

Recent Publications on Asian Elephants

Compiled by Jennifer Pastorini

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S.L. Bartlett, N. Abou-Madi, M.S. Kraus, E.B. Wiedner, S.R. Starkey & G.V. Kollias

Electrocardiography of the Asian elephant (*Elephas maximus*)

Journal of Zoo and Wildlife Medicine 40 (2009) 466-473

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°, mean -5°; left lateral range -15 to +104°, mean 27°; right lateral range -16 to +78°, mean

9°. 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. © 2009 American Association of Zoo Veterinarians.

A. Benz, W. Zenker, T.B. Hildebrandt, G. Weissengruber, K. Eulenberger & H. Geyer
Microscopic morphology of the elephant's hoof

J. of Zoo and Wildlife Med. 40 (2009) 711-725

Abstract. As a result of the lack of basic microscopic anatomy of the elephants' foot, this study deals with the normal microscopic morphology of both the Asian (*Elephas maximus*) and African (*Loxodonta africana*) elephant foot with consideration of pathologic changes. A total of 727 histologic samples from defined locations of 24 hooves of both species (17 Asian and seven African species) were studied, measured, and evaluated. Minor differences between the feet and species are seen histologically. Poor horn quality in captive elephants' hooves and loci of minor resistance in captive and wild animals are detected. The thickness of the weight-bearing surface of the captive elephants' hooves is histologically measured as "very thin" (about 10 mm). The normal histologic findings provide a basis for assessing histopathologic changes and especially horn quality. The histologic findings might explain some of the foot problems, but they also give rise to questions about the quality and correctness of current husbandry techniques. © 2009 American Association of Zoo Veterinarians.

R.W. Byrne, L.A. Bates, & C.J. Moss

Elephant cognition in primate perspective

Comparative Cognition & Behavior Reviews 4 (2009) 65-79

Abstract. On many of the staple measures of comparative psychology, elephants show no

obvious differences from other mammals, such as primates: discrimination learning, memory, spontaneous tool use, etc. However, a range of more naturalistic measures have recently suggested that elephant cognition may be rather different. Wild elephants sub-categorize humans into groups, independently making this classification on the basis of scent or colour. In number discrimination, elephants show no effects of absolute magnitude or relative size disparity in making number judgements. In the social realm, elephants show empathy into the problems faced by others, and give hints of special abilities in cooperation, vocal imitation and perhaps teaching. Field data suggest that the elephant's vaunted reputation for memory may have a factual basis, in two ways. Elephants' ability to remember large-scale space over long periods suggests good cognitive mapping skills. Elephants' skill in keeping track of the current locations of many family members implies that working memory may be unusually developed, consistent with the laboratory finding that their quantity judgements do not show the usual magnitude effects. © 2009 Byrne.

A. Campos-Arceiz

Shit happens (to be useful)! Use of elephant dung as habitat by amphibians

Biotropica 41 (2009) 406–407

Abstract. Although elephants are commonly cited as an example of ecosystem engineering, cases involving Asian elephants are missing in the literature. In a dry environment of southeastern Sri Lanka, I examined 290 elephant dung piles and found a total of six frogs from three different species in 1.7 percent (N= 5) of the dung piles. This suggests a facilitative role of elephants by providing habitat for amphibians. © 2009 The Author.

R. Clubb, M. Rowcliffe, P. Lee, K.U. Mar, C. Moss & G.J. Mason

Fecundity and population viability in female zoo elephants: problems and possible solutions

