extenders, cryoprotectants, flow cytometry, freezing, thawing, sperm motility, glycerol, dimethyl sulfoxide, plasma membrane, membrane permeability, acrosome reaction, male fertility, membrane integrity.

Thongtip, N., J. Saikhun, S. Mahasawangkul, K. Kornkaewrat, P. Suthanmapinanh, and A. Pinyopummin (2008). **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): 37-45. ISSN: 0125-6491.

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 (*Elephas maximus*), 14 semen collection attempts in 9 elephant bulls in Thailand by manual stimulation were undertaken and eleven ejaculates fitted the criteria of investigation (0-30% motility). These were divided into 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. The semen samples were incubated at 37 degrees C for 15 and 30 min 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 maintained the percentage of total and progressive motility, path velocity and progressive velocity at a higher level than the control group. The present study indicates that PTX added to low motility semen does not increase elephant semen quality. However, it may partially have a tendency to maintain sperm motility and sperm movement characteristics. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, male fertility, motility, pentoxifylline, semen, semen characters, spermatozoa, velocity.

Language of Text: Thai.

Vandebona, H., N.C.W. Goonesekere, W.D. Ratnasooriya, J. Alahakoon, and M.B. Gunasekera (2005). **Using dna fingerprinting to establish paternity of Asian elephants, *Elephas maximus*, born at Pinnawela Elephant Orphanage, Sri Lanka.** *Annales Academiae Regiae Scientiarum Upsaliensis* 39: 214-221. ISSN: 0504-0736.

Descriptors: Asian elephants, paternity identification, DNA fingerprinting, blood samples, genetic diversity, breeding programs, estrus, mating, Sri Lanka.

Yon, L., S. Kanchanapangka, N. Chaiyabutr, S. Meehan, F.Z. Stanczyk, N. Dahl, and B. Lasley (2007). **A longitudinal study of LH gonadal and adrenal steroids in four intact Asian bull elephants (*Elephas maximus*) and one castrate African bull (*Loxodonta africana*) during musth and non-musth periods.** *General and Comparative Endocrinology* 151(3): 241-245. ISSN: 0016-6480; Online: 1095-6840.

Descriptors: African elephant, *Loxodonta africana*, Asian elephant, *Elephas maximus*, endocrine system, reproduction, castration, musth cycle.

[Back to Top](#)

[<< Table of Contents](#)

[<< Previous](#) | [Next >>](#)

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[<< Table of Contents](#)
[<< Previous](#) | [Next >>](#)

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- [Anatomy / Histology / Physiology](#)
- [Anesthesia / Analgesia / Sedation / Capture](#)
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- [Genetics / DNA](#)
- [Parasites](#)
- [Reproductive](#)
- [Research](#)
- [Veterinary](#)

Research

Campos Arceiz, A., A.R. Larrinaga, U.R. Weerasinghe, S. Takatsuki, J. Pastorini, P. Leimgruber, P. Fernando, and L. Santamaria (2008). **Behavior rather than diet mediates seasonal differences in seed dispersal by Asian elephants.** *Ecology* 89(10): 2684-2691. ISSN: 0012-9658.

Online: <http://dx.doi.org/10.1890/07-1573.1>

Abstract: Digestive physiology and movement patterns of animal dispersers determine deposition patterns for endozoochorously dispersed seeds. We combined data from feeding trials, germination tests, and GPS telemetry of Asian elephants (*Elephas maximus*) to (1) describe the spatial scale at which Asian elephants disperse seeds; (2) assess whether seasonal differences in diet composition and ranging behavior translate into differences in seed shadows; and (3) evaluate whether scale and seasonal patterns vary between two ecologically distinct areas: Sri Lanka's dry monsoon forests and Myanmar's (Burma) mixed-deciduous forests. The combination of seed retention times (mean 39.5 h, maximum 114 h) and elephant displacement rates (average 1988 m in 116 hours) resulted in 50% of seeds dispersed over 1.2 km (mean 1222-2105 m, maximum 5772 m). Shifts in diet composition did not affect gut retention time and germination of ingested seeds. Elephant displacements were slightly longer, with stronger seasonal variation in Myanmar. As a consequence, seed dispersal curves varied seasonally with longer distances during the dry season in Myanmar but not in Sri Lanka. Seasonal and geographic variation in seed dispersal curves was the result of variation in elephant movement patterns, rather than the effect of diet changes on the fate of ingested seeds. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, seed dispersal, seed germination, spatial variation.

Clauss, M., Y. Wang, K. Ghebremeskel, C.E. Lendl, and W.J. Streich (2003). **Plasma and**

erythrocyte fatty acids in captive Asian (*Elephas maximus*) and African (*Loxodonta africana*) elephants. *Veterinary Record* 153(2): 54-8.

NAL Call Number: 41.8 V641

Abstract: The fatty acid components of the plasma triglycerides and the phospholipid fractions of the red blood cells of a captive group of two African (*Loxodonta africana*) and four Asian (*Elephas maximus*) elephants were investigated. All the animals received the same diet of hay, fruits and vegetables, and concentrates. A comparison with data from free-ranging African elephants or Asian work-camp elephants showed that the captive elephants had lower proportions of polyunsaturated fatty acids (PUFAs), and for several lipid fractions a higher n-6:n-3 ratio, than their counterparts in the wild or under the more natural, in terms of diet, work-camp conditions. The difference in PUFA content was smaller in the African than in the Asian elephants. The captive Asian elephants tended to have lower levels of n-3 and total unsaturated fatty acids in their red blood cells than the captive African elephants.

Descriptors: metabolism, erythrocytes metabolism, unsaturated metabolism fatty acids, phospholipids metabolism, triglycerides metabolism, zoo animals, blood chemical analysis, diet, blood, unsaturated blood fatty acids, triglycerides blood, workload.

Dahl, N.J., D. Olson, D.L. Schmitt, D.R. Blasko, R.S. Kristipati, and J.F. Roser (2004).

Development of an enzyme-linked immunosorbent assay (ELISA) for luteinizing hormone (LH) in the elephant (*Loxodonta africana* and *Elephas maximus*). *Zoo Biology* 23(1): 65-78. ISSN: 0733-3188.

NAL Call Number: QL77.5.Z6

Descriptors: African elephant, Asian elephant, ELISA, luteinizing hormone, enzyme-linked immunosorbent assay, LH, development.

Dehnhard, M. (2007). **Characterisation of the sympathetic nervous system of Asian (*Elephas maximus*) and African (*Loxodonta africana*) elephants based on urinary catecholamine analyses.** *General and Comparative Endocrinology* 151(3): 274-284. ISSN: (p) 0016-6480; (E) 1095-6840.

Online: <http://dx.doi.org/10.1016/j.ygcen.2007.01.001>

Abstract: Assessing the welfare status of captive animals using non-invasive measurements of hormones is of growing interest because this can serve as an effective tool to facilitate the optimization of environmental and husbandry conditions. Both the African elephant (*Loxodonta africana*) and the Asian elephant (*Elephas maximus*) exhibit extremely low breeding success in captivity, and because elevated levels of stress may negatively influence reproductive functions, this study sought to establish a method for assessing sympathoadrenal activity in captive female elephants. We found a circadian variation in urinary noradrenaline (norepinephrine, NE), adrenaline (epinephrine, Epi) and dopamine (DA) under short day length. Peak activity of noradrenaline and dopamine was noted at 3 a.m. Adrenaline showed a biphasic pattern with a minor peak recorded at 3 a.m. and a major peak 9 a.m. Under long-day photoperiodic conditions, simultaneous peaks of noradrenaline and adrenaline were again noted at 3 a.m. whereas dopamine does not appear to have a distinct circadian pattern under long-day length. A transfer of two elephant cows resulted in a marked increase in urinary adrenaline and noradrenaline levels, confirming that the transfer represented a stressful event. During the periparturition period, noradrenaline concentrations increased and maximum concentrations were obtained at delivery. Daily measurements of urinary dopamine throughout the follicular phase revealed an increase in dopamine secretion close to ovulation. This increase might indicate a role of dopamine in the ovulatory mechanisms. These results suggest that changes in urinary catecholamine excretion reflect fluctuations in sympathoadrenal activity and may be a useful indicator of stress. *Reproduced with Permission from CAB Abstracts.*

Descriptors: animal welfare, catecholamines, circadian rhythm, diurnal variation, dopamine, epinephrine, norepinephrine, reproductive performance, stress, sympathetic nervous system, urine, zoo animals, Asian elephant, *Elephas maximus*, African elephant, *Loxodonta africana*.

Dehnhard, M., J.M. Hatt, K. Eulenberger, A. Ochs, and G. Strauss (2003). **Headspace solid-phase microextraction (SPME) and gas chromatography-mass spectrometry (GC-MS) for the determination of 5alpha-androst-2-en-17-one and -17beta-ol in the female Asian elephant: application for reproductive monitoring and prediction of parturition.** *Journal of Steroid Biochemistry and Molecular Biology* 84(2-3): 383-91.

NAL Call Number: QD426.A1J6

Abstract: Asian elephants are not self-sustaining in captivity. The main reasons for this phenomenon are a low birth rate, an aging population, and poor calf-rearing. Therefore, it is essential that reproductive rates had to be improved and there is need for rapid quantitative measures to monitor reproductive functions focussing on estrous detection and the prediction of the period of parturition. The objective of this study was to develop a method which combines headspace solid-phase microextraction (SPME) and gas chromatography-mass spectrometry (GC-MS) for analyses of 5alpha-androst-2-en-17beta-ol and -17-one to prognose estrous and to predict the period of parturition. SPME was carried out with a CTC Combi Pal system. The course of the luteal phase-specific substance 5alpha-androst-2-en-17beta-ol and -17-one followed a cyclic pattern in which the follicular and luteal phases could be clearly distinguished (mean estrous cycle length,

15+/-1.4 weeks). Based on daily urine samples, estrous prognosis might be possibly based on the initial 5alpha-androst-2-en-17beta-o1 increase at the end of the follicular phase. Parturition prognosis was performed in three elephant cows based on the 5alpha-androst-2-en-17beta-o1 drop to baseline levels 5-4 days prior parturition. Experiments revealed that 5alpha-androst-3alpha-ol-17-one and probably 5alpha-androst-3alpha-ol-17beta-ol are generated from sulfate conjugates by a thermal process.

Descriptors: androstane 3,17 diol blood, androsterone blood, chemistry, clinical methods, mass fragmentography methods, parturition blood, chromatography, gas, estrous cycle, pregnancy, animal blood, temperature, time factors.

Duer, C., M. Carden, and T. Tomasi (2007). **Detection of fetal gender differences in maternal serum progesterone concentrations of Asian elephants (*Elephas maximus*).**

Animal Reproduction Science 97(3/4): 278-283. ISSN: 0378-4320.

Abstract: Previous studies have analysed total testosterone concentrations in maternal serum for a reliable method of fetal gender determination in Asian elephants (*Elephas maximus*). The present study investigated the possibility that progesterone concentrations in maternal serum may reflect these testosterone patterns. Weekly serum samples were collected from 17 pregnancies in captive Asian elephants and analysed via radioimmunoassay (RIA) for progesterone concentrations. Nine and eight cows carried male and female calves, respectively. Mean progesterone concentrations in maternal serum of elephants carrying male calves were greater than in those carrying female calves ($P < 0.01$). Mean progesterone concentrations (based on 5-week means) in maternal serum were greater at weeks 20-55 ($P < 0.01$) and 60-65 ($P < 0.05$) for elephants carrying male calves. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, pregnancy, progesterone, sex determination, sex differences, testosterone.

Faust, L.J., S.D. Thompson, J.M. Earnhardt (2006). **Is reversing the decline of Asian elephants in North American zoos possible? An individual-based modeling approach.** *Zoo Biology* 25(3): 201-218. ISSN: 0733-3188.

Online: <http://dx.doi.org/10.1002/zoo.20054>

NAL Call Number: QL77.5.Z6

Descriptors: *Elephas maximus*, zoo animals, population dynamics, population structure, simulation models, stochastic processes, mortality, fecundity, animal reproduction, animal husbandry, North America, captive elephants, population decline, demographic models, individual based stochastic models.

Fickel, J., D. Lieckfeldt, L.K. Richman, W.J. Streich, T.B. Hildebrandt, and C. Pitra (2003).

Comparison of glycoprotein B (gB) variants of the elephant endotheliotropic herpesvirus (EEHV) isolated from Asian elephants (*Elephas maximus*).

Veterinary Microbiology 91(1): 11-21. ISSN: 0378-1135.

NAL Call Number: SF601.V44

Abstract: The recently described elephant endotheliotropic herpesviruses (EEHV) have been associated with the deaths of numerous captive elephants. A proposed tool for the detection of EEHV infection in elephants is the PCR-based screening for EEHV-DNA in whole blood samples. Unfortunately, this detection method has only been successful in post-mortem analyses or in animals already displaying clinical signs of EEHV disease, thus rendering this method unsuitable for identification of carrier elephants. Here, we focus on glycoprotein B (gB) for serologic assay development, since gB is an envelope protein known to induce a neutralising antibody response in other herpesvirus infections. We sequenced the entire gB gene from five Asian elephants with EEHV, representing four different gB variants. Computer-aided methods were used to predict functionally important regions within EEHVgB. An extra-cytoplasmic region of 153 amino acids was predicted to be under positive selection and may potentially contain antigenic determinants that will be useful for future serologic assay development.

Descriptors: *Elephas maximus*, viral proteins, glycoproteins, disease transmission, detection, polymerase chain reaction, cytoplasm, amino acid sequences, molecular sequence data.

Greenwood, A.D., C.C. Enlbrecht, and R.D. MacPhee (2004). **Characterization of an endogenous retrovirus class in elephants and their relatives.** *BMC Evolutionary Biology* 4(1): 38.

NAL Call Number: QH359.B63

Abstract: BACKGROUND: Endogenous retrovirus-like elements (ERV-Ls, primed with tRNA leucine) are a diverse group of reiterated sequences related to foamy viruses and widely distributed among mammals. As shown in previous investigations, in many primates and rodents this class of elements has remained transpositionally active, as reflected by increased copy number and high sequence diversity within and among taxa. RESULTS: Here we examine whether proviral-like sequences may be suitable molecular probes for investigating the phylogeny of groups known to have high element diversity. As a test we characterized ERV-Ls occurring in a sample of extant members of superorder Uranotheria (Asian and African elephants, manatees, and hyraxes). The ERV-L complement in this group is even more diverse than previously suspected, and there is sequence evidence for active expansion, particularly in elephantids. Many of the elements characterized have protein coding potential suggestive of activity. CONCLUSIONS: In general, the evidence

supports the hypothesis that the complement had a single origin within basal Uranotheria.

Descriptors: genetics, virology, endogenous retroviruses classification, endogenous retroviruses genetics, Africa, Asia, molecular cloning methods, viral DNA genetics, hyraxes genetics, hyraxes virology, mice, molecular sequence data, phylogeny, proteins genetics, retroelements genetics, Trichechus genetics, Trichechus virology.

Greenwood, D.R., D. Comeskey, M.B. Hunt, and L.E. Rasmussen (2005). **Chemical communication: chirality in elephant pheromones.** *Nature* 438(7071): 1097-8.
NAL Call Number: 472 N21

Abstract: Musth in male elephants is an annual period of heightened sexual activity and aggression that is linked to physical, sexual and social maturation. It is mediated by the release of chemical signals such as the pheromone frontalin, which exists in two chiral forms (molecular mirror images, or enantiomers). Here we show that enantiomers of frontalin are released by Asian elephants in a specific ratio that depends on the animal's age and stage of musth, and that different responses are elicited in male and female conspecifics when the ratio alters. This precise control of communication by molecular chirality offers insight into societal interactions in elephants, and may be useful in implementing new conservation protocols.

Descriptors: heterocyclic chemistry of bicyclo compounds, heterocyclic pharmacology of bicyclo compounds, physiology, pheromones chemistry, pheromones secretion, drug effects on animal sex behavior, aging physiology, heterocyclic metabolism of bicyclo compounds, pheromones pharmacology, sex behavior, animal physiology, stereoisomerism.