Animal Welfare 18 (2009) 237-247

Abstract. We previously reported that African (*Loxodonta africana*) and Asian (*Elephas maximus*) female elephants in European zoos

have shorter adult lifespans than protected conspecifics in range countries. This effect was the cause of greatest concern in Asian elephants, and risk factors within this species included being zoo-born, transferred between zoos, and possibly removed early from the mother. Here, we investigate these risk factors further; assess fecundity and sustainability in European zoos; and propose testable hypotheses as to the causes of these animals' problems. Although imported wild-born Asian elephants live longer than zoo-born conspecifics, being imported when juvenile or adult appears no more protective than being imported in infancy, suggesting that the benefits of being wild-rather than zoo-born are conferred early in life. Zoo-born Asian neonates are significantly heavier than those born to working animals in range countries, with a possible tendency to be fatter. In zoos, African elephants have tended to be removed from their mothers at older ages than young Asians, and were also transferred between zoos significantly less often: factors that could possibly underlie this species' lower calf losses and improving adult survivorship in Europe. Both species have low fecundity in European zoos compared to in situ populations, and are not self-sustaining, declining at approximately 10% per annum if reliant on captive-bred females under historically prevailing conditions. Data from other species suggest that stress and/or obesity are parsimonious explanations for the suite of problems seen. We recommend specific screens for testing these hypotheses, and for potentially identifying vulnerable individuals within the extant zoo populations. © 2009 Universities Federation for Animal Welfare.

A. Datta-Roy, N. Ved & A.C. Williams

Participatory elephant monitoring in South Garo Hills: efficacy and utility in a human-animal conflict scenario

Tropical Ecology 50 (2009) 163-171

Abstract. We evaluate the efficacy of community based elephant monitoring programme in South Garo Hills, Meghalaya (India). Major objectives of the programme are to understand the ranging and habitat utilization patterns of free ranging Asian elephants in a human interspersed habitat with frequent human - elephant conflicts. We collected information on elephant presence in

the landscape through participatory wildlife monitoring techniques by modifying an existing model for African elephants from six 'akings' or clan villages which are worst affected by human-elephant conflict (HEC). A total of 201 visits were recorded in six 'akings' during June 2005 to July 2006, of which solitary elephants accounted for 100 visits. The visits were found to peak during the two main harvesting periods in the Garo hills indicating a definite seasonality pattern in the visits. Information from individual 'akings' also indicate that some 'akings' were particularly prone to visits by solitary animals indicating the complexity in the dynamics of elephant ranging patterns within the landscape. We note that participatory elephant monitoring can be a useful tool to collect basic data on elephant presence in tropical ecosystems where traditional line transect method is restricted by considerations of terrain, access and resources. Other advantages, limitations and conservation implications are discussed. © 2009 International Society for Tropical Ecology.

G. Iossa, C.D. Soulsbury & S. Harris

Are wild animals suited to a travelling circus life?

Animal Welfare 18 (2009) 129-140

Abstract. A comprehensive synopsis of the welfare of captive, wild (ie non-domesticated) animals in travelling circuses is missing. We examined circus animal welfare and, specifically, behaviour, health, living and travelling conditions. We compared the conditions of non-domesticated animals in circuses with their counterparts kept in zoos. Data on circus animals were very scarce; where data were absent, we inferred likely welfare implications based on zoo data. Circus animals spent the majority of the day confined, about 1-9% of the day performing/training and the remaining time in exercise pens. Exercise pens were significantly smaller than minimum zoo standards for outdoor enclosures. Behavioural budgets were restricted, with circus animals spending a great amount of time performing stereotypies, especially when shackled or confined in beast wagons. A higher degree of stereotyping in circuses may be indicative of poorer welfare. Inadequate diet and housing conditions, and the effects of repeated performances, can lead to

significant health problems. Circus animals travel frequently and the associated forced movement, human handling, noise, trailer movement and confinement are important stressors. Although there is no conclusive evidence as to whether animals habituate to travel, confinement in beast wagons for long time periods is a definite welfare concern. Circuses have a limited ability to make improvements, such as increased space, environmental enrichment and appropriate social housing. Consequently, we argue that non-domesticated animals, suitable for circus life, should exhibit low space requirements, simple social structures, low cognitive function, non-specialist ecological requirements and an ability to be transported without adverse welfare effects. None of the commonest species exhibited by circuses, such as elephants and large felids, currently meet these criteria. We conclude that the species of non-domesticated animals commonly kept in circuses appear the least suited to a circus life. © 2009 Universities Federation for Animal Welfare.

R. Joshi

Asian elephant's *Elephas maximus* behaviour in the Rajaji National Park, north-west India: Eight years with Asian elephant

Nature and Science 7 (2009) 49-77

Abstract. In order to generate scientific knowledge on behaviour of wild Asian elephant *Elephas maximus*, field study was conducted from 1999 to 2007. The data were derived from a novel combination of self field observations (direct and indirect methods), traditional knowledge of various local communities, and available literature on elephant studies. During the course of study 19 different behaviours of elephant were documented from Rajaji National Park, north-west India. Despite, the status, movement pattern, habitat utilization, feeding behaviour and human-elephant conflict of Asian elephant, extremely rare research work has been carried out on its behaviour in the wild. My review of available evidences suggested that wild elephants also used to perform various usual and unusual behaviours, which are directly linked with their management and conservation. The elephants in Rajaji are emerge out in the open areas in evening hours. The movement of elephants was entirely seasonal

and they also utilize the adjoining protected habitats. Fodder requirements are quite variable in groups and bulls and breeding season seems maximum to extent from May to November. Locomotion, social organization, drinking and bathing, resting and sleeping, defecation and urination, recognition, male-male aggression, sympathy and cooperation, play behaviour, association with other wild animals, parental care and elephant communication were another major behaviours observed in elephants. Besides, four unusual behaviours were also studied during this period. This is the first documented study, which could be helpful in generating more biological information about the activities of wild Asian elephants. All of these findings may have wider implications for developing predictive models of human – elephant interactions.

R. Joshi & R. Singh

Gujjar community rehabilitation from Rajaji National Park: Moving towards an integrated Approach for Asian elephant (*Elephas maximus*) conservation

Journal of Human Ecology 28 (2009) 199-206

Abstract. Rehabilitation of Gujjar community from the Rajaji National Park area is a persistent and better effort in the direction of wildlife conservation in India. On one hand it has provided the better opportunity for livelihood to pastoral Gujjars and on the other hand it has promoted the regeneration of forest wealth along with movement related activities of wildlife. The major objectives of the study are to generate the database of impact of Gujjar rehabilitation on frequent movement of wildlife. Eight forest ranges were surveyed for about seven years before and after the resettlement of Gujjar and all the data on animal sighting, movement and vegetation component were recorded. Currently wild animals are utilizing whole of the forest area frequently for their routine activities whereas before the resettlement of Gujjars wild animals generally used the water points after sunset. The undisturbed conditions created as a result of the resettling of the pastoral Gujjars, have had a noticeable effect on the elephant and tiger population of the forest area. As per the records of 1998 a total of 1390 families were existing in the park area and after the commencement of the

programme 512 families were resettled at Pathri area and 613 were relocated at Gaidikhatta area. Presently 265 families are to be relocated who are residing inside the national park area. After the establishment of state Uttarakhand the rehabilitation programme has conducted very rapidly and over the past six years five forest ranges of the park are freed from the Gujjars. © 2009 Kamla-Raj Enterprises, Delhi, India.

N. Kontogeorgopoulos

Wildlife tourism in semi-captive settings: a case study of elephant camps in northern Thailand

Current Issues in Tourism 12 (2009) 429-449

Abstract: Due to improved transportation and communication technology, changing social attitudes towards nature and wildlife, and the physiological benefits of interaction with animals, tourism centred on wildlife in captive and semi-captive settings is becoming increasingly popular. One example of wildlife tourism in a semi-captive setting is the proliferation of ‘elephant camps’ in Thailand, where tourists interact in a variety of ways with domesticated elephants. Though work in elephant camps can be difficult for elephants, tourism provides the only viable legal option for elephant owners and handlers to earn income. This study examines the characteristics, preferences, and values of the visitors of three elephant camps in the vicinity of Chiang Mai in northern Thailand and argues that despite reflecting divergent worldviews on, and practical approaches to, animal rights, each type of camp makes significant contributions to the overall welfare of Thailand’s domesticated elephants. © 2009 Taylor & Francis.