Hildebrandt, T.B., R. Hermes, P. Ratanakorn, W. Rietschel, J. Fickel, R. Frey, G. Wibbelt, C. Reid, and F. Goritz (2005). **Ultrasonographic assessment and ultrasound-guided biopsy of the retropharyngeal lymph nodes in Asian elephants (*Elephas maximus*).** *Veterinary Record* 157(18): 544-8.
NAL Call Number: 41.8 V641

Abstract: Endotheliotropic herpesvirus causes a fatal disease in young Asian elephants, but there are no methods for identifying latent carriers of the virus. During the postmortem study of one female African elephant and three male and two female Asian elephants, a lymph node located bilaterally caudoventral to the parotid gland, approximately 1.5 to 5 cm below the skin, was identified as suitable for transcutaneous ultrasound-guided biopsy. An ultrasonographic assessment and two biopsies were performed on 39 Asian elephants, and these lymph nodes were classified ultrasonographically as active, inactive or chronically active. The calculated mean (se) volume of 10 active lymph nodes was 17.4 (6.9) cm³, and that of three chronically active lymph nodes was 10.6 (1.0) cm³, whereas the mean volume of 17 inactive lymph nodes was 3.1 (0.6) cm³. The presence of lymph node tissue in samples obtained by ultrasound-guided biopsy from three animals that were maintained under conditions that allowed for additional sampling was confirmed histologically. The dna extracted from the lymphoid tissue and the whole blood of all the elephants was negative for endotheliotropic herpesvirus by PCR.

Descriptors: DNA viral isolation and purification, herpesviridae isolation and purification, herpesviridae infections, lymph nodes pathology, zoo animals, fine needle biopsy methods, disease reservoirs, disease reservoirs virology, Herpesviridae pathogenicity, Herpesviridae infections epidemiology, Herpesviridae infections pathology, lymph nodes ultrasonography, lymph nodes virology, polymerase chain reaction, prevalence, virus latency.

Kilgallon, C., E. Flach, W. Boardman, A. Routh, T. Strike, and B. Jackson (2008). **Analysis of biochemical markers of bone metabolism in Asian elephants (*Elephas maximus*).** *Journal of Zoo and Wildlife Medicine* 39(4): 527-536. ISSN: 1042-7260.

Online: <http://dx.doi.org/10.1638/2006-0024.1>

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. Reproduced with Permission from CAB Abstracts.

Descriptors: Asian elephant, *Elephas maximus*, alkaline phosphatase, antibodies, antigens, biochemical markers, blood serum, bone density, bone diseases, bones,

collagen, cross reaction, enzyme immunoassay, enzymes, immunoassay, metabolism, osteocalcin, radioimmunoassay.

Kongrit, C., C. Siripunkaw, W.Y. Brockelman, V. Akkarapatumwong, T.F. Wright, and L.S. Eggert (2008). **Isolation and characterization of dinucleotide microsatellite loci in the Asian elephant (*Elephas maximus*)**. *Molecular Ecology Resources* 8(1): 175-177. ISSN: 1471-8278.

Online: <http://dx.doi.org/10.1111/j.1471-8286.2007.01916.x>

NAL Call Number: QH541.15 .M632

Abstract: The endangered Asian elephant is found today primarily in protected areas. We characterized 18 dinucleotide microsatellite loci in this species. Allelic diversity ranged from three to eight per locus, and observed heterozygosity ranged from 0.200 to 0.842 in a wild population. All loci were in Hardy-Weinberg equilibrium, but linkage disequilibrium was detected between two loci in the wild, but not in the zoo elephants. These loci will be useful for the population-level studies of this species. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, microsatellite repeats, noninvasive, population studies, conservation.

Lamps, L.W., B.R. Smoller, T.E. Goodwin, and L.E.L. Rasmussen (2004). **Hormone receptor expression in interdigital glands of the Asian elephant (*Elephas maximus*)**. *Zoo Biology* 23(5): 463-469. ISSN: 0733-3188.

NAL Call Number: QL77.5.Z6

Descriptors: Asian elephant, interdigital glands, hormone receptor, expression, *Elephas maximus*.

Landolfi, J.A., S.A. Schultz, S.K. Mikota, and K.A. Terio (2009). **Development and validation of cytokine quantitative, real time RT-PCR assays for characterization of Asian elephant immune responses**. *Veterinary Immunology and Immunopathology* 131(1/2): 73-78. ISSN: 0165-2427.

Online: <http://dx.doi.org/10.1016/j.vetimm.2009.03.012>

Abstract: Infectious disease is an important factor in Asian elephant health and long-term species survival. In studying disease pathogenesis, it is important to consider not only the pathogen, but also the effectiveness of the host immune response. Currently, there is a paucity of information available on elephant immune function. Measurement of cytokine levels within clinical samples can provide valuable information regarding immune function during health and disease that may elucidate disease susceptibility. To develop tools for assessment of elephant immune function, Asian elephant partial mRNA sequences for interleukin (IL)-2, IL-4, IL-10, IL-12, interferon (IFN)- gamma, tumor necrosis factor (TNF)- alpha, transforming growth factor (TGF)- beta, glyceraldehyde 3-phosphate dehydrogenase (GAPDH), and beta-actin were determined. Sequence information was then utilized to design elephant-specific primers and probes for quantitative, real time, RT-PCR assays for the measurement of cytokine mRNA. Greater than 300 bps of Asian elephant mRNA sequence were determined for each cytokine of interest. Consistent and reproducible, real time, RT-PCR assays with efficiencies of greater than 93% were also developed. Assay sensitivities ranged from less than 1 to 5000 DNA copies with the exception of IL-12, which had a sensitivity of 42,200 copies. Employment of molecular techniques utilizing mRNA-based detection systems, such as real time, RT-PCR, facilitate sensitive and specific cytokine detection and measurement in samples from species for which commercial reagents are not available. Future studies utilizing these techniques to compare elephant immune function during health and in the face of infection will be useful for characterizing the contribution of the elephant immune system to disease. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, characterization, cytokines, DNA, enzymes, glyceraldehyde, growth factors, health, hosts, immune response, immune system, immunology, infectious diseases, interferon, interleukin 10, interleukins, measurement, messenger RNA, necrosis, pathogenesis, polymerase chain reaction, transforming growth factor, tumor necrosis factor.

Lazar, J., L.E. Rasmussen, D.R. Greenwood, I.S. Bang, and G.D. Prestwich (2004). **Elephant albumin: a multipurpose pheromone shuttle**. *Chemistry and Biology* 11(8): 1093-100.

Abstract: (Z)-7-dodecenyl acetate (Z7-12:Ac) is present in the urine of female Asian elephants (*Elephas maximus*) approaching ovulation and functions as a female-to-male sex pheromone. Here we show that a significant fraction of the pheromone in the urine is bound to a protein, elephant serum albumin (ESA), and provide evidence for key physiological functions of urinary ESA. Our biochemical and behavioral experiments suggest a three-fold role of ESA in pheromone signaling: (1) transporting Z7-12:Ac from serum into urine; (2) extending the presence of the pheromone in the environment without hampering detection; and (3) targeting pheromone delivery to chemosensory organs through localized release of the ligand induced by a pH change. The exploitation of albumin in pheromone transport clearly distinguishes the elephant from other mammals studied, and complements the uniqueness of elephant anatomy, physiology, and behavior.

Descriptors: acetates metabolism, albumins metabolism, pheromones metabolism,

acetates urine, albumins chemistry, albumins genetics, biological availability, biological transport, cloning, molecular, hydrogen ion concentration, molecular structure, pheromones urine, substrate specificity, time factors, urine chemistry.

Lin Liu, Feng LiMin, Pan WenJing, Guo XianMing, Zhao JianWei, Luo AiDong, and Zhang Li (2008).

Habitat selection and the change in distribution of Asian elephants in Mengyang Protected Area, Yunnan, China. *Acta Theriologica* 53(4): 365-374. ISSN: 0001-7051.

Abstract: Elephants were confined to Mengyang Protected Area in China and their distribution range had reduced greatly compared to past records. A preliminary study of habitat selection by Asian elephants *Elephas maximus* and their distribution was conducted in Mengyang Protected Area and its surrounding areas using site visits and transect surveys from July 2003 to December 2006. Although no variable significantly influenced their habitat selection, elephants still showed preference for altitudes between 900 and 1200 m, gradients <30 degrees and orientations to the south-east, south and south-west. Human activities, including habitat transformation and degradation, disturbance by large infrastructure and poaching were considered to be the main factors inducing elephant distribution changes. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, behavior, animal ecology, habitat selection, human activity, spatial distribution, wildlife management.

Pradhan, N.M.B., P. Wegge, and S.R. Moe (2007). **How does a recolonizing population of Asian elephants affect the forest habitat.** *Journal of Zoology* 273(2): 183-191. ISSN: 0952-8369; Online: 1469-7998.

Online: <http://dx.doi.org/10.1111/j.1469-7998.2007.00313.x>

NAL Call Number: QL1.J68

Abstract: The Asian elephant *Elephas maximus* is currently re-colonizing the Bardia National Park in lowland Nepal. We studied their impact on woody vegetation in the nutrient-rich floodplain and in the relatively nutrient-poor sal forest. The types and extent of tree impact were recorded along fixed-width transects (335 km). Species composition, density and size classes ≥ 8 cm diameter breast height (dbh) were recorded in 15-m radius random plots (n=95). Impact was higher in the floodplain complex than in the sal-dominated forest. Our hypothesis that elephants were more selective on species in the nutrient-poor sal forest was only partly supported; the niche breadth of impacted trees was slightly higher in the floodplain complex. Pushed-over trees accounted for the highest proportion of impact (55%), followed by killed trees (39%). Of the pushed trees, 10% were not used for food. Among food trees, elephants selectively impacted size class 12-16 cm dbh, whereas non-food trees were impacted independently of size. A large proportion of the freshly browsed trees had been felled previously, indicating that most felled trees survived, enabling elephants to feed on them again. This may reflect an evolutionary adaptation among long-lived species with high site fidelity. Owing to preferential use but low abundance, two species in sal forest, *Grewia* spp. and *Desmodium oojeinense*, were found to be particularly vulnerable to local extinction due to elephants. Although the elephants had impacted a large number of species (62, 73% of all), 56.4% of the impacted trees consisted of *Mallotus philippinensis*. A recently observed increase in the density of *M. philippinensis* and the concurrent reduction of the hardly utilized *Shorea robusta* indicates that the rapidly growing elephant population may modify the composition of the forest by increasing its preferred food species. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, Asia, Nepal, alluvial-floodplain, *Mallotus philippinensis*, megaherbivores, sal forest, tree impact.

Rasmussen, L.E. and D.R. Greenwood (2003). **Frontalin: a chemical message of musth in Asian elephants (*Elephas maximus*).** *Chemical Senses* 28(5): 433-46.

NAL Call Number: QP456.C5

Abstract: Musth is an important male phenomenon affecting many aspects of elephant society including reproduction. During musth, the temporal gland secretions (as well as the urine and breath) of adult male Asian elephants (*Elephas maximus*) discharge a variety of malodorous compounds together with the bicyclic ketal, frontalin. In contrast, teenage male elephants in musth release a sweet-smelling exudate from their facial temporal gland. We recently demonstrated that the concentration of frontalin becomes increasingly evident as male elephants mature. In the present study, we demonstrate that behaviors exhibited towards frontalin are consistent and dependent on the sex, developmental stage and physiological status of the responding conspecific individual. To examine whether frontalin functions as a chemical signal, perhaps even a pheromone, we bioassayed older and younger adult males, and luteal- and follicular-phase and pregnant females for their chemosensory and behavioral responses to frontalin. Adult males were mostly indifferent to frontalin, whereas subadult males were highly reactive, often exhibiting repulsion or avoidance. Female chemosensory responses to frontalin varied with hormonal state. Females in the luteal phase demonstrated low frequencies of responses, whereas pregnant females responded significantly more frequently, with varied types of responses including those to the palatal pits. Females in the follicular phase were the most responsive and often demonstrated mating-related behaviors subsequent to high chemosensory responses to frontalin. Our evidence strongly suggests that frontalin, a well-studied pheromone in insects, also functions as a pheromone in the Asian elephant: it exhibits all of the determinants that define a pheromone and evidently

conveys some of the messages underlying the phenomenon of musth.

Descriptors: bicyclo compounds, heterocyclic pharmacology, physiology, aging physiology, Asia, drug effects on behavior, heterocyclic urine, buffers, urine, pheromones pharmacology, pheromones in urine, drug effects on sex behavior, sex characteristics, smell.

Ren, L. and J.R. Hutchinson (2008). **The three dimensional locomotor dynamics of African (*Loxodonta africana*) and Asian (*Elephas maximus*) elephants reveal a smooth gait transition at moderate speed.** *Journal of the Royal Society Interface* 5(19): 195-211. ISSN: 1742-5689; Online: 1742-5662.

Descriptors: African elephant, *Loxodonta africana*, Asian elephant, *Elephas maximus*, locomotion, smooth gait transition, center of mass motion.

Rezaian, M. and S. Yamashiro (2005). **Comparison between elephant and bovine platelet ultra structure.** *Indian Journal of Animal Sciences* 75(3): 267-270. ISSN: 0367-8318.
NAL Call Number: 41.8 IN22

Descriptors: Asian elephant, bovine platelet, ultra structure, elephant platelets, comparison, discoid shape.

Sa Ardit, M., J. Saikhun, N. Thongtip, M. Damyang, S. Mahasawangkul, T. Angkawanish, S. Jansittiwate, T. Faisaikarm, Y. Kitiyanant, K. Pavasuthipaisit, and A. Pinyopummin (2006). **Ultrastructural alterations of frozen-thawed Asian elephant (*Elephas maximus*) spermatozoa.** *International Journal of Andrology* 29(2): 346-52.
NAL Call Number: QP251.I55

Abstract: Intact plasma and acrosome membranes and functional mitochondria following cryopreservation are important attributes for the fertilizing ability of spermatozoa. In the present study, functional and ultrastructural changes of Asian elephant spermatozoa after cryopreservation either in TEST + glycerol or HEPT + dimethyl sulphoxide (DMSO) were evaluated by fluorescent techniques and electron microscopy. Sperm frozen in TEST + glycerol had higher proportion of sperm with intact plasma (49.1 +/- 9.2% vs. 30.9 +/- 3.9%) and acrosomal (53.7 +/- 4.9% vs. 35.8 +/- 6.1%) membranes, as well as active mitochondria (57.0 +/- 7.2% vs. 42.0 +/- 5.0%) than those cryopreserved in HEPT + DMSO. The results obtained from electron microscopy were similar to those obtained by fluorescence microscopy. The percentage of normal spermatozoa was higher when spermatozoa were frozen in TEST + glycerol than those frozen in HEPT + DMSO (31.8 +/- 5.6 vs. 28.5 +/- 6.4). The ultrastructural alterations revealed by transmission electron microscopy could be classified as (i) distension of plasma membrane, while the acrosome was swollen; (ii) disruption or loss of plasma membrane, while acrosome was swollen with distended outer acrosomal membrane; (iii) disruption or loss of plasma and outer acrosomal membrane with leakage of acrosome content; (iv) extensive vesiculation of plasma and outer acrosomal membrane and leakage of acrosome content; (v) a complete loss of both plasma membrane and outer acrosomal membrane; and (vi) swelling of mitochondria. These findings suggest that the freezing and thawing procedure caused structural damage to elephant spermatozoa, especially in the plasma membrane, acrosome and mitochondria. Fluorescence and electron microscopic evaluations are potentially a powerful tool in the analysis of elephant spermatozoa after freezing and thawing.

Descriptors: Asian elephant, spermatozoa, frozen, thawed, ultrastructural, alterations, cryopreservation, fertilizing ability.

Saragusty, J., T.B. Hildebrandt, Y. Natan, R. Hermes, S. Yavin, F. Goeritz, and A. Arav (2005). **Effect of egg-phosphatidylcholine on the chilling sensitivity and lipid phase transition of Asian elephant (*Elephas maximus*) spermatozoa.** *Zoo Biology* 24(3): 233-245. ISSN: 0733-3188.

NAL Call Number: QL77.5.Z6

Descriptors: semen extenders, cooling, liposomes artificial, cryopreservation, cryoprotectants, spermatazoa.

Saragusty, J., T.B. Hildebrandt, B. Behr, A. Knieriem, J. Kruse, and R. Hermes (2009). **Successful cryopreservation of Asian elephant (*Elephas maximus*) spermatozoa.** *Animal Reproduction Science* 115(1-4): 255-266. ISSN: 0378-4320.

Online: <http://dx.doi.org/10.1016/j.anireprosci.2008.11.010>

NAL Call Number: QP251.A5

Abstract: Reproduction in captive elephants is low and infant mortality is high, collectively leading to possible population extinction. Artificial insemination was developed a decade ago; however, it relies on fresh-chilled semen from just a handful of bulls with inconsistent sperm quality. Artificial insemination with frozen-thawed sperm has never been described, probably, in part, due to low semen quality after cryopreservation. The present study was designed with the aim of finding a reliable semen freezing protocol. Screening tests included freezing semen with varying concentrations of ethylene glycol, propylene glycol, trehalose, dimethyl sulfoxide and glycerol as cryoprotectants and assessing cushioned centrifugation, rapid chilling to suprazero temperatures, freezing extender osmolarity, egg yolk concentration, post-thaw dilution with cryoprotectant-free BC solution and the addition of 10% (v/v) of autologous seminal plasma. The resulting optimal freezing protocol uses cushioned centrifugation, two-step dilution with isothermal

285mOsm/kg Berliner Cryomedium (BC) with final glycerol concentration of 7% and 16% egg yolk, and freezing in large volume by the directional freezing technique. After thawing, samples are diluted 1:1 with BC solution. Using this protocol, post-thaw evaluations results were: motility upon thawing: 57.2pl5.4%, motility following 30min incubation at 37pC: 58.5pl6.0% and following 3h incubation: 21.7pl7.6%, intact acrosome: 57.1pl5.2%, normal morphology: 52.0pl5.8% and viability: 67.3pl6.1%. With this protocol, good quality semen can be accumulated for future use in artificial inseminations when and where needed. *Reproduced with Permission from CAB Abstracts.*
Descriptors: Asian elephant, *Elephas maximus*, spermatozoa, cryopreservation, artificial insemination, reproduction.

Shimosawa, K. and N. Misawa (2008). **Assessment of Protein G in serodiagnosis of zoo animals and development of an enzyme-linked immunosorbent assay for Asian elephant.** *Journal of the Japan Veterinary Medical Association* 61(1): 75-78. ISSN: 0446-6454.

Abstract: Enzyme-linked immunosorbent assay (ELISA), a fast and cost-effective serodiagnosis, is a helpful screening method in the diagnosis of infectious diseases. However, it remains unclear whether ELISA is suitable for the diagnosis of zoo animals. This study examined the reactivity of Protein G, an IgG-binding protein, to sera from zoo animals. Results showed that most sera examined bound strongly to Protein G, while sera from marsupial animals, Panthera and Asian elephant showed weak reactions. These findings suggest that Protein G does not bind to IgG uniformly in zoo animals. IgG was purified from Asian elephant serum, and used to obtain antiserum by immunizing a rabbit. This made it possible to develop an ELISA system for effectively detecting IgG in an Asian elephant. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, binding proteins, ELISA, IgG, immunodiagnosis, immunological diseases, zoo animals, infectious disease diagnosis.
Language of Text: Japanese, Summary in English.

Sreekumar, E., M.B.V. Janki, D.S. Arathy, R. Harharan, C.A. Premraj, and T.J. Rasool (2006). **Molecular characterization and expression of Interferon-d of Asian elephant (*Elephas maximus*).** *Veterinary Immunology and Immunopathology* 118(1-2): 75-83. ISSN: 0165-2427.

Online: <http://dx.doi.org/10.1016/j.vetimm.2007.04.012>

NAL Call Number: SF757.2.V38

Abstract: Tuberculosis (TB) caused by Mycobacterial organisms has emerged as one of the major diseases in captive elephants. In vitro Interferon-gamma (IFN-d) assay is being used as an ancillary test for early detection of TB in domestic and captive wild animals. In the present study, basic sequence information and immunological cross-reactivity of this major cytokine of Asian elephants were explored. At predicted amino acid level, IFN-d of Asian elephant showed maximum identity to that of horse (73%). Other IFN-d amino acid sequences that showed high level identity were that of giant panda (72%), dog (71%), nine-banded armadillo (69%), cattle (63%) and human (62%). IFN-d promoter sequences of Asian elephant, human, cattle and mouse showed high level conservation of the putative transcription factor binding sites, TATA box and transcriptional start site. The functionally important human IFN-d promoter elements, such as AP-2IRE-BE, YY1-dIFN-BED, ATFCS and AP-1dINF binding sites, were absolutely conserved in the corresponding elephant sequence. There was only a single nucleotide variation in the other two important elements, NFAT-dINF and IFN-dPE, indicating the highly conserved regulation of IFN-d expression across different species. Phylogenetic analysis based on IFN-d protein sequences revealed a closer relation of Asian elephants and nine-banded armadillo. This shows a closer evolution of these members of Afrotheria and Xenarthra, respectively; and supports the previous reports based on mitochondrial DNA studies. In Western blot analysis, IFN-d of Asian elephant expressed in *Escherichia coli* was detected using an anti-bovine IFN-d monoclonal antibody, indicating immunological cross-reactivity. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, molecular genetics, complementary DNA, amino acid sequences, species differences, tuberculosis, captive wild animals.

Suwattana, D., W. Koykul, J. Jirasupphachok, and S. Kanchanapangka (2007). **Microsatellite polymorphism and parentage control in Thai domestic elephants (*Elephas maximus*).** *Thai Journal of Veterinary Medicine* 37(4): 33-38. ISSN: 0125-6491.

Abstract: Polymorphism of microsatellite DNA in Thai domestic elephants (*Elephas maximus*) was studied using five genetic markers including LaT05, LaT07, LaT16, La17 and LaT26, in order to determine the efficiency of such markers in parentage identification. Eleven elephants from 5 families and 10 unrelated ones located in the northern, northeastern and central parts of Thailand were tested. It was found that LaT05, LaT16, LaT17 and LaT26 possessed marker sizes of 250-500 bp with numbers of alleles ranging from 4-13, heterozygosity 0.62-0.88 and PIC 0.56-0.87 whereas LaT07 could not be detected in all specimens used. LaT05 and LaT26 appeared to be the most desirable markers with PIC=0.87. Parentage identification using the 4 genetic markers showed the results corresponding to the family history and pedigree record of all specimens with up to 99.14% of efficiency and accuracy. It was concluded that LaT05, LaT16, LaT17 and LaT26 all together could be used in parentage identification. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, animal breeding, genes, genetic markers, genetic polymorphism, parentage, pedigree.

Language of Text: Thai.

Thongtip, N., J. Saikhun, M. Damyang, S. Mahasawangkul, P. Suthunmapinata, M. Yindee, A. Kongsila, T. Angkawanish, S. Jansittiwate, and W. Wongkalasin (2004). **Evaluation of post-thaw Asian elephant (*Elephas maximus*) spermatozoa using flow cytometry: the effects of extender and cryoprotectant.** *Theriogenology* 62(3-4): 748-760. ISSN: 0093-691X.

NAL Call Number: QP251.A1T5

Abstract: Although the development of semen cryopreservation in the African elephants (*Loxodonta africana*) has been accomplished, effective procedures for cryopreservation of Asian elephant (*Elephas maximus*) spermatozoa have not been established. In the present study, we investigate the freezing methods for conservation of Asian elephant spermatozoa under field conditions and identify the most suitable freezing protocols which provide acceptable post-thaw semen quality. Semen was collected from two Asian elephant bulls (EM1 and EM2, 10 ejaculates from each bull) by manual manipulation and were assessed for volume, pH, sperm cell concentration, and progressive motility. Eight out of 20 ejaculates were of acceptable quality (progressive motility greater than or equal to 60%), and were used for cryopreservation studies. Semen were frozen in TEST+glycerol, TEST+DMSO, HEPT+glycerol, or HEPT+DMSO. The post-thaw progressive sperm motilities were assessed, and sperm cells were stained with PI and FITC-PNA for membrane and acrosomal integrity assessment using flow cytometry. Post-thaw progressive motility of spermatozoa (EM1: 42.0±4.3%; EM2: 26.0±17.3%) and the percentage of membrane and acrosome intact spermatozoa (EM1: 55.5±8.1%; EM2: 46.3±6.4%) cryopreserved in TEST+glycerol were significantly higher than ($P<0.05$) those frozen in the other medium investigated choices for cryopreservation of Asian elephant spermatozoa. The data support the use of TEST+glycerol as an acceptable cryopreservation media of Asian elephant semen for the establishment of sperm banks.

Descriptors: *Elephas maximus*, spermatozoa, cryopreservation, semen extenders, cryoprotectants, flow cytometry, freezing, thawing, sperm motility, glycerol, dimethyl sulfoxide, plasma membrane, membrane permeability, acrosome reaction, male fertility, membrane integrity.

Uemura, Y., S. Asakuma, L. Yon, T. Saito, K. Fukuda, I. Arai, and T. Urashima (2006). **Structural determination of the oligosaccharides in the milk of an Asian elephant (*Elephas maximus*).** *Comparative Biochemistry and Physiology A, Molecular and Integrative Physiology* 145(4): 468-478. ISSN: 1095-6433.

Online: <http://dx.doi.org/10.1016/j.cbpa.2006.08.001>

Abstract: Milk of an Asian elephant (*Elephas maximus*), collected at 11 days post partum, contained 91 g/L of hexose and 3 g/L of sialic acid. The dominant saccharide in this milk sample was lactose, but it also contained isoglobotriose (Glc(α 1-3)Gal(β 1-4)Glc) as well as a variety of sialyl oligosaccharides. The sialyl oligosaccharides were separated from neutral saccharides by anion exchange chromatography on DEAE-Sephadex A-50 and successive gel chromatography on Bio Gel P-2. They were purified by high performance liquid chromatography (HPLC) using an Amide-80 column and characterized by 1H-NMR spectroscopy. Their structures were determined to be those of 3'-sialyllactose, 6'-sialyllactose, monofucosyl monosialyl lactose (Neu5Ac(α 2-3)Gal(β 1-4)[Fuc(α 1-3)]Glc), sialyl lacto-N-neotetraose c (LST c), galactosyl monosialyl lacto-N-neohexaose, galactosyl monofucosyl monosialyl lacto-N-neohexaose and three novel oligosaccharides as follows: Neu5Ac(α 2-3)Gal(β 1-4)[Fuc(α 1-3)]GlcNAc(β 1-3)Gal(β 1-4)Glc, Neu5Ac(α 2-6)Gal(β 1-4)GlcNAc(β 1-3)Gal(β 1-4)GlcNAc(β 1-3)Gal(β 1-4)Glc, and Neu5Ac(α 2-3)Gal(β 1-4)[Fuc(α 1-3)]GlcNAc(β 1-3)Gal(β 1-4)Glc. The higher oligosaccharides contained only the type II chain (Gal(β 1-4)GlcNAc); this finding differed from previously published data on Asian elephant milk oligosaccharides. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, chemical composition, milk, milk composition, oligosaccharides.

van der Kolk, J.H., J.P.T.M. van Leeuwen, A.J.M. van den Belt, R.H.N. van Schaik, and W. Schaftenaar (2008). **Subclinical hypocalcaemia in captive Asian elephants (*Elephas maximus*).** *Veterinary Record* 162(15): 475-479. ISSN: 0042-4900.

Abstract: The hypothesis that hypocalcaemia may play a role in dystocia in captive Asian elephants (*Elephas maximus*) was investigated. The objectives of the study were to measure the total calcium concentration in elephant plasma; assess the changes in parameters of calcium metabolism during a feeding trial; investigate a possible relationship between calcium metabolism and dystocia; and assess bone mineralisation in captive Asian elephants in vivo. The following parameters were measured: total and ionised calcium, inorganic phosphorous and magnesium, the fractional excretions of these minerals, intact parathyroid hormone, 25-OH-D₃ and 1,25-OH-D₃. Radiographs were taken from tail vertebrae for assessment of bone mineralisation. The mean (sd) heparinised plasma total calcium concentration was 2.7 (0.33) mmol/l (n=43) ranging from 0.84 to 3.08 mmol/l in 11 Asian elephants. There was no significant correlation between plasma total calcium concentration and age. Following

feeding of a calcium rich ration to four captive Asian elephant cows, plasma total and ionised calcium peaked at 3.6 (0.24) mmol/l (range 3.4 to 3.9 mmol/l) and 1.25 (0.07) mmol/l (range 1.17 to 1.32 mmol/l), respectively. Plasma ionised calcium concentrations around parturition in four Asian elephant cows ranged from 0.37 to 1.1 mmol/l only. The present study indicates that captive Asian elephants might be hypocalcaemic, and that, in captive Asian elephants, the normal plasma concentration of total calcium should actually be around 3.6 mmol/l and normal plasma concentration of ionised calcium around 1.25 mmol/l. Given the fact that elephants absorb dietary calcium mainly from the intestine, it could be concluded that elephants should be fed calcium-rich diets at all times, and particularly around parturition. In addition, normal values for ionised calcium in captive Asian elephants should be reassessed. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, blood picture, blood plasma, bone mineralization, calcium, dystocia, hypocalcaemia, inorganic phosphorus, intestines, magnesium, mineral absorption, mineral metabolism, parathyrin, zoo animals.

Vandebona, H., N.C.W. Goonesekere, W.D. Ratnasooriya, J. Alahakoon, and M.B. Gunasekera (2005). **Using dna fingerprinting to establish paternity of Asian elephants, *Elephas maximus*, born at Pinnawela Elephant Orphanage, Sri Lanka.** *Annales Academiae Regiae Scientiarum Upsaliensis* 39: 214-221. ISSN: 0504-0736.

Descriptors: Asian elephants, paternity identification, DNA fingerprinting, blood samples, genetic diversity, breeding programs, estrus, mating, Sri Lanka.

Vidya, T. and R. Sukumar (2005). **Amplification success and feasibility of using microsatellite loci amplified from dung to population genetic studies of the Asian elephant (*Elephas maximus*).** *Current Science (Bangalore)* 88(3): 489-492. ISSN: 0011-3891.

NAL Call Number: 475 SCI23

Descriptors: Asian elephant, *Elephas maximus*, population genetics, nucleic acids, feces, molecular genetics, microsatellite DNA, India, fecal microsatellite DNA samples, dung samples, population genetics analysis, evaluation.

Yon, L., J.G. Chen, P. Moran, and B. Lasley (2008). **An analysis of the androgens of musth in the Asian bull elephant (*Elephas maximus*).** *General and Comparative Endocrinology* 155(1): 109-115. ISSN: 0016-6480.

Online: <http://dx.doi.org/10.1016/j.ygcen.2007.03.006>

Abstract: During musth in bull elephants, the androgens testosterone (T), dihydrotestosterone (DHT), and androstenedione all increase significantly. Given the unusual endocrine physiology that has been discovered in female elephants, it is also possible that bull elephants produce some unusual androgens. A cell-based androgen receptor assay was used to explore this possibility using two different methods. The first method compared the level of T measured by radioimmunoassay (RIA) with the level of androgen receptor (AR) activity measured in the serum of eight bull elephants during musth and non-musth periods. A ratio was calculated for T/AR activity for non-musth and musth, to determine if there was a change in the ratio between these two states. The second method used HPLC to separate two pooled serum samples (one non-musth and one musth) into fractions using a protocol which separates known androgens into specific, previously identified fractions. Each fraction was then tested with the AR assay to determine the androgenicity of any compounds present. This was done to determine if there were any fractions which had androgenic activity but did not contain any previously identified androgens. Results from the first analysis indicated no change in the T/AR ratio between non-musth and musth states. Clearly whatever active androgens are present during musth, they increase proportionately with T. Findings from the second analysis suggested that the only bioactive androgen present in the serum of non-musth Asian bulls is a low level of T. During musth, the only bioactive androgens detected were T and DHT; of these, T was by far the predominant active androgen present. Taken together, these two analyses suggest that T is by far the predominant active androgen present during musth in Asian bull elephants, and that no previously unidentified bioactive androgen is present. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, androgens, androstenedione, blood chemistry, HPLC, radioimmunoassay, testosterone.

Yon, L., S. Kanchanapangka, N. Chaiyabutr, F. Stanczyk, and S.L.B. Meehan (2007). **ACTH stimulation in four Asian bull elephants (*Elephas maximus*): an investigation of androgen sources in bull elephants.** *General and Comparative Endocrinology* 151(3): 246-251. ISSN: 0016-6480; (Online) 1095-6840.

Abstract: The phenomenon of musth is a very stressful event, both behaviorally and physiologically. An ACTH stimulation test was conducted in four adult Asian bull elephants to investigate the possibility that the classical hypothalamic-pituitary-adrenal (HPA) axis is active during musth, resulting in an increase in adrenally produced steroids. Serum cortisol, testosterone (T), androstenedione (A4), androstenediol (A5), and dehydroepiandrosterone (DHEA) were measured. Cortisol increased 3-10 times above baseline in response to ACTH stimulation, and DHEA doubled. A4 and A5 were erratic, while testosterone decreased significantly in all bulls. The pattern of results suggests that the adrenal steroid increase which occurs during musth results from some mechanism other than the classical HPA axis. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, adrenal glands, androstenedione, blood chemistry, corticotropin, hydrocortisone, hypothalamus, pituitary, prasterone, testosterone.

[Back to Top](#)

.....
[<< Table of Contents](#)
.....