J.A. Landolfi, S.A. Schultz, S.K. Mikota & K.A. Terio

Development and validation of cytokine quantitative, real time RT-PCR assays for characterization of Asian elephant immune responses

Veterinary Immunology and Immunopathology 131 (2009) 73-78

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)- γ , tumor necrosis factor (TNF)- α , transforming growth factor (TGF)- β , glyceraldehyde 3-phosphate dehydrogenase (GAPDH), and β -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. © 2009 with permission from Elsevier.

W.A. Lindsay, E. Wiedner, R. Isaza, H.G.G. Townsend, M. Boleslawski & D.P. Lunn

Immune responses of Asian elephants (*Elephas maximus*) to commercial tetanus toxoid vaccine

Veterinary Immunology and Immunopathology 133 (2010) 287-289

Abstract. Although captive elephants are commonly vaccinated annually against tetanus using commercially available tetanus toxoid vaccines marketed for use in horses and livestock, no data exists to prove that tetanus toxoid vaccination produces measurable antibody titers in

elephants. An ELISA test was created to measure antibody responses to tetanus toxoid vaccinations in 22 Asian elephants ranging in age from 24 to 56 years (mean age 39 years) over a 7-month period. All animals had been previously vaccinated with tetanus toxoid vaccine, with the last booster administered 4 years before the start of the study. The great majority of elephants had titers prior to booster vaccination, and following revaccination all elephants demonstrated anamnestic increases in titers, indicating that this species does respond to tetanus vaccination. Surprisingly older animals mounted a significantly higher response to revaccination than did younger animals. © 2009 with permission from Elsevier.

J. Lorimer & S. Whatmore

After the 'king of beasts': Samuel Baker and the embodied historical geographies of elephant hunting in mid-nineteenth-century Ceylon

J. of Historical Geography 35 (2009) 668-689

Abstract. This paper draws on and develops a range of concepts and methodologies from 'more-than-human' and animal geographies to map some embodied historical geographies of elephant hunting in mid-nineteenth-century Ceylon. It focuses in particular on the exploits of Samuel Baker and some of his contemporaries. The paper attends to the attachments, crossings and ethics that passed between hunted and hunting bodies to flesh out the colonial visions of these 'seeing men' of empire. It critically engages with existing work on hunting and colonial natural history by examining interwoven human and nonhuman experiences, exploring elephant hunting as a collection of embodied and co-evolutionary processes with complex material histories. Drawing out the importance of embodiment, affect and intercorporeal exchange the paper then reflects on the performance, epistemology and ethics of hunting practice and traces the role played by a code of sportsmanship in orientating and legitimating the ethical sensibility of hunting. In conclusion the paper details what is gained from this style of embodied historical analysis which unsettles any simple spatio-temporal territorialisation of (post-) colonial historical geographies. © 2008 with permission from Elsevier.

A. Mallapur & A. Ramanathan

Differences in husbandry and management systems across ten facilities housing Asian elephants *Elephas maximus* in India

International Zoo Yearbook 43 (2009) 189-197

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). © 2009 The Zoological Society of London.

P. Matson, Wendy Kappelle & I. Malecki

The use of a hypo-osmotic swelling (HOS) test on sperm of the pig (*Sus scrofa domestica*), emu (*Dromaius novaehollandiae*), Asian elephant (*Elephas maximus*), hamadryas baboon (*Papio hamadryas hamadryas*), and central rock rat (*Zyomys pedunculatus*)

Reproductive Biology 9 (2009) 181-187

Abstract. A hypo-osmotic swelling test using TALP-HEPES medium over a range of 50 to 300 mOsm/kg was applied to sperm from domestic and endangered species. Maximal responses of curling of the sperm tails were seen over a range

of osmolalities for epididymal sperm from the pig (100 mOsm/kg), hamadryas baboon (range 50-125 mOsm/kg), and central rock rat (range 50-100 mOsm/kg), and the ejaculated sperm from the emu (50 mOsm/kg) and the Asian elephant (range 75-150 mOsm/kg). A solution of TALP-HEPES medium at 100 mOsm/kg would be suitable to obtain the maximal response in this range of mammals tested, though it would need to be diluted to at least 50 mOsm/kg when testing the viability of the emu sperm. © 2009 Society for Biology of Reproduction.