[<< Previous](#) | [Next >>](#)

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[Printer Friendly Page](#)

Publications

Information Resources on Elephants

[<< Table of Contents](#)[<< Previous](#)

Asian Elephants

- [Anatomy / Histology / Physiology](#)
- [Anesthesia / Analgesia / Sedation / Capture](#)
- [Behavior / Care / Enrichment / Handling / Training](#)
- [Blood / Circulation / Cardiac / Hematology](#)
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- [Digestive / Food / Nutrition](#)
- [Diseases / Conditions](#)
- [Genetics / DNA](#)
- [Parasites](#)
- [Reproductive](#)
- [Research](#)
- [Veterinary](#)

Veterinary

- Abou Madi, N., G.V. Kollias, R.P. Hackett, N.G. Ducharme, R.D. Glead, and J.P. Moakler (2004). **Umbilical herniorrhaphy in a juvenile Asian elephant (*Elephas maximus*)**. *Journal of Zoo and Wildlife Medicine* 35(2): 221-5.
NAL Call Number: SF601.J6
Abstract: An umbilical hernia was diagnosed in a 2-wk-old Asian elephant (*Elephas maximus*) by physical and ultrasonographic examinations. Umbilical herniorrhaphy was elected because the defect was large (approximately 7 cm long and 10 cm deep) and could potentially lead to incarceration of an intestinal loop. General anesthesia was induced with a combination of ketamine, xylazine, and diazepam and maintained with isoflurane in oxygen. The hernial sac was explored and contained fibrous tissue, fat, and an intestinal loop but no adhesions. The hernial sac was resected and the body wall closed using the technique of simple apposition. Following a superficial wound infection, the surgical site healed with no further complications.
Descriptors: umbilical hernia, anesthesia, zoo animals, umbilical hernia diagnosis, umbilical hernia surgery, treatment outcome, wound infection.
- Agatsuma, T., R. Rajapakse, V. Kuruwita, M. Iwagami, and R. Rajapakse (2004). **Molecular taxonomic position of the elephant schistosome, *Bivitellobilharzia nairi*, newly discovered in Sri Lanka**. *Parasitology International* 53(1): 69-75. ISSN: 1383-5769.
NAL Call Number: QL757.P3747
Descriptors: *Bivitellobilharzia nairi*, molecular genetics, phylogeny, Asian elephant, parasites, hosts, *Elephas maximus*, Sri Lanka, adult worm, schistosome.
- Agnew, D.W., L. Munson, and E.C. Ramsay (2004). **Cystic endometrial hyperplasia in elephants**. *Veterinary Pathology* 41(2): 179-83.
NAL Call Number: 41.8 P27

Abstract: Most captive female elephants are nulliparous and aged and many have endometrial disease, factors that may hinder fertility. This study characterized the pathologic features and demographic distribution of endometrial lesions from 27 captive Asian (*Elephas maximus*) and 13 African elephants (*Loxodonta africanus*), 12- to 57-years of age. The principal lesion was marked cystic and polypoid endometrial hyperplasia (CEH), present in 67% of Asian and 15% of African elephants ranging from 26 to 57 years. The lower prevalence in African elephants likely reflects their younger age range in this study. Fourteen of 15 affected elephants with breeding information were nulliparous. These results suggest that CEH and polyps are common in aged nulliparous elephants, and the severity of these lesions may impair fertility. These findings will be useful in the interpretation of ultrasonographic findings during reproductive examinations of potential breeding cows. Also, breeding programs should focus on younger animals.

Descriptors: zoo animals, endometrial hyperplasia, endometrium pathology, fertility physiology, polyps, endometrial hyperplasia pathology, histological techniques, polyps pathology, species specificity.

Agrawal, D.K. and J.L. Singh (2003). **Electrocution in an Asiatic elephant (*Elephas maximus*) - a case report.** *Indian Journal of Veterinary Medicine* 23(1): 58. ISSN: 0970-051X.

NAL Call Number: SF703.I54

Descriptors: animal pathology, case reports, clinical aspects, death, diagnosis, electricity, electrocution, wild animals, *Elephas maximus*.

Ashoka Dangolla, I. Silva, and V.Y. Kuruwita (2004). **Neuroleptanalgesia in wild Asian elephants (*Elephas maximus maximus*).** *Veterinary Anesthesia and Analgesia* 31(4): 276-279. ISSN: (p) 1467-2987; Online: 1467-2995.

Online: <http://dx.doi.org/10.1111/j.1467-2995.2004.00166.x>

NAL Call Number: SF914.V47

Abstract: OBJECTIVE: To evaluate the suitability of etorphine with acepromazine for producing prolonged neuroleptanalgesia in wild Asian elephants. ANIMALS: Ten adult wild elephants (four males, six females), free-roaming in the jungles of the north-western province of Sri Lanka. MATERIALS AND METHODS: Ten wild elephants were tranquilized for attachment of radio transmitter collars from September to November 1997, using Large-Animal Immobilon (C-Vet Veterinary Products, Leyland, UK), which is a combination of etorphine (2.45 mg mL(-1)) and acepromazine (10 mg mL(-1)). This was injected using projectile syringes fired from a Cap-Chur gun (Palmer Chemical Co. Inc., Atlanta, USA). A volume of 3.3 (2.5-4.5) mL Immobilon (6.12-11.02 mg of etorphine and 25-45 mg acepromazine) was injected intramuscularly after body mass estimation of individual elephants. RESULTS: The body condition of all darted elephants was good, and the mean (minimum-maximum) shoulder height was 225 (180-310) cm. The average approximate distance to elephants at firing was 26 (15-50) m. The average time to recumbency after injection was 18 (15-45) minutes. Nine out of 10 elephants remained in lateral recumbency (and did not require additional dosing) for a period of 42 (28-61) minutes. The respiratory and heart rates during anaesthesia were 7 (4-10) breaths and 52 (40-60) beats minute(-1), respectively. An equal volume (8.15-14.67 mg) of diprenorphine hydrochloride (Revivon, 3.26 mg mL(-1) diprenorphine; C-Veterinary Products, Leyland, UK) was given intravenously when the procedure was completed. Recovery (return to standing position) occurred in 6 (2-12) minutes after diprenorphine injection. Immediately afterwards, all elephants slowly retreated into the jungle without complications. Continuous radio tracking of the animals involved in this study indicated no post-operative mortality for several months after restraint. CONCLUSIONS/CLINICAL RELEVANCE: Etorphine-acepromazine combinations can be used safely in healthy wild Asian elephants for periods of restraint lasting up to 1 hour.

Descriptors: Asian elephant, *Elephas maximus*, acepromazine, anesthesia, anesthetics, analgesics, diprenorphine, drug combinations, etorphine, heart rate, neuroleptics, pharmacodynamics, respiration rate, telemetry.

Ashwani, K. and S. Neetu (2004). **Diseases of Indian elephants: an overview.** *Veterinary Practitioner* 5(2): 179-183. ISSN: 0972-4036.

Descriptors: bacterial diseases, cardiovascular diseases, digestive disorders, granuloma, kidney diseases, liver diseases, nervous system diseases, parasitism, skin diseases, viral diseases, *Elephas maximus*, *Loxodonta africana*.

Atthi, R., P. Chuaplaivech, W. Pintawong, S. Takoonwong, P. Sunpachudayan, N. Ruksri, and W. Teerathavorawan (2003). **Comparison of serum antibody responses in domestic elephants to three different haemorrhagic septicaemia oil adjuvant vaccine formulations.** *Journal of the Thai Veterinary Medical Association* 54(3): 29-37. ISSN: 0125-0620.

Descriptors: adjuvants, antibody formation, disease control, disease prevention, disease resistance, hemorrhagic septicemia, immune response, immunity, vaccination, vaccine development, vaccines, wild animals, *Elephas maximus*, *Loxodonta africana*, *Pasteurella multocida*, ELISA.

Language of Text: Thai, with English summary.

Atthi, R., P. Chuaplaivech, W. Pintawong, S. Takoonwong, P. Sunpachudayan, N. Ruksri, and W.

Teerathavorawan (2003). **Comparison of serum antibody responses in domestic elephants to three different hemorrhagic septicaemia oil adjuvant vaccine formulations.** *Journal of the Thai Veterinary Medical Association* 54(3): 29-37. ISSN: 0125-0620.

Descriptors: Asian elephant, *Elephas maximus*, African elephant, *Loxodonta africana*, adjuvants, antibody formation, disease control, disease prevention, disease resistance, hemorrhagic septicemia, immune response, immunity, vaccine development, vaccines.
Language of Text: Thai, Summary in English.

Bajpai, S.K. and V.P. Chandrapuria (2003). **Experience of using melonex for sprained joint of an elephant.** *Intas Polivet* 4(1): 109-110. ISSN: 0972-1738.

Online: <http://journals.indexcopernicus.com/karta.php?action=masterlist&id=5028>

Descriptors: case reports, clinical aspects, drug therapy, joint diseases, *Elephas maximus*.

Ball, R.L., J.L. Brown, J. Meyer, J. St. Leger, and J.H. Olsen (2004). **Treatment of anestrus due to hyperprolactinemia with cabergoline in a captive Asian elephant (*Elephas maximus*).** *Proceedings: American Association of Zoo Veterinarians, American Association of Wildlife Veterinarians, Wildlife Disease Association: Health and Conservation of Captive and Free-Ranging Wildlife. Joint Conference, August 28, 2004-September 3, 2004, San Diego, California, American Association of Zoo Veterinarians:* p. 363-365. 660 p.

Descriptors: Asian elephant, anestrus, treatment, hyperprolactinemia, *Elephas maximus*, cabergoline, plasma, serum prolactin levels, hormones, prolactin, ovary.

Bartlett, S.L., N. Abou Madi, M.S. Kraus, E.B. Wiedner, S.R. Starkey, and G.V. Kollias (2009).

Electrocardiography of the Asian elephant (*Elephas maximus*). *Journal of Zoo and Wildlife Medicine* 40(3): 466-473. ISSN: 1042-7260.

Online: <http://dx.doi.org/10.1638/2008-0140.1>

Abstract: Electrocardiograms (ECGs) are infrequently performed on Asian elephants (*Elephas maximus*), and few studies have been reported in the literature. The aim of this study was to determine reference ranges of ECG parameters in Asian elephants and to ascertain if age, body weight, and position of the elephant significantly affected the ECG. Electrocardiograms were obtained from 27 captive, nonsedated apparently healthy Asian elephants while they were standing (ST), in right lateral recumbency (RL), and/or in left lateral recumbency (LL). Six-lead ECGs were obtained using novel clamps and long ECG cables (71 cm). From lead I, standard waveforms and intervals were analyzed, including PR interval, QT interval, ST segment, P, QRS, T, and U waves if they were present. One animal was determined to have a previously undiagnosed conduction abnormality and was not included in the study. Most elephants had a sinus arrhythmia in at least one position. With increasing age, there was a trend toward a slower heart rate and significantly longer P waves. Increasing body weight was significantly correlated with longer QT intervals and T waves with lower amplitude. Compared with measurements in ST, LL resulted in P waves and QRS complexes with shorter amplitude, U waves with greater amplitude, PR intervals with shorter duration, and an increased heart rate. Compared with measurements in LL, RL resulted in larger QRS complexes. U waves were most commonly detected in RL and LL. Mean electrical axis calculated in the frontal plane were as follows: standing range -125 to +141 degrees, mean -5 degrees; left lateral range -15 to +104 degrees, mean 27 degrees; right lateral range -16 to +78 degrees, mean 9 degrees. Position-specific reference ranges should be used when interpreting ECGs, and clinicians must be aware of how age and body weight may affect the ECG. *Reproduced with Permission from CAB Abstracts.*

Descriptors: arrhythmia, body weight, electrocardiograms, electrocardiography, heart, heart rate, *Elephas maximus*.

Bhupen Sarma (2004). **Corneal abrasion and iridocyclitis in an elephant.** *Intas Polivet* 5(1): 128-129. ISSN: 0972-1738.

Descriptors: abrasion, atropine, cornea, drug therapy, eye diseases, eyes, gentamicin, healing, zoo animals, *Elephas maximus*.

Bojesen, A.M., K.E.P. Olsen, and M.F. Bertelsen (2006). **Fatal enterocolitis in Asian elephants (*Elephas maximus*) caused by *Clostridium difficile*.** *Veterinary Microbiology* 116(4): 329-335. ISSN: 0378-1135.

Online: <http://dx.doi.org/10.1016/j.vetmic.2006.04.025>

NAL Call Number: SF601.V44

Abstract: Two cases of fatal enteritis caused by *Clostridium difficile* in captive Asian elephants are reported from an outbreak affecting five females in the same zoo. Post mortem examination including histopathology demonstrated fibrinonecrotic enterocolitis. *C. difficile* was isolated by selective cultivation from two dead and a third severely affected elephant. Four isolates were obtained and found positive for toxin A and B by PCR. All isolates were positive in a toxigenic culture assay and toxin was demonstrated in the intestinal content from one of the fatal cases and in a surviving but severely affected elephant. PCR ribotyping demonstrated that the *C. difficile* isolates shared an identical profile, which was different from an epidemiologically unrelated strain, indicating that the outbreak was caused by the same *C. difficile* clone. It is speculated that the feeding of

large quantities of broccoli, a rich source of sulforaphane, which has been shown to inhibit the growth of many intestinal microorganisms may have triggered a subsequent overgrowth by *C. difficile*. This is the first report of *C. difficile* as the main cause of fatal enterocolitis in elephants. The findings emphasize the need to regard this organism as potentially dangerous for elephants and caution is recommended concerning antibiotic treatment and feeding with diets containing antimicrobials, which may trigger an expansion of a *C. difficile* population in the gut. Reproduced with Permission from CAB Abstracts>

Descriptors: animal diseases, Asian elephant, *Elephas maximus*, enterocolitis, bacterial infections, *Clostridium difficile*, disease diagnosis, polymerase chain reaction, DNA profiling, pathogen identification, strains, animal nutrition, animal feeding, broccoli.

de Oliveira, C.A., G.D. West, R. Houck, and M. Leblanc (2004). **Control of musth in an Asian elephant bull (*Elephas maximus*) using leuprolide acetate.** *Journal of Zoo and Wildlife Medicine* 35(1): 70-6.

NAL Call Number: SF601.J6

Abstract: The results of long-term administration of leuprolide acetate (LA) depot in a 52-yr-old Asian elephant bull (*Elephas maximus*) for control of musth are presented. Twelve injections were administered for 6 yr during our interpretation of early musth or "premusth." Intervals between musth periods during the study varied from 2 to 34 mo. Blood samples, drawn weekly, were assayed for serum testosterone concentrations; mean levels were 11.78 +/- 1.97 nmol/L throughout the first 26 mo of the study, 7.28 +/- 1.28 nmol/L during the following 21 mo, and 0.45 +/- 0.035 nmol/L in the last 34 mo of this study. Early musth signs ceased within 3 days of drug administration after 10 of 12 injections. The mean serum testosterone concentrations were significantly decreased by the last 34 mo of the study. The results suggest leuprolide is a suitable alternative for controlling or preventing (or both) musth in captive Asian elephants, although permanent reproductive effects may occur. Zoos and wildlife conservation institutions could benefit from the use of LA in Asian elephants to increase the male availability in captivity, consequently ensuring genetic diversity and the perpetuation of the species.

Descriptors: drug effects behavior, physiology, gonadorelin agonists, leuprolide administration and dosage, drug effects on aggression, blood, drug effects on eliminative behavior, leuprolide pharmacology, drug effects on sex behavior, social dominance, testosterone.

de Oliveira, C.A., G.D. West, R. Houck, and M. Leblanc (2004). **Control of musth in an Asian elephant bull (*Elephas maximus*) using leuprolide acetate.** *Journal of Zoo and Wildlife Medicine* 35(1): 70-76. ISSN: 1042-7260.

NAL Call Number: SF601.J6

Descriptors: Asian elephant, bull, musth, behavior, testosterone, control, leuprolide acetate, *Elephas maximus*.

Dumonceaux, G., R. Isaza, D.E. Koch, and R.P. Hunter (2005). **Pharmacokinetics and i.m. bioavailability of ceftiofur in Asian elephants (*Elephas maximus*).** *Journal of Veterinary Pharmacology and Therapeutics* 28(5): 441-6.