N.K. Nath, B.P. Lahkar, N. Brahma, S. Dey, J.P. Das, P.K. Sarma & B.K. Talukdar

An assessment of human-elephant conflict in Manas National Park, Assam, India

Journal of Threatened Taxa 1 (2009) 309-316

Abstract: An assessment of human-elephant conflict was carried out in the fringe villages around Manas National Park, Assam during 2005-06. The available forest department conflict records since 1991 onwards were also incorporated during analysis. Conflict was intense in the months of July-August and was mostly concentrated along the forest boundary areas, decreasing with distance from the Park. Crop damage occurred during two seasons; paddy (the major crop) suffered the most due to raiding. Crop maturity and frequency of raiding were positively correlated. Single bull elephants were involved in conflicts more frequently (59%) than female herds (41%), while herds were involved in majority of crop raiding cases. Of the single elephants, 88% were *makhnas* and 11.9% were tuskers. The average herd size recorded was 8 individuals, with group size ranging up to 16. Mitigation measures presently adopted involve traditional drive-away techniques including making noise by shouting, drum beating, bursting fire crackers and firing gun shots into the air, and using torch light, pelting stones and throwing burning torches. *Kunkis* have been used in severe cases. *Machans* are used for guarding the crops. Combinations of methods are most effective. Family herds were easily deflected, while single bulls were difficult to ward off. Affected villagers have suggested methods like regular patrolling (39%) by the Forest Department officials along

the Park boundary, erection of a concrete wall (18%) along the Park boundary, electric fencing (13%), simply drive away (13%), culling (11%) and lighting the Park boundary during night hours (6%). Attempts to reduce conflict by changing the traditional cropping pattern by introducing some elephant-repellent alternative cash crops (e.g. lemon and chilli) are under experiment. © 2009 The Authors.

W. Pan, L. Lin, A. Luo, & L. Zhang

Corridor use by Asian elephants

Integrative Zoology 4 (2009) 220–231

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. © 2009 ISZS, Blackwell Publishing and IOZ/CAS

G. Paul

The nearly columnar limbs of elephants are very different from the more flexed, spring action limbs of running mammals and birds

J. of Experimental Biology 212 (2009) 152–154

No abstract. This is correspondence to the recently

published article: “Ren, L., Butler, M., Miller, C., Paxton, H., Schwerda, D., Fischer, M.S. & Hutchinson, J.R. (2008) The movement of limb segments and joints during locomotion in African and Asian elephants. *Journal of Experimental Biology* 211: 2735–2751.” There is also a reply included from J.R. Hutchinson: “Response: Of ideas, dichotomies, methods, and data – how much do elephant kinematics differ from those of other large animals?”

P.A. Rees

Activity budgets and the relationship between feeding and stereotypic behaviors in Asian elephants (*Elephas maximus*) in a zoo

Zoo Biology 28 (2009) 79–97

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 co-related with the frequency of feeding behavior was tested and was found to be true. Stereotypic behavior increased with 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. © 2009 Wiley-Liss, Inc.

Y. Ren, M.T. Johnson, P.J. Clemins, M. Darre, S. Stuart Glaeser, T.S. Osiejuk & E. Out-Nyarko

A framework for bioacoustic vocalization analysis using hidden Markov models

Algorithms 2 (2009) 1410-1428

Abstract. Using Hidden Markov Models (HMMs) as a recognition framework for automatic classification of animal vocalizations has a number of benefits, including the ability to handle duration variability through nonlinear time alignment, the ability to incorporate complex language or recognition constraints, and easy extensibility to continuous recognition and detection domains. In this work, we apply HMMs to several different species and bioacoustic tasks using generalized spectral features that can be easily adjusted across species and HMM network topologies suited to each task. This experimental work includes a simple call type classification task using one HMM per vocalization for repertoire analysis of Asian elephants, a language-constrained song recognition task using syllable models as base units for ortolan bunting vocalizations, and a stress stimulus differentiation task in poultry vocalizations using a non-sequential model via a one-state HMM with Gaussian mixtures. Results show strong performance across all tasks and illustrate the flexibility of the HMM framework for a variety of species, vocalization types, and analysis tasks. © 2009 by the authors.

A.L. Roca, Y. Ishida, N. Nikolaidis, S.O. Kolokotronis, S. Fratpietro, K. Stewardson, S. Hensley, M. Tisdale, G. Boeskorov & A.D. Greenwood

Genetic variation at hair length candidate genes in elephants and the extinct woolly mammoth

BMC Evolutionary Biology 9 (2009) 232

Abstract. Background: Like humans, the living elephants are unusual among mammals in being sparsely covered with hair. Relative to extant elephants, the extinct woolly mammoth, *Mammuthus primigenius*, had a dense hair cover and extremely long hair, which likely were adaptations to its subarctic habitat. The fibroblast

growth factor 5 (*FGF5*) gene affects hair length in a diverse set of mammalian species. Mutations in *FGF5* lead to recessive long hair phenotypes in mice, dogs, and cats; and the gene has been implicated in hair length variation in rabbits. Thus, *FGF5* represents a leading candidate gene for the phenotypic differences in hair length notable between extant elephants and the woolly mammoth. We therefore sequenced the three exons (except for the 3' UTR) and a portion of the promoter of *FGF5* from the living elephantid species (Asian, African savanna and African forest elephants) and, using protocols for ancient DNA, from a woolly mammoth. Results: Between the extant elephants and the mammoth, two single base substitutions were observed in *FGF5*, neither of which alters the amino acid sequence. Modeling of the protein structure suggests that the elephantid proteins fold similarly to the human FGF5 protein. Bioinformatics analyses and DNA sequencing of another locus that has been implicated in hair cover in humans, type I hair keratin pseudogene (*KRTHAP1*), also yielded negative results. Interestingly, *KRTHAP1* is a pseudogene in elephantids as in humans (although fully functional in non-human primates). Conclusion: The data suggest that the coding sequence of the *FGF5* gene is not the critical determinant of hair length differences among elephantids. The results are discussed in the context of hairlessness among mammals and in terms of the potential impact of large body size, subarctic conditions, and an aquatic ancestor on hair cover in the Proboscidea. © 2009 Roca et al.

J. Saragusty, R. Hermes, F. Göritz, D.L. Schmitt & T.B. Hildebrandt

Skewed birth sex ratio and premature mortality in elephants

Animal Reprod. Science 115 (2009) 247-254

Abstract. Sex allocation theories predict equal offspring number of both sexes unless differential investment is required or some competition exists. Left undisturbed, elephants reproduce well and in approximately even numbers in the wild. We report an excess of males are born and substantial juvenile mortality occurs, perinatally, in captivity. Studbook data on captive births (CB, n=487) and premature deaths (PD, <5 years of age; n=164) in Asian and African elephants in

Europe and North America were compared with data on Myanmar timber (Asian) elephants (CB, n=3070; PD, n=738). Growth in CB was found in three of the captive populations. A significant excess of male births occurred in European Asian elephants (ratio: 0.61, P = 0.044) and in births following artificial insemination (0.83, P=0.003), and a numerical inclination in North American African elephants (0.6). While juvenile mortality in European African and Myanmar populations was 21–23%, it was almost double (40–45%) in all other captive populations. In zoo populations, 68–91% of PD were within 1 month of birth with stillbirth and infanticide being major causes. In Myanmar, 62% of juvenile deaths were at >6 months with maternal insufficient milk production, natural hazards and accidents being the main causes. European Asian and Myanmar elephants PD was biased towards males (0.71, P=0.024 and 0.56, P<0.001, respectively). The skewed birth sex ratio and high juvenile mortality hinder efforts to help captive populations become self-sustaining. Efforts should be invested to identify the mechanism behind these trends and seek solutions for them. © 2008 with permission from Elsevier.