NAL Call Number: SF915.J63

Abstract: Captive elephants are prone to infections of the feet, lungs, and skin. Often treatment regimens are established with no pharmacokinetic data on the agents being used for treatment in these species. A pharmacokinetic study using ceftiofur (1.1 mg/kg) was conducted in four adult female captive Asian elephants (*Elephas maximus*) at Busch Gardens in Tampa, Florida. Elephants were given both i.v. and i.m. administrations in a complete crossover design with a 3-week washout period between treatments. Blood samples were collected prior to drug administration and at 0.33, 0.67, 1, 1.5, 2, 4, 8, 12, 24, 48 and 72 h postadministration. Ceftiofur analysis was performed using a validated liquid chromatography/mass spectrophotometric (LC/MS) assay. Plasma concentrations for the i.m. samples were lower than expected. The mean C(max) following i.m. administration was 1.63 microg/mL with a corresponding T(max) of 0.55 h. Following i.v. administration, the median V(d(ss)) was 0.51 L/kg and a median CI(p) of 0.069 L/kg/h. Mean i.m. bioavailability was 19%. The results indicate that ceftiofur used at 1.1 mg/kg i.m. could be useful in elephants when given two to three times a day or alternatively, 1.1 mg/kg i.v. once daily, depending upon the MIC of the pathogen.

Descriptors: cephalosporins pharmacokinetics, metabolism, area under curve, biological availability, cephalosporins administration and dosage, cephalosporins blood, intramuscular veterinary injections.

Fickel, J., D. Lieckfeldt, L.K. Richman, W.J. Streich, T.B. Hildebrandt, and C. Pitra (2003).

Comparison of glycoprotein B (gB) variants of the elephant endotheliotropic herpesvirus (EEHV) isolated from Asian elephants (*Elephas maximus*). *Veterinary Microbiology* 91(1): 11-21. ISSN: 0378-1135.

NAL Call Number: SF601.V44

Abstract: The recently described elephant endotheliotropic herpesviruses (EEHV) have been associated with the deaths of numerous captive elephants. A proposed tool for the detection of EEHV infection in elephants is the PCR-based screening for EEHV-DNA in whole blood samples. Unfortunately, this detection method has only been successful in post-mortem analyses or in animals already displaying clinical signs of EEHV disease, thus

rendering this method unsuitable for identification of carrier elephants. Here, we focus on glycoprotein B (gB) for serologic assay development, since gB is an envelope protein known to induce a neutralising antibody response in other herpesvirus infections. We sequenced the entire gB gene from five Asian elephants with EEHV, representing four different gB variants. Computer-aided methods were used to predict functionally important regions within EEHVgB. An extra-cytoplasmic region of 153 amino acids was predicted to be under positive selection and may potentially contain antigenic determinants that will be useful for future serologic assay development.

Descriptors: *Elephas maximus*, viral proteins, glycoproteins, disease transmission, detection, polymerase chain reaction, cytoplasm, amino acid sequences, molecular sequence data.

Garner, M.M., K. Helmick, J. Ochsenreiter, L.K. Richman, E. Latimer, A.G. Wise, R.K. Maes, M. Kiupel, R.W. Nordhausen, J.C. Zong, and G.S. Hayward (2009). **Clinico-pathologic features of fatal disease attributed to new variants of endotheliotropic herpesviruses in two Asian elephants (*Elephas maximus*)**. *Veterinary Pathology* 46(1): 97-104. ISSN: 0300-9858.

Online: <http://dx.doi.org/10.1354/vp.46-1-97>

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. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, herpesviruses, endotheliotropic herpesviruses (EEHV), virulence.

Hildebrandt, T.B., R. Hermes, P. Ratanakorn, W. Rietschel, J. Fickel, R. Frey, G. Wibbelt, C. Reid, and F. Goritz (2005). **Ultrasonographic assessment and ultrasound-guided biopsy of the retropharyngeal lymph nodes in Asian elephants (*Elephas maximus*)**. *Veterinary Record* 157(18): 544-8.

NAL Call Number: 41.8 V641

Abstract: Endotheliotropic herpesvirus causes a fatal disease in young Asian elephants, but there are no methods for identifying latent carriers of the virus. During the postmortem study of one female African elephant and three male and two female Asian elephants, a lymph node located bilaterally caudoventral to the parotid gland, approximately 1.5 to 5 cm below the skin, was identified as suitable for transcutaneous ultrasound-guided biopsy. An ultrasonographic assessment and two biopsies were performed on 39 Asian elephants, and these lymph nodes were classified ultrasonographically as active, inactive or chronically active. The calculated mean (se) volume of 10 active lymph nodes was 17.4 (6.9) cm³, and that of three chronically active lymph nodes was 10.6 (1.0) cm³, whereas the mean volume of 17 inactive lymph nodes was 3.1 (0.6) cm³. The presence of lymph node tissue in samples obtained by ultrasound-guided biopsy from three animals that were maintained under conditions that allowed for additional sampling was confirmed histologically. The dna extracted from the lymphoid tissue and the whole blood of all the elephants was negative for endotheliotropic herpesvirus by PCR.

Descriptors: DNA viral isolation and purification, herpesviridae isolation and purification, herpesviridae infections, lymph nodes pathology, zoo animals, fine needle biopsy methods, disease reservoirs, disease reservoirs virology, Herpesviridae pathogenicity, Herpesviridae infections epidemiology, Herpesviridae infections pathology, lymph nodes ultrasonography, lymph nodes virology, polymerase chain reaction, prevalence, virus latency.

Hildebrandt, T.B., T. Strike, E. Flach, L. Sambrook, J. Dodds, N. Lindsay, C.F. Furley, P.S. Glatzel, and M. McGowan (2003). **Fetotomy in the elephant**. *Erkrankungen der Zootiere: Verhandlungsbericht des 41 Internationalen Symposiums über die Erkrankungen der Zoo und Wildtiere. Proceedings of the Institute for Zoo and Wildlife Research, Berlin, No.5, May 1, 1928-June 1, 2003, Rome, Italy*, Vol. 5, p. 315-318.

NAL Call Number: SF996.I5

Descriptors: fetotomy, dystocia, fetus, surgery, *Elephas maximus*, *Loxodonta africana*, reproduction.

Hoyer, M.J., M.J. Kik, F.A. Vestappen, M.S. Wolters, H.H. van der Kolk, and M. Treskes (2004).

Medical management of a geriatric bull elephant (*Elaphus maximus*) with multiple problems, a case report. In: *Proceedings: American Association of Zoo*

Veterinarians, American Association of Wildlife Veterinarians, Wildlife Disease Association: Health and Conservation of Captive and Free-Ranging Wildlife. Joint Conference, August 28, 2004-September 3, 2004, San Diego, California, American Association of Zoo Veterinarians: p. 357-362. 660 p.

Descriptors: Asian elephant, *Elephas maximus*, diseases, disorders, geriatric male, multiple problems, medical management, case report.

Hunter, R.P., R. Isaza, and D.E. Koch (2003). **Oral bioavailability and pharmacokinetic characteristics of ketoprofen enantiomers after oral and intravenous administration in Asian elephants (*Elephas maximus*).** *American Journal of Veterinary Research* 64(1): 109-14.

NAL Call Number: 41.8 Am3A

Abstract: OBJECTIVE: To assess oral bioavailability (F) and pharmacokinetic characteristics of the R- and S-enantiomers of ketoprofen administered IV and orally to captive Asian elephants (*Elephas maximus*). ANIMALS: 5 adult Asian elephants. PROCEDURE: Elephants received single treatments of racemic ketoprofen at a dose of 2.2 mg/kg, administered IV and orally, in a complete crossover design. Blood samples were collected at intervals during the 24 hours following treatment. At least 4 weeks elapsed between drug administrations. Samples were analyzed for R- and S-ketoprofen with a validated liquid chromatography-mass spectroscopic assay. Pharmacokinetic parameters were determined by use of noncompartmental analysis. RESULTS: The enantiomers of ketoprofen were absorbed well after oral administration, with median F of 101% for R-ketoprofen and 85% for S-ketoprofen. Harmonic mean half-life ranged from 3.8 to 5.5 hours, depending on route of administration and enantiomer. The area under the concentration-time curve, mean residence time, apparent volume of distribution, plasma clearance, and maximum plasma concentration values were all significantly different between the 2 enantiomers for both routes of administration. CONCLUSIONS AND CLINICAL RELEVANCE: Ketoprofen has a long terminal half-life and complete absorption in this species. Based on the pharmacokinetic data, a dosage of ketoprofen of 1 mg/kg every 48 hours to 2 mg/kg every 24 hours, PO or IV, is recommended for use in Asian elephants, although the safety and efficacy of ketoprofen during long-term administration in elephants have not been determined.

Descriptors: anti inflammatory agents, non steroidal pharmacokinetics, metabolism, ketoprofen pharmacokinetics, oral administration, anti inflammatory agents, non steroidal administration and dosage, anti inflammatory agents, non steroidal blood, area under curve, biological availability, cross over studies, half life, intravenous injections, ketoprofen administration and dosage, ketoprofen blood, random allocation, stereoisomerism.

Indramani Nath, S.K. Panda, Jasmeet Singh, and P.K. Roy (2009). **Complication of immobilization tranquilization in an Asian elephant (*Elephas maximus*).** *Indian Journal of Veterinary Surgery* 30(1): 69. ISSN: 0254-4105.

Abstract: A captive male Asian elephant, 45 years old, showed excitement and uncontrollable behaviour on 16 August 2007. The behaviour caused damages to nearby villages and properties. Forest officials guided the animal back to the sanctuary. It was immediately hobbled and tethered securely. Then, the animal became aggressive and it was decided to tranquilize it using 4 ml Immobilon-LA. After darting, the animal became more excited, broke its chain and ate two bags of wheat and turmeric from a store by breaking its door. An antidote, 8 ml M 50-50 (Diprenorphine), was administered to the ear vein. The elephant died within 45 min. Postmortem examination revealed that the larynx was blocked with pasty wheat material. The oesophagus was filled with food materials and the lungs were congested. The heart was soft and flabby with blood clots inside the ventricles. The cause of death was respiratory blockage resulting from feeding during sedation. The excitation of the bull after darting as evidenced by breaking of the chain and eating of grains in semi-sedated condition resulted to choking and death of the elephant. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, aggression, animal behavior, case reports, mortality, neuroleptics.

Isaza, R., B.J. Behnke, J.K. Bailey, P. McDonough, N.C. Gonzalez, and D.C. Poole (2003). **Arterial blood gas control in the upright versus recumbent Asian elephant.** *Respiratory Physiology and Neurobiology* 134(2): 169-76.

NAL Call Number: QP121.A1R4

Abstract: In the elephant, there is concern that lateral recumbency (LR) impairs respiratory muscle and lung function resulting in clinically significant arterial hypoxemia. Using healthy adult female Asian elephants (*Elephas maximus*, n=6), the hypothesis was tested that, given the O₂ binding characteristics of elephant blood, substantial reductions in arterial O₂ pressure (Pa(O₂)) in LR could be tolerated without lowering arterial O₂ content appreciably. Fifteen minutes of LR decreased Pa(O₂) from 103+/-2 (upright, U) to 77+/-4 mmHg (P<0.05) and hemoglobin O₂ saturation (U, 97.8+/-0.1, LR, 95.3+/-0.5%, P<0.05). However, due to a recumbency-induced hemoconcentration, arterial O₂ content was unchanged (U, 18.2+/-2.4, LR, 18.3+/-2.1 ml O₂ per 100 ml). In addition, there was a mild hyperventilation in LR that reduced arterial CO₂ pressure (P(CO₂)) from 39.4+/-0.3 to 37.1+/-1.0 mmHg (P<0.05). These data indicate that the Asian elephant can endure at least short periods of LR without lowering arterial

O(2) content.

Descriptors: acid base equilibrium physiology, anoxemia, blood pressure physiology, posture physiology, anoxemia blood, arteries, blood gas analysis.

Isaza, R., R.D. Davis, S.M. Moore, and D.J. Briggs (2006). **Results of vaccination of Asian elephants (*Elephas maximus*) with monovalent inactivated rabies vaccine.** *American Journal of Veterinary Research* 67(11): 1934-1936. ISSN: 0002-9645.

NAL Call Number: 41.8 Am3A

Descriptors: Asian elephant, *Elephas maximus*, zoo animals, animal diseases, rabies, Rabies virus, vaccination, inactivated vaccines, immune response, humoral immunity, temporal variation, blood chemistry, antibodies, seroconversion, booster vaccinations, neutralizing antibodies.

Isaza, R. and R.P. Hunter (2004). **Drug delivery to captive Asian elephants - treating Goliath.** *Current Drug Delivery* 1(3): 291-8.

Abstract: Captive Asian elephants have been maintained in captivity by humans for over 4000 years. Despite this association, there is little published literature on the treatment of elephant diseases or methods of drug administration to these animals. Elephants in captivity are generally healthy and require few therapeutic interventions over the course of their lifetime. However, when they become acutely ill, treatment becomes a serious issue. The successful and consistent administration of therapeutics to elephants is formidable in an animal that presents significant limitations in drug delivery options. The single most important factor in administering drugs to an elephant is the animal's cooperation in accepting the medication. Working around elephants can be very dangerous and this is magnified when working around sick or injured animals where the elephant is subject to increased stress, pain, and unusual situations associated with treatment. The large body size of the Asian elephant produces a separate set of issues. In this paper, methods of drug administration and their associated limitations will be reviewed. Considerations of medicating such large animals can serve to highlight the problems and principles of treatment that are inherent in these species.

Descriptors: zoo animal physiology, drug delivery system methods, drug administration routes, veterinary medicine methods.

Jani, R.G. (2008). **Prevalence and hemato biochemical studies of gastrointestinal parasites of Indian elephants (*Elephas maximus*).** *Veterinary World* 1(10): 296-298. ISSN: 0972-8988.

Abstract: Fecal samples were collected from 40 Indian elephants (*Elephas maximus*). The examination revealed a 62.5% prevalence of parasites in the elephants. Among the single infection with parasites, a high prevalence of *Fasciola* spp. (15.00%) was observed followed by mixed infections. The elephants harbouring parasites were clinically dull, depressed and lethargic. About 48% of the elephants manifested dehydration and loose feces as well as the habit of soil licking. The hematological studies of elephants harboring parasites revealed mild anaemia and eosinophilia, whereas biochemical studies revealed insignificant hypoproteinaemia. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, anemia, blood chemistry, dehydration, hypoproteinaemia, infections, parasitoses.

Kajaysri, J., S. Huayjunteuk, S. Reunpech, C. Thammakarn, N. Warrasuth, and S. Eardmusic (2003). **The condition of paper thin bone layer and fracture by metabolic bone disease in an orphan elephant.** *Proceedings of 41st Kasetsart University Annual Conference, Subject: Animals and Veterinary Medicine, February 3, 2003-February 7, 2003, Bangkok, Thailand: Kasetsart University, Kasetsart University: Bangkok, Thailand, p. 508-515.*

Descriptors: Asian elephant, metabolic bone diseases, bone layer, fracture, case reports, clinical aspects, diagnosis, treatment, fracture fixation, *Elephas maximus*.

Language of Text: Thai, with English summary.

Kanchanapangka, S., S. Supawong, K. Koedlab, J. Kaewpannarai, P. Khawnual, P. Tummaruk, and K. Sajjarengpong (2007). **Body weight formulation in Asian elephant.** *Thai Journal of Veterinary Medicine* 37(1): 49-58. ISSN: 0125-6491.

Abstract: Accurate estimation of body weight is useful for feeding program evaluation, assessing nutritional status and general health, and for accurate dose calculation in medical treatment. However, it is impractical to weight elephants due to their enormous size and tremendous weight, and also due to the lack of a suitable weighing machine. The objective of the present study was to correlate various body measurements and actual body weight of the elephant in order to formulate a regression model to approximate the body weight of the elephant from body measurements. Seventy-eight Asian elephants (*Elephas maximus indicus*) comprising 18 males and 60 females, from 9 months to 57 years in age were used. Body weight, girth measurements (heart, neck and flank), shoulder height, and circumference of feet and elbows were measured. All possible linear regressions of body weight were calculated. The most accurate model when using one parameter for domestic elephants is the flank girth ($R^2=0.939$), although the body weight of domestic Asian elephants can be reliably calculated from various body measurements ($R^2 \geq 0.813$). For wild elephants, we suggested that shoulder height and circumference of feet are more practical ($R^2 \geq 0.839$). Inclusion of sex and age group (< 10 years, 10

to < / 0 years, and ≥ 20 years) in the statistical model increased the R2. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, body measurements, body weight, estimation, heart girth, mathematical models, morphometrics.

Language of Text: Thai.

Kilgallon, C., E. Flach, W. Boardman, A. Routh, T. Strike, and B. Jackson (2008). **Analysis of biochemical markers of bone metabolism in Asian elephants (*Elephas maximus*)**. *Journal of Zoo and Wildlife Medicine* 39(4): 527-536. ISSN: 1042-7260.

Online: <http://dx.doi.org/10.1638/2006-0024.1>

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. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, alkaline phosphatase, antibodies, antigens, biochemical markers, blood serum, bone density, bone diseases, bones, collagen, cross reaction, enzyme immunoassay, enzymes, immunoassay, metabolism, osteocalcin, radioimmunoassay.

Kongsila, A., N. Thongtip, and N. Yatbantung (2003). **Oesophageal obstruction (choke) in Asiatic elephant (*Elephas maximus*): case report**. *Proceedings of 41st Kasetsart University Annual Conference, Subject: Animals and Veterinary Medicine, February 3, 2003-February 7, 2003, Bangkok, Thailand: Kasetsart University, Kasetsart University: Bangkok, Thailand, p. 678-683.*

Descriptors: Asian elephant, choke, esophageal obstruction, case report, clinical signs, diagnosis, treatment, *Elephas maximus*.

Language of Text: Thai, with English summary.

Landolfi, J.A., S.A. Schultz, S.K. Mikota, and K.A. Terio (2009). **Development and validation of cytokine quantitative, real time RT-PCR assays for characterization of Asian elephant immune responses**. *Veterinary Immunology and Immunopathology* 131(1/2): 73-78. ISSN: 0165-2427.

Online: <http://dx.doi.org/10.1016/j.vetimm.2009.03.012>

Abstract: Infectious disease is an important factor in Asian elephant health and long-term species survival. In studying disease pathogenesis, it is important to consider not only the pathogen, but also the effectiveness of the host immune response. Currently, there is a paucity of information available on elephant immune function. Measurement of cytokine levels within clinical samples can provide valuable information regarding immune function during health and disease that may elucidate disease susceptibility. To develop tools for assessment of elephant immune function, Asian elephant partial mRNA sequences for interleukin (IL)-2, IL-4, IL-10, IL-12, interferon (IFN)- gamma, tumor necrosis factor (TNF)- alpha, transforming growth factor (TGF)- beta, glyceraldehyde 3-phosphate dehydrogenase (GAPDH), and beta-actin were determined. Sequence information was then utilized to design elephant-specific primers and probes for quantitative, real time, RT-PCR assays for the measurement of cytokine mRNA. Greater than 300 bps of Asian elephant mRNA sequence were determined for each cytokine of interest. Consistent and reproducible, real time, RT-PCR assays with efficiencies of greater than 93% were also developed. Assay sensitivities ranged from less than 1 to 5000 DNA copies with the exception of IL-12, which had a sensitivity of 42,200 copies. Employment of molecular techniques utilizing mRNA-based detection systems, such as real time, RT-PCR, facilitate sensitive and specific cytokine detection and measurement in samples from species for which commercial reagents are not available. Future studies utilizing these techniques to compare elephant immune function during health and in the face of infection will be useful for characterizing the contribution of the elephant immune system to disease. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, characterization, cytokines, DNA, enzymes, glyceraldehyde, growth factors, health, hosts, immune response, immune system, immunology, infectious diseases, interferon, interleukin 10, interleukins, measurement, messenger RNA, necrosis, pathogenesis, polymerase chain reaction, transforming growth factor, tumor necrosis factor.

Laws, N., A. Ganswindt, M. Heistermann, M. Harris, S. Harris, and C. Sherwin (2007). **A case study: fecal corticosteroid and behavior as indicators of welfare during relocation of an Asian elephant.** *Journal of Applied Animal Welfare Science* 10(4): 349-358. ISSN: 1088-8705.

Abstract: This study was a preliminary investigation of an enzyme immunoassay for measuring fecal glucocorticoid metabolites in a male Asian elephant (*Elephas maximus*) by investigating changes in behavior and cortisol metabolite excretion associated with a putative stressful event. The study collected fecal samples for 10 days prior to, and 10 days after, 24-hr transport and relocation of the elephant to a new herd. The study measured cortisol metabolites using 2 enzyme immunoassays indicating a 389% and 340% increase in cortisol metabolite excretion following relocation. Maximal cortisol metabolite excretion occurred 2 days after relocation and remained elevated during establishment of the new herd. Stereotypic behavior increased approximately 400% after relocation. The relocation disturbed sleep patterns, the elephant spent less time sleeping during the night, and the elephant slept standing up. These results provide preliminary evidence that noninvasive monitoring of fecal cortisol metabolites can be used to investigate adrenal activity in Asian elephants and may be a safe, practical, and accurate welfare indicator. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, animal behavior, animal welfare, case report, corticoids, excretion, feces, glucocorticoids, hydrocortisone, immunoassay.

Lewerin, S.S., S.L. Olsson, K. Eld, B. Roken, S. Ghebremichael, T. Koivula, G. Kallenius, and G. Bolske (2005). **Outbreak of *Mycobacterium tuberculosis* infection among captive Asian elephants in a Swedish zoo.** *Veterinary Record* 156(6): 171-5.

NAL Call Number: 41.8 V641

Abstract: Between 2001 and 2003, there was an outbreak of tuberculosis in a Swedish zoo which involved elephants, giraffes, rhinoceroses and buffaloes. Cultures of trunk lavages were used to detect infected elephants, tuberculin testing was used in the giraffes and buffaloes, and tracheal lavage and tuberculin testing were used in the rhinoceroses. The bacteria isolated were investigated by spoligotyping and restriction fragment length polymorphism. Five elephants and one giraffe were found to have been infected by four different strains of *Mycobacterium tuberculosis*.

Descriptors: disease outbreaks, *Mycobacterium tuberculosis* isolation and purification, tuberculosis, zoo animals *Mycobacterium tuberculosis* classification, *Mycobacterium tuberculosis* pathogenicity, polymorphism, restriction fragment length, Sweden epidemiology, tuberculosis diagnosis, tuberculosis epidemiology.

Liu, C.H., C.H. Chang, S.C. Chin, P.H. Chang, Y.X. Zhuo, and C.C. Lee (2004). **Fibrosarcoma with lung and lymph node metastases in an Asian elephant (*Elephas maximus*).** *Journal of Veterinary Diagnostic Investigation* 16(5): 421-3.

NAL Call Number: SF774.J68

Abstract: A case of fibrosarcoma with lung and lymph node metastases in a 54-year-old female Asian elephant (*Elephas maximus*) is described. After pododermatitis of 2 years duration in the right forefoot, a mass developed in the lateral toenail. At postmortem, metastasis to the right axillary lymph node and both lungs was noted. Microscopic examination of primary and metastatic sites revealed infiltrating bundles of spindle cells, with fairly distinct cell borders, variable amounts of eosinophilic cytoplasm, and elongate or oval nuclei. Tumor cells were often arranged in interwoven bundles and herringbone patterns. Mitotic figures were numerous and frequently bizarre. The diagnosis of fibrosarcoma with lung and lymph node metastases was made on the basis of histologic features and positive immunohistochemical staining for vimentin.

Descriptors: zoo animals, fibrosarcoma, secondary lung neoplasms, lung neoplasms, lymph nodes pathology, skin neoplasms, biopsy, fatal outcome, fibrosarcoma secondary, immunohistochemistry, skin neoplasms pathology.

Liamsiricharoen, M., T. Prapong, C. Thitaram, C. Somgird, C. Sarachai, W. Wongkalasin, S. Mahasawangkul, P. Kongtueng, N. Tongtip, and A. Suprasert (2005). **Gross and microscopic anatomy of cranial dura mater of Asian elephant (*Elephas maximus*).** *Kasetsart Journal, Natural Sciences* 39(3): 477-481. ISSN: 0075-5192.

Abstract: The gross and microscopic anatomy of the cranial dura mater of 2 dying, male, Asian elephants (*Elephas maximus*) aged 24 and 68 years was studied. The cranial dura mater consisted of 2 layers, an outer periosteal layer and an inner meningeal layer. The porous appearance formed by blood vessels was seen between the 2 layers. Some completed foramina were found in the falx cerebri sheet. Unlike most of domestic animals, there were 2 falx cerebelli running along the 2 sides of the vermis and also many small tubercles on the surface of the inner meningeal layer. By staining with hematoxylin and eosin, Masson trichrome and Weigert stains, these small tubercles were observed as collagenous mass protrusions. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, animal anatomy, blood vessels, brain, meninges.

Manna, S. (2003). **Enteritis and its treatment in an Asian elephant.** *Zoos' Print Journal* 18(6): 1130. ISSN: 0971-6378.

Descriptors: Asian elephant, atropine, clinical aspects, diagnosis, diarrhea, drug therapy, enteritis, oxytetracycline, zoo elephant, *Elephas maximus*.

- Manohar, B.M., J. Selvaraj, S.M. Sakthivelan, W.M. Paul, M.G. Jayathangaraj, K.S. Kumar, and Koteeswaran (2004). **Pododermatitis in an elephant calf**. *Indian Veterinary Journal* 81(1): 107-108. ISSN: 0019-6479.
NAL Call Number: 41.8 IN2
Descriptors: Asian elephant, calf, pododermatitis, infection.
- Martelli, P., S. Herbert, and Oh Soon Hock (2004). **Humeral fracture in a newborn Asian elephant calf (*Elephas maximus*)**. In: *Proceedings: American Association of Zoo Veterinarians, American Association of Wildlife Veterinarians, Wildlife Disease Association: Health and Conservation of Captive and Free-Ranging Wildlife. Joint Conference, August 28, 2004-September 3, 2004, San Diego, California, American Association of Zoo Veterinarians*: p. 597-600. 660 p.
Descriptors: Asian elephants, *Elephas maximus*, calf, treatment techniques, forelimb skeleton, injuries, humeral fracture, neonate, successful treatment, case report.
- Martinez del Castillo, G. (2006). **Tecnica de lavado de trompa mediante contacto protegido para diagnostico de tuberculosis en elefantes (*Elephas maximus*)**. [Trunk wash technique by protected contact for the diagnosis of tuberculosis in elephants (*Elephas maximus*)]. *REDVET* 7(9): 1-3. ISSN: 1695-7504.
Online: <http://www.veterinaria.org/revistas/redvet/n090906/090608.pdf>
Abstract: The article discusses the development and training of elephant in captivity for trunk wash technique in the diagnosis of Mycobacterium infection. *Reproduced with Permission from CAB Abstracts*.
Descriptors: Asian elephant, *Elephas maximus*, trunk wash, tuberculosis, diagnostic techniques, training of animals, zoo animals, Mycobacterium.
Language of Text: Spanish, Summary in English.
- Maslow, J.N., S.K. Mikota, M. Zhu, R. Isaza, L.R. Peddie, F. Dunker, J. Peddie, H. Riddle, and C.A. Peloquin (2005). **Population pharmacokinetics of isoniazid in the treatment of *Mycobacterium tuberculosis* among Asian and African elephants (*Elephas maximus* and *Loxodonta africana*)**. *Journal of Veterinary Pharmacology and Therapeutics* 28(1): 21-7.
NAL Call Number: SF915.J63
Abstract: We recently described the clinical presentation and treatment of 18 elephants from six herds infected with TB. Treatment protocols and methods varied between herds to include both oral and rectal dosing using multiple drug doses and formulations. In this paper we present information regarding the pharmacokinetics (PK) of isoniazid (INH) in elephants and provide suggestions regarding initial treatment regimens. Forty-one elephants received INH daily by either oral or rectal administration with different formulations. Population PK analysis was performed using Non-linear Mixed Effect Modeling (NONMEM). Results of oral administration indicated that compared with premixed INH solution, the drug exposure was highest with a suspension prepared freshly with INH powder. When INH was concomitantly given as an admixture over food, T_{max} was delayed and variability in drug absorption was significantly increased. Compared with oral administration, similar drug exposures were found when INH was dosed rectally. The data generated suggest that a starting dose of 7.5 mg/kg of INH is appropriate for initial TB treatment in elephants when premixed solution is administered directly into the oropharynx or rectal vault and 4 mg/kg are when INH is administered following immediate suspension from powdered form.
Descriptors: antitubercular agents pharmacokinetics, metabolism, isoniazid pharmacokinetics, oral administration, rectal administration, administration and dosage of antitubercular agents, antitubercular agents in blood, therapeutic use of antitubercular agents, area under curve, isoniazid administration and dosage, isoniazid in blood, therapeutic use of isoniazid, *Mycobacterium tuberculosis*, tuberculosis drug therapy, tuberculosis.
- Maslow, J.N., S.K. Mikota, M. Zhu, H. Riddle, and C.A. Peloquin (2005). **Pharmacokinetics of ethambutol (EMB) in elephants**. *Journal of Veterinary Pharmacology and Therapeutics* 28(3): 321-3.
NAL Call Number: SF915.J63
Descriptors: antitubercular agents pharmacokinetics, metabolism, ethambutol pharmacokinetics, oral administration, rectal administration, antitubercular agents administration and dosage, antitubercular agents in blood, area under curve, ethambutol administration and dosage, ethambutol in blood.
- McAloon, F.M. (2004). **Oribatid mites as intermediate hosts of *Anoplocephala manubriata*, cestode of the Asian elephant in India**. *Experimental and Applied Acarology* 32(3): 181-5.
NAL Call Number: SB940 .E9
Abstract: *Anoplocephala manubriata* (Cestoda: Anoplocephalidae) is a tapeworm that parasitizes both African (*Loxodonta africana*) and Asian (*Elephas maximus*) elephants. Its life cycle has not yet been completely elucidated nor have intermediate hosts been previously reported. Soil and substrate was collected in the Kodanadu Forest Range, Ernakulum District and Guruvayur Devaswom Temple grounds, Thrissur District, in Kerala, India. Oribatid mites (Acari: Oribatida) were collected from dung piles near

captive elephants' bedding and examined for immature stages of the tapeworm. Five species of oribatids were found to contain at least one immature life stage of *A. manubriata*: *Galumna flabellifera orientalis* Hammer 1958, *Schelorbitates latipes* (C.L. Koch 1844), *S. praeincisus* (Berlese 1913), *Protorbitates seminudus* (Hammer 1971), and *P. triangularis* (Hammer 1971).

Descriptors: Cestoda growth and development, cestode infections, mites parasitology, cestode infections parasitology, cestode infections transmission, India, mite infestations parasitology, mite infestations.

Nath, I., V.S.C. Bose, S.K. Panda, B.C. Das, and L.K. Singh (2003). **A case of multiple abscesses in a baby elephant.** *Zoos' Print Journal* 18(11): 1270.

Descriptors: baby elephant, abscesses, multiple, disease, infection.

Nath, I., N. Sahoo, D.N. Mohanty, S.N. Mohapatra, S.K. Panda, V.S.C. Bose, and K.L. Purohit (2006). **Foreign body obstruction of pharynx in an Asian elephant *Elephas maximus*.** *Zoos' Print Journal* 21(10): 2441. ISSN: 0971-6378.

Abstract: This article reports on a case of transverse obstruction of the pharynx due to an intake of sugarcane by an adult free living cow elephant *E. maximus* in a forest near the Nandankanan Zoo in India. The highlight of the report focused on the diagnosis and treatment of the elephant. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, case reports, foreign bodies, histopathology, medical treatment, obstruction, pharynx, postmortem examinations, sugarcane.

Ollivet Courtois, F., A. Lecu, R.A. Yates, and L.H. Spelman (2003). **Treatment of a sole abscess in an Asian elephant (*Elephas maximus*) using regional digital intravenous perfusion.** *Journal of Zoo and Wildlife Medicine* 34(3): 292-5.

NAL Call Number: SF601.J6

Abstract: Regional digital i.v. perfusion was used to treat a severe sole abscess associated with a wire foreign body in a 19-yr-old female Asian elephant (*Elephas maximus*) housed at the Paris Zoo. The cow presented with acute right forelimb lameness and swelling that persisted despite 4 days of anti-inflammatory therapy. Under anesthesia, a 10- x 0.5- x 0.5-cm wire was extracted from the sole of the right foot. There was a 2-cm-deep, 7-cm-diameter abscess pocket that was subsequently debrided. Regional digital i.v. perfusion was performed and repeated 15 days later, using cefoxitin and gentamicin on both occasions. Between treatments, the cow received trimethoprim-sulfamethoxazole and phenylbutazone orally. Within 2 days of administering anesthesia and the first perfusion treatment, the lameness improved dramatically. When phenylbutazone was discontinued 1 wk after the first treatment, the lameness had completely resolved. At the second treatment, there was no evidence of further soft tissue infection, and the abscess pocket had resolved.

Descriptors: abscess, anti bacterial agents therapeutic use, injuries, foreign bodies, hoof and claw pathology, abscess therapy, zoo animals, cefoxitin therapeutic use, debridement, foreign bodies complications, gentamicins therapeutic use, lameness, etiology, perfusion methods, treatment outcome.