J. Saragusty, T.B. Hildebrandt, B. Behr, A. Knieriem, J. Kruse & R. Hermes

Successful cryopreservation of Asian elephant (*Elephas maximus*) spermatozoa

Animal Reprod. Science 115 (2009) 255-266

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 +/- 5.4%, motility following 30 min incubation at 37 degrees C: 58.5 +/- 6.0% and following 3 h 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. © 2008 with permission from Elsevier.

B.E. Slade-Cain, L.E.L. Rasmussen & B.A. Schulte

Estrous state influences on investigative, aggressive, and tail flicking behavior in captive female Asian elephants

Zoo Biology 27 (2008) 167-180

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. © 2008 Wiley-Liss, Inc.

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Use of genital inspection and female urine tests to detect oestrus in captive Asian elephants

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Captive Asian elephant (*Elephas maximus*) populations are decreasing due to low birth rates compared to wild elephants. Improving oestrous 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 oestrous 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 progestagen. 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-oestrous 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 oestrous 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 oestrous 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

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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 (2009) 672–678

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 oestrous 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 80µg GnRH-Ag intravenously at three time periods during the oestrous 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 progestagens. In contrast, despite responding to the GnRH-Ag with an immediate increase in LH, none of the females treated during other periods of the oestrous 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. © 2009 CSIRO, www.publish.csiro.au.

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Successful artificial insemination in the Asian elephant (*Elephas maximus*) using chilled and frozen-thawed semen.

Reproductive Biology and Endocrinology 7 (2009) 75

Abstract. Background: Artificial insemination (AI) using frozen-thawed semen is well established and routinely used for breeding in various mammalian species. However, there is no report of the birth of elephant calves following AI with frozen-thawed semen. The objective of the present study was to investigate the fertilizing ability of chilled and frozen-thawed semen in the Asian elephant following artificial insemination (AI). Methods: Semen samples were collected by from 8 bulls (age range, 12-to 42-years) by manual stimulation. Semen with high quality were either cooled to 4°C or frozen in liquid nitrogen (-196°C) before being used for AI. Blood samples collected from ten elephant females (age range, 12-to 52-years) were assessed for estrus cycle and elephants with normal cycling were used for AI. Artificial insemination series were conducted during 2003 to 2008; 55 and 2 AI trials were conducted using frozen-thawed and chilled semen, respectively. Pregnancy was detected using transrectal ultrasonography and serum progesterone measurement. Results: One female (Khod) inseminated with chilled semen became pregnant and gave birth in 2007. The gestation length was 663 days and the sex of the elephant calf was male. One female (Sao) inseminated with frozen-thawed semen showed signs of pregnancy by increasing progesterone levels and a fetus was observed for 5 months by transrectal ultrasonography. © 2009 Thongtip et al.

E. Wiedner, A.R. Alleman & R. Isaza
Urinalysis in Asian elephants (*Elephas maximus*)

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Abstract. Urine was collected from 22 healthy female adult Asian elephants (*Elephas maximus*) and analyzed for the purpose of determining normal biochemical and microscopic parameters.

Findings included urine that was less concentrated compared to other mammals, predominantly alkaline pH, crystalluria of varying types in all samples, and minimal cellularity. Glucose and urobilinogen were not detected in any samples. Trace ketones and trace bilirubin occurred in two different samples. Trace blood was identified in another sample. Three samples tested positive for protein via dipstick but were confirmed negative through the sulfosalicylic acid test. Two samples contained mucus threads. Bacteria were seen microscopically in four samples, and could be cultured from six others, but, because of the lack of an associated inflammatory response and the heterogeneous populations of organisms observed