Oni, O., K. Sujit, S. Kasemsuwan, T. Sakpuaram, and D.U. Pfeiffer (2007). **Seroprevalence of leptospirosis in domesticated Asian elephants (*Elephas maximus*) in north and west Thailand in 2004.** *Veterinary Record* 160(11): 368-371. ISSN: 0042-4900.

Abstract: Serum samples from Asian elephants (*Elephas maximus*) in the Kanchanaburi, Chiang Mai and Lampang provinces of Thailand were tested using the microscopic agglutination test against 22 serovars of *Leptospira interrogans*. A titre of more than 1:100 was used as evidence of infection. In northern Thailand, the seroprevalence was 58 per cent and the prevalent serovars were *Leptospira interrogans serovar Sejroe*, *Leptospira interrogans serovar Tarassovi*, *Leptospira interrogans serovar Ranarum* and *Leptospira interrogans serovar Shermani*. In western Thailand, the seroprevalence was 57 per cent and the prevalent serovars were *L Tarassovi*, *L Sejroe*, *L Ranarum*, *Leptospira interrogans serovar Bataviae* and *L Shermani*. These results were similar to studies in domestic livestock and stray dogs in the Bangkok district. Among the elephants from Kanchanaburi there were significant associations between seropositivity and between the camp and between the prevalent serovars and the camp. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, epidemiology, leptospirosis, seroprevalence, *Leptospira interrogans*.

Portas, T.J., B.R. Bryant, F. Goritz, R. Hermes, T. Keeley, G. Evans, W.M.C. Maxwell, and T.B. Hildebrandt (2007). **Semen collection in an Asian elephant (*Elephas maximus*) under combined physical and chemical restraint.** *Australian Veterinary Journal* 85(10): 425-427. ISSN: 1751-0813.

Online: <http://dx.doi.org/10.1111/j.1751-0813.2007.00207.x>

Abstract: This article describes technique of manual stimulation for semen collection in a captive 50-year-old male Asian elephant (*Elephas maximus*) in New South Wales, Australia, physically restrained in a restraint chute and anesthetized with a combination of xylazine (Xylazil-100) and butorphanol (Torbugesic). This technique was effective for semen collection on the same animal for three occasions, but cannot be recommended for

routine and repeated use due to the potential risk associated with anesthesia. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, anesthesia, anesthetics, butorphanol, restraint of animals, semen, techniques, xylazine, zoo animals.

Pucher, H.E., C. Stremme, and F. Schwarzenberger (2003). **Priapism in a semiwild Asian elephant (*Elephas maximus*) in Vietnam.** *Veterinary Record* 153(23): 717-718. ISSN: 0042-4900.

NAL Call Number: 41.8 V641

Descriptors: *Elephas maximus*, penis, case studies, chronic diseases, males, adult animals, male genital diseases, necrosis, medical treatment, sulfonamides, Vietnam, priapism.

Rajakse, R.C., G.U.S.P. Mendis, C.G. Wijesinghe, J. Alahakoon, and L.N.T. De Silva (2005). **Treatment and management of an elephant calf with a head injury.** *Zoos Print Journal* 20(9): 1995-1996. ISSN: 0971-6378.

Descriptors: elephant calf, head injury, treatment, management.

Rao, S.S. (2004). **Recovery of an elephant calf from articular fracture.** *Zoos' Print Journal* 19(4): 17-18. ISSN: 0971-6378.

Descriptors: Asian elephant, calf, articular fracture, clinical aspects, healing, therapy, tibia, recovery, *Elephas maximus*.

Ratanakorn, P. (2006). **Warning: fatal viral disease in Asian elephant found in South East Asia.** *Tigerpaper* 33(2): 25. ISSN: 1014-2789.

Abstract: This article discusses the risk of transmission of Elephant epitheliotropic herpesvirus (EEHV) between domestic and wild elephants (*Elephas maximus*) in Thailand, and the establishment of a reference laboratory for the diagnosis of the disease. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, Indian elephant, Elephant epitheliotropic herpesvirus (EEHV), diagnosis and disease transmission, endangered species, epidemiology.

Reid, C.E., N. Marx, J. Fickel, F. Goritz, M. Hunt, N. Thy, J.M. Reynes, W. Schaftenaar, and T.B. Hildebrandt (2005). **Endotheliotropic herpes in Asia: the impact on captive and wild Asian elephant populations.** *Proceedings of the Institute for Zoo and Wildlife Research, Berlin*(6): 273. ISSN: 1431-7338.

Descriptors: Asian elephant, *Elephas maximus*, herpes, latent infections, mortality, viral diseases.

Ren, L. and J. Hutchinson (2007). **Three dimensional locomotor dynamics of African (*Loxodonta africana*) and Asian (*Elephas maximus*) elephants.** *Comparative Biochemistry and Physiology Part A Molecular and Integrative Physiology* 146(4, Suppl. S): S110-S111. ISSN: 1095-6433.

Descriptors: African elephant, *Loxodonta africana*, Asian elephant, *Elephas maximus*, movement and support, footfall pattern, trunk rotation, locomotor dynamics, hindlimb stance, comparative study.

Salakij, J., C. Salakij, N.A. Narkkong, S. Apibal, P. Suthunmapinuntra, J. Rattanakuprakarn, G. Nunklang, and M. Yindee (2005). **Hematology, cytochemistry and ultrastructure of blood cells from Asian elephant (*Elephas maximus*).** *Kasetsart Journal, Natural Sciences* 39(3): 482-493. ISSN: 0075-5192.

Abstract: The blood cells from 14 adult Asian elephants were examined and cytochemically stained with Sudan Black B (SBB), peroxidase, periodic acid Schiff's reaction (PAS), anaphthyl acetate esterase (ANAE) and beta -glucuronidase (beta -glu). The complete blood counts were performed using an automated cell counter. Insignificant differences were observed in almost all the hematological values between the male and female elephants, except the leukocyte count and fibrinogen concentration which were higher and lower, respectively, in the males than in the females. The neutrophils had poorly segmented nuclei and many well-differentiated granules. The neutrophils stained strongly positive to SBB, faintly stained with PAS, focal dot stained to ANAE and beta -glu. Eosinophils contained 2-3 lobed nuclei and numerous small, round, red-refractive granules with some vacuoles. The eosinophils stained moderately positive to SBB and strongly positive to ANAE but negative to beta -glu. The basophils had variable number of intense granules which did not obscure the lobed nuclei. The basophils were negative for SBB but moderately positive to ANAE and beta -glu. Monocytes stained moderately positive to SBB and moderately to strongly positive to ANAE and beta -glu. The bilobed cells stained moderately positive to SBB and strongly positive for ANAE and beta -glu which were similar to monocytes. Ultrastructurally, they contained a large number of mitochondria similar to those of monocytes, except the shape of the nuclei. The number of bilobed cells exceeded the number of the other leukocytes. Scanning electron microscopy revealed the surfaces of all blood cells. Transmission electron microscopy revealed organelles within erythrocytes, platelets and all leukocytes especially bilobed cells. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, basophils, blood cells, cell ultrastructure,

cytochemistry, eosinophils, erythrocytes, fibrinogen, hematology, leukocyte count, mitochondria, monocytes, neutrophils, nuclei, organelles, platelets, sex differences.

Sanchez, C.R., S. Murray, R.J. Montali, and L.H. Spelman (2004). **Diagnosis and treatment of presumptive pyelonephritis in an Asian elephant (*Elephas maximus*)**. *Journal of Zoo and Wildlife Medicine* 35(3): 397-9.

NAL Call Number: SF601.J6

Abstract: A 37-yr-old female Asian elephant (*Elephas maximus*) presented with anorexia, restlessness, and dark-colored urine. Urinalyses showed hematuria, leukocyturia, isosthenuria, proteinuria, granular casts, and no calcium oxalate crystals. Bloodwork revealed azotemia. Urine culture revealed a pure growth of *Streptococcus zooepidemicus* resistant to sulfamethoxazole-trimethoprim but susceptible to cephalosporins. A presumptive diagnosis of pyelonephritis was made based on bloodwork, urinalysis, and urine culture. The animal was treated with intravenous ceftiofur, and intravenous and per rectum fluids were given for hydration. The elephant's attitude and appetite returned to normal, the abnormal blood parameters resolved, and urinary calcium oxalate crystals reappeared after treatment, supporting presumptive diagnosis. Follow-up ultrasonography revealed an abnormal outline of both kidneys with parenchymal hyperechogenicity and multiple uterine leiomyomas.

Descriptors: anti bacterial agents therapeutic use, cephalosporins therapeutic use, blood, urine, pyelonephritis, streptococcal infections, *Streptococcus equi* isolation and purification, calcium oxalate urine, differential diagnosis, fluid therapy, kidney ultrasonography, leiomyomatosis complications, leiomyomatosis diagnosis, pyelonephritis diagnosis, pyelonephritis drug therapy, streptococcal infections diagnosis, streptococcal infections drug therapy, *Streptococcus equi* drug effects, uterine neoplasms complications, uterine neoplasms diagnosis.

Sanchez, C.R., S.Z. Murray, R. Isaza, and M.G. Papich (2005). **Pharmacokinetics of a single dose of enrofloxacin administered orally to captive Asian elephants (*Elephas maximus*)**. *American Journal of Veterinary Research* 66(11): 1948-53.

NAL Call Number: 41.8 Am3A

Abstract: OBJECTIVE: To determine the pharmacokinetics of enrofloxacin after oral administration to captive elephants. ANIMALS: 6 clinically normal adult Asian elephants (*Elephas maximus*). PROCEDURE: Each elephant received a single dose of enrofloxacin (2.5 mg/kg, PO). Three elephants received their complete diet (pellets and grain) within 2 hours after enrofloxacin administration, whereas the other 3 elephants received only hay within 6 hours after enrofloxacin administration. Serum concentrations of enrofloxacin and ciprofloxacin were measured by use of high-performance liquid chromatography. RESULTS: Harmonic mean half-life after oral administration was 18.4 hours for all elephants. Mean +/- SD peak serum concentration of enrofloxacin was 1.31 +/- 0.40 microg/mL at 5.0 +/- 4.2 hours after administration. Mean area under the curve was 20.72 +/- 4.25 (microg x h)/mL. CONCLUSIONS AND CLINICAL RELEVANCE: Oral administration of enrofloxacin to Asian elephants has a prolonged elimination half-life, compared with the elimination half-life for adult horses. In addition, potentially therapeutic concentrations in elephants were obtained when enrofloxacin was administered orally at a dosage of 2.5 mg/kg. Analysis of these results suggests that enrofloxacin administered with feed in the manner described in this study could be a potentially useful antimicrobial for use in treatment of captive Asian elephants with infections attributable to organisms, such as *Bordetella* spp, *Escherichia coli*, *Mycoplasma* spp, *Pasteurella* spp, *Haemophilus* spp, *Salmonella* spp, and *Staphylococcus* spp.

Descriptors: anti bacterial agents pharmacokinetics, metabolism, fluoroquinolones pharmacokinetics, oral administration, animal feed, zoo animals, anti bacterial agents administration and dosage, anti bacterial agents in blood, area under curve, fluoroquinolones administration and dosage, fluoroquinolones blood, half life.

Saragusty, J., T.B. Hildebrandt, B. Behr, A. Knieriem, J. Kruse, and R. Hermes (2009). **Successful cryopreservation of Asian elephant (*Elephas maximus*) spermatozoa**. *Animal Reproduction Science* 115(1-4): 255-266. ISSN: 0378-4320.

Online: <http://dx.doi.org/10.1016/j.anireprosci.2008.11.010>

NAL Call Number: QP251.A5

Abstract: Reproduction in captive elephants is low and infant mortality is high, collectively leading to possible population extinction. Artificial insemination was developed a decade ago; however, it relies on fresh-chilled semen from just a handful of bulls with inconsistent sperm quality. Artificial insemination with frozen-thawed sperm has never been described, probably, in part, due to low semen quality after cryopreservation. The present study was designed with the aim of finding a reliable semen freezing protocol. Screening tests included freezing semen with varying concentrations of ethylene glycol, propylene glycol, trehalose, dimethyl sulfoxide and glycerol as cryoprotectants and assessing cushioned centrifugation, rapid chilling to suprazero temperatures, freezing extender osmolarity, egg yolk concentration, post-thaw dilution with cryoprotectant-free BC solution and the addition of 10% (v/v) of autologous seminal plasma. The resulting optimal freezing protocol uses cushioned centrifugation, two-step dilution with isothermal 285mOsm/kg Berliner Cryomedium (BC) with final glycerol concentration of 7% and 16% egg yolk, and freezing in large volume by the directional freezing technique. After thawing, samples are diluted 1:1 with BC solution. Using this protocol, post-thaw

evaluations results were: motility upon thawing: 57.2p15.4%, motility following 30min incubation at 37pC: 58.5p16.0% and following 3h incubation: 21.7p17.6%, intact acrosome: 57.1p15.2%, normal morphology: 52.0p15.8% and viability: 67.3p16.1%. With this protocol, good quality semen can be accumulated for future use in artificial inseminations when and where needed. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, spermatozoa, cryopreservation, artificial insemination, reproduction.

Sarma, K.K. (2004). **Extraction of decayed tusk in elephants.** *Indian Veterinary Journal* 81(7): 812-814. ISSN: 0019-6479.

NAL Call Number: 41.8 IN2

Descriptors: decayed tusk, extraction, Asian elephant, injury, infection, clinical signs, treatment, anesthetic management, post operative care, outcome.

Sarma, K.K., A. Bhawal, V.K. Yadav, G. Saikia, and Jogiraj Das. (2006). **Investigation of tuberculosis in captive Asian elephants of Assam vis a vis its cross infections with the handlers.** *Intas Polivet* 7(2): 269-274. ISSN: 0972-1738.

Abstract: This study was conducted to screen selected captive elephants in Assam for tuberculosis. Cross infections with handlers were also investigated. 88 adult captive elephants from different locations in Assam were included in this study. Serum samples were subjected to indirect haemagglutination test (IHA). The animals seropositive in the IHA test were again examined by single intradermal tuberculin test using purified protein derivative and Trunk wash method. 36 elephants were serologically positive. Out of the 36 suspected animals subjected to the single intradermal tuberculin and Trunk wash tests, 7 were highly suspected. Only 2 cases could be positively diagnosed as infected with Mycobacterium based on the colony and staining characteristics. The positive animals were treated with a combination of 5 mg/kg body weight isoniazid (Solonex-DT) and 4.5 g/t body weight streptomycin (Ambistryn-S). An improvement in the general appearance of the animals was observed after one month of treatment. Mahouts and elephant keepers whose elephants were found to be seropositive were subjected to Moutex test, estimation of ESR and chest radiography. None of the mahouts suffered from the active form of tuberculosis. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, clinical aspects, cross infection, diagnostic techniques, disease control, disease prevention, drug therapy, epidemiology, isoniazid, streptomycin, tuberculosis.

Shimada, Y., N. Hama, M. Ashida, K. Ishikawa, Y. Matsuo, A. Yamada, A. Noda, K. Murata, and K. Okuno (2005). **Pregnancy and stillbirth of an Asian elephant, *Elephas maximus*.** *Journal of Japanese Association of Zoos and Aquariums* 46(2): 41-49. ISSN: 0386-7498.

NAL Call Number: QL77.5.D63

Descriptors: Asian elephant, stillbirth, clinical aspects, prevalence, fetal death, pregnancy, *Elephas maximus*.

Language of Text: Japanese.

Shimosawa, K. and N. Misawa (2008). **Assessment of Protein G in serodiagnosis of zoo animals and development of an enzyme-linked immunosorbent assay for Asian elephant.** *Journal of the Japan Veterinary Medical Association* 61(1): 75-78. ISSN: 0446-6454.

Abstract: Enzyme-linked immunosorbent assay (ELISA), a fast and cost-effective serodiagnosis, is a helpful screening method in the diagnosis of infectious diseases. However, it remains unclear whether ELISA is suitable for the diagnosis of zoo animals. This study examined the reactivity of Protein G, an IgG-binding protein, to sera from zoo animals. Results showed that most sera examined bound strongly to Protein G, while sera from marsupial animals, Panthera and Asian elephant showed weak reactions. These findings suggest that Protein G does not bind to IgG uniformly in zoo animals. IgG was purified from Asian elephant serum, and used to obtain antiserum by immunizing a rabbit. This made it possible to develop an ELISA system for effectively detecting IgG in an Asian elephant. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, binding proteins, ELISA, IgG, immunodiagnosis, immunological diseases, zoo animals, infectious disease diagnosis.

Language of Text: Japanese, Summary in English.

Siegal Willott, J., R. Isaza, R. Johnson, and M. Blaik (2008). **Distal limb radiography, ossification, and growth plate closure in the juvenile Asian elephant (*Elephas maximus*).** *Journal of Zoo and Wildlife Medicine* 39(3): 320-334. ISSN: 1042-7260.

Online: <http://dx.doi.org/10.1638/2007-0031.1>

Abstract: Eleven juvenile Asian elephants (*Elephas maximus*) were evaluated radiographically to determine the relative times of growth plate closure and phalangeal ossification in the bones of the distal forelimb. Specifically, the first, second, and third phalanges of the third digit (D3) were evaluated, as well as the third phalanx of digits 1, 2, 4, and 5. All elephants were healthy at the time of examination. A retrospective evaluation of radiographs from six of the 11 juvenile elephants was also completed to augment the data set. This study reports the methods used to obtain high-quality radiographs of the distal juvenile elephant limb, ossification characteristics of the phalanges, relative times of growth plate closure within the proximal phalanges of D3,

and a method for age estimation based on radiographic findings. This study will help clinicians in conducting elephant foot radiography, in evaluating foot radiographs in juvenile elephants, in recognizing normal versus pathologic change, and in estimating juvenile elephant age based on radiographic ossification characteristics and growth plate closure times. Consistent use of the proposed foot radiograph technique is recommended to facilitate foot disease recognition and as part of the annual examination of captive Asian elephants. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, bones, foot diseases, ossification, phalanges, radiography.

Thitaram, C., P. Pongsopawijit, N. Thongtip, T. Angkavanich, S. Chansittivej, W. Wongkalasin, C. Somgird, N. Suwankong, W. Prachsilpchai, and K. Suchit (2006). **Dystocia following prolonged retention of a dead fetus in an Asian elephant (*Elephas maximus*)**. *Theriogenology* 66(5): 1284-1291. ISSN: 0093-691X.

Online: <http://dx.doi.org/10.1016/j.theriogenology.2006.04.020>

NAL Call Number: QP251.A1T5

Abstract: A 32-year-old nulliparous female Asian elephant (*Elephas maximus*) showed signs of parturition 8 months later than predicted from the breeding records. However, while serosanguineous fluid, necrotic tissue and pieces of amnion were expelled, second-stage labor did not progress. Since the fetus was not found during an endoscopic examination of the vestibule, it was assumed that the elephant had calved unseen and she was returned to the forest to recuperate. Twelve months later, the elephant showed clear signs of second-stage labor accompanied by a bulge in the perineum and passage of keratinized nail through the vulva. A 35 cm episiotomy incision was made in the perineum just below the anus, via which chains were attached to the forelimbs of the fetus. Traction on the forelimbs alone proved insufficient to achieve delivery because the fetal head kept rotating and impacting in the pelvis. However, traction applied via a hook inserted behind the mandibular symphysis allowed the head to be elevated and extended, and the fetus to be delivered. The episiotomy wound was sutured in two layers and although the skin did not heal during primary closure it subsequently healed uneventfully by second intention. Retrospective evaluation of the elephant's serum progesterone profile demonstrated a fall to baseline at the suspected onset of parturition, supporting the supposition that the fetus was retained in the uterus for 12 months after parturition began. It is suggested that serum progesterone concentrations should be monitored regularly in mated elephant cows to verify the establishment of pregnancy and to better estimate the expected timing, and the onset of calving. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, case studies, females, fetal death, dystocia, postoperative care, Thailand.

Thongtip, N., M. Damyang, S. Mahasawangkul, A. Kongsila, T. Angkawanich, S. Jansittiwate, C. Thitaram, and P. Phongsopawijit (2003). **Frozen semen artificial insemination in Asian elephants (*Elephas maximus*) using endoscope and ultrasound guide**. *Proceedings of 41st Kasetsart University Annual Conference, Subject: Animals and Veterinary Medicine, February 3, 2003-February 7, 2003, Bangkok, Thailand: Kasetsart University, Bangkok, Thailand, p. 652-657.*

Descriptors: Asian elephant, frozen semen, artificial insemination, endoscopy, cervix, thawed semen, ultrasonography, *Elephas maximus*.

Language of Text: Thai, with English summary.

Thongtip, N., J. Saikhun, S. Mahasawangkul, K. Kornkaewrat, P. Suthanmapinanh, and A. Pinyopummin (2008). **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): 37-45. ISSN: 0125-6491.

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 (*Elephas maximus*), 14 semen collection attempts in 9 elephant bulls in Thailand by manual stimulation were undertaken and eleven ejaculates fitted the criteria of investigation (0-30% motility). These were divided into 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. The semen samples were incubated at 37 degrees C for 15 and 30 min 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 maintained the percentage of total and progressive motility, path velocity and progressive velocity at a higher level than the control group. The present study indicates that PTX added to low motility semen does not increase elephant semen quality. However, it may partially have a tendency to maintain sperm motility and sperm movement characteristics. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, male fertility, motility, pentoxifylline, semen, semen characters, spermatozoa, velocity.

Language of Text: Thai.

- van der Kolk, J.H., J.P.T.M. van Leeuwen, A.J.M. van den Belt, R.H.N. van Schaik, and W. Schaftenaar (2008). **Subclinical hypocalcaemia in captive Asian elephants (*Elephas maximus*)**. *Veterinary Record* 162(15): 475-479. ISSN: 0042-4900.
- Abstract:** The hypothesis that hypocalcaemia may play a role in dystocia in captive Asian elephants (*Elephas maximus*) was investigated. The objectives of the study were to measure the total calcium concentration in elephant plasma; assess the changes in parameters of calcium metabolism during a feeding trial; investigate a possible relationship between calcium metabolism and dystocia; and assess bone mineralisation in captive Asian elephants in vivo. The following parameters were measured: total and ionised calcium, inorganic phosphorous and magnesium, the fractional excretions of these minerals, intact parathyroid hormone, 25-OH-D₃ and 1,25-OH-D₃. Radiographs were taken from tail vertebrae for assessment of bone mineralisation. The mean (sd) heparinised plasma total calcium concentration was 2.7 (0.33) mmol/l (n=43) ranging from 0.84 to 3.08 mmol/l in 11 Asian elephants. There was no significant correlation between plasma total calcium concentration and age. Following feeding of a calcium rich ration to four captive Asian elephant cows, plasma total and ionised calcium peaked at 3.6 (0.24) mmol/l (range 3.4 to 3.9 mmol/l) and 1.25 (0.07) mmol/l (range 1.17 to 1.32 mmol/l), respectively. Plasma ionised calcium concentrations around parturition in four Asian elephant cows ranged from 0.37 to 1.1 mmol/l only. The present study indicates that captive Asian elephants might be hypocalcaemic, and that, in captive Asian elephants, the normal plasma concentration of total calcium should actually be around 3.6 mmol/l and normal plasma concentration of ionised calcium around 1.25 mmol/l. Given the fact that elephants absorb dietary calcium mainly from the intestine, it could be concluded that elephants should be fed calcium-rich diets at all times, and particularly around parturition. In addition, normal values for ionised calcium in captive Asian elephants should be reassessed. *Reproduced with Permission from CAB Abstracts.*
- Descriptors:** Asian elephant, *Elephas maximus*, blood picture, blood plasma, bone mineralization, calcium, dystocia, hypocalcaemia, inorganic phosphorus, intestines, magnesium, mineral absorption, mineral metabolism, parathyrin, zoo animals.
- Vodicka, R. (2008). **Trunk pyoderma in a male Ceylon elephant (*Elephas maximus maximus*)**. *Acta Veterinaria Brno* 77(1): 127-131. ISSN: 0001-7213.
- Abstract:** The study describes the therapy of purulent trunk dermatitis in an aggressive male Ceylon elephant (*Elephas maximus maximus*). The elephant was immobilized 4 times with 1.7 ml Large Animal (LA) Immobilon i.m. within 50 days. The anesthetic action was antagonised with 1.7 ml LA Revivon+8.0 ml Naloxone i.v. and 0.5 ml LA Revivon+6.0 ml Naloxone i.m. From skin lesions the following pathogens were isolated: *Staphylococcus* spp., *Streptococcus* spp. and *Candida tropicalis*. Local therapy consisted of the debridement of the affected skin, application of antibiotics and skin antiseptics. Depot penicillin, vitamins, probiotics and autogenous yeast vaccine were administered generally. In hematological indicators the biggest changes were found in the numbers of white blood cells and segmented neutrophils. Markedly low zinc concentrations were found repeatedly. Despite the non-standard steps we took (repeated anesthesia during a short time, non-compliance with the recommendations for the administration of some drugs, etc.) and difficult handling (aggressive, uncontrollable elephant, no restraint chute), it proved possible to treat such a case in this manner. *Reproduced with Permission from CAB Abstracts.*
- Descriptors:** Asian elephant, *Elephas maximus*, case report, dermatitis, skin diseases, *Candida tropicalis*, *Staphylococcus*, *Streptococcus*.
- Language of Text:** Slovakian.
- Vodicka, R. and J. Kral (2003). **Purulent trunk dermatitis in a male Ceylon elephant (*Elephas maximus maximus*)**. In: *Erkrankungen der Zootiere: Verhandlungsbericht des 41 Internationalen Symposiums über die Erkrankungen der Zoo und Wildtiere, May 1, 1928-June 1, 2003, Rome, Italy*, Vol. 5, p. 151-153.
- NAL Call Number:** SF996.I5
- Descriptors:** Asian elephant, trunk, purulent dermatitis, pyoderma, skin diseases, treatment, aggressive male, anesthesia, handling, *Elephas maximus*.
- Wanke, R., N. Herbach, and T. Haenichen (2005). **Metastasising granulosa cell tumour in an Asian elephant (*Elephas maximus*)**. *Proceedings of the Institute for Zoo and Wildlife Research, Berlin*(6): 308. ISSN: 1431-7338.
- Descriptors:** Asian elephant, *Elephas maximus*, animal pathology, case report, granulosa cells, histopathology, metastasis, neoplasms, uterine diseases.
- Weissenboeck, N.M., H.M. Schwammer, and T. Voracek (2007). **Thermographische diagnostik bei afrikanischen (*Loxodonta africana*) und asiatischen (*Elephas maximus*) elefanten. [Thermographic diagnostic in African (*Loxodonta africana*) and Asiatic elephants (*Elephas maximus*)]**. *Zoologische Garten* 76(5-6): 331-344. ISSN: 0044-5169.
- Descriptors:** African elephant, *Loxodonta africana*, Asian elephant, *Elephas maximus*, thermography, diagnostic techniques.
- Language of Text:** German.
- Weissengruber, G.E., F.K. Fuss, G. Egger, G. Stanek, K.M. Hittmair, and G. Forstenpointner

(2006). **The elephant knee joint: morphological and biomechanical considerations.** *Journal of Anatomy* 208(1): 59-72.

NAL Call Number: 447.8 J826

Abstract: Elephant limbs display unique morphological features which are related mainly to supporting the enormous body weight of the animal. In elephants, the knee joint plays important roles in weight bearing and locomotion, but anatomical data are sparse and lacking in functional analyses. In addition, the knee joint is affected frequently by arthrosis. Here we examined structures of the knee joint by means of standard anatomical techniques in eight African (*Loxodonta africana*) and three Asian elephants (*Elephas maximus*). Furthermore, we performed radiography in five African and two Asian elephants and magnetic resonance imaging (MRI) in one African elephant. Macerated bones of 11 individuals (four African, seven Asian elephants) were measured with a pair of callipers to give standardized measurements of the articular parts. In one Asian and three African elephants, kinematic and functional analyses were carried out using a digitizer and according to the helical axis concept. Some peculiarities of healthy and arthrotic knee joints of elephants were compared with human knees. In contrast to those of other quadruped mammals, the knee joint of elephants displays an extended resting position. The femorotibial joint of elephants shows a high grade of congruency and the menisci are extremely narrow and thin. The four-bar mechanism of the cruciate ligaments exists also in the elephant. The main motion of the knee joint is extension-flexion with a range of motion of 142 degrees. In elephants, arthrotic alterations of the knee joint can lead to injury or loss of the cranial (anterior) cruciate ligament.

Descriptors: knee joint, anatomy, morphological, biomechanical, weight bearing, locomotion, radiography, MRI, magnetic resonance imaging, arthrosis.

Wemmer, C., V. Krishnamurthy, S. Shrestha, L.A. Hayek, M. Thant, and K.A. Nanjappa (2006). **Assessment of body condition in Asian elephants (*Elephas maximus*).** *Zoo Biology* 25(3): 187-200. ISSN: 0733-3188.

Online: <http://dx.doi.org/10.1002/zoo.20099>

NAL Call Number: QL77.5.Z6

Descriptors: Asian elephant, *Elephas maximus*, body condition, body regions, morphometry, animal age, gender differences, sexual dimorphism, body fat, subcutaneous fat, India, index of body condition, visual-assessment.

Wiedner, E.B., C. Gray, P. Rich, G.L. Jacobson, R. Isaza, D. Schmitt, and W.A. Lindsay (2008). **Nonsurgical repair of an umbilical hernia in two Asian elephant calves (*Elephas maximus*).** *Journal of Zoo and Wildlife Medicine* 39(2): 248-251. ISSN: 1042-7260.

Online: <http://dx.doi.org/10.1638/2007-0024R.1>

Abstract: Umbilical hernias were diagnosed in two captive-born, female Asian elephant (*Elephas maximus*) calves several weeks after birth. Daily manual reduction of the hernias for 5 wk in the first case and for 5 mo in the second resulted in complete closure of the defects. Nonsurgical repair of uncomplicated, fully reducible umbilical hernias in Asian elephants can be an alternative to surgery. *Reproduced with Permission from CAB Abstracts.*

Descriptors: Asian elephant, *Elephas maximus*, case reports, clinical aspects, diagnosis, medical treatment, surgery, umbilical hernia, umbilicus, zoo animals.

Zhu, M., J.N. Maslow, S.K. Mikota, R. Isaza, F. Dunker, H. Riddle, and C.A. Peloquin (2005). **Population pharmacokinetics of pyrazinamide in elephants.** *Journal of Veterinary Pharmacology and Therapeutics* 28(5): 403-9.

NAL Call Number: SF915.J63

Abstract: This study was undertaken to characterize the population pharmacokinetics (PK), therapeutic dose, and preferred route of administration for pyrazinamide (PZA) in elephants. Twenty-three African (*Loxodonta africana*) and Asian (*Elephas maximus*) elephants infected with or in contact with others culture positive for *Mycobacterium tuberculosis* were dosed under treatment conditions. PZA was dosed daily at 20-30 mg/kg via oral (fasting or nonfasting state) or rectal (enema or suppository) administration. Blood samples were collected 0-24 h postdose. Population PK was estimated using nonlinear mixed effect modeling. Drug absorption was rapid with T(max) at or before 2 h regardless of the method of drug administration. C(max) at a mean dose of 25.6 (+/-4.6) mg/kg was 19.6 (+/-9.5 microg/mL) for PZA given orally under fasting conditions. Under nonfasting conditions at a mean dose of 26.1 +/- 4.2 mg/kg, C(max) was 25% (4.87 +/- 4.89 microg/mL) and area under concentration curve (AUC) was 30% of the values observed under fasting conditions. Mean rectal dose of 32.6 +/- 15.2 mg/kg yielded C(max) of 12.3 +/- 6.3 microg/mL, but comparable AUC to PZA administered orally while fasting. Both oral and rectal administration of PZA appeared to be acceptable and oral dosing is preferred because of the higher C(max) and lower inter-subject variability. A starting dose of 30 mg/kg is recommended with drug monitoring between 1 and 2 h postdose. Higher doses may be required if the achieved C(max) values are below the recommended 20-50 microg/mL range.

Descriptors: antitubercular agents pharmacokinetics, metabolism, pyrazinamide pharmacokinetics, pulmonary tuberculosis, oral administration, rectal administration, antitubercular agents administration and dosage, antitubercular agents therapeutic use, area under curve, *Mycobacterium tuberculosis* pathogenicity, pyrazinamide administration and dosage, pyrazinamide therapeutic use, tuberculosis, pulmonary blood, pulmonary

drug therapy.

Zuba, J.R., M.D. Stetter, S.R. Dover, and M. Briggs (2003). **Development of rigid laparoscopy techniques in elephants and rhinoceros.** *Proceedings of the American Association of Zoo Veterinarians Annual Conference, October 4, 2003-October 10, 2003, Minneapolis, Minnesota*, American Association of Zoo Veterinarians: p. 223-227. 333 p.

NAL Call Number: SH171.I22

Descriptors: Rhinocerotidae, *Loxodonta africana*, *Elephas maximus*, literature review, diagnostic techniques, rigid laparoscopy techniques, development, applications, review.

[Back to Top](#)

[<< Table of Contents](#)

[<< Previous](#)

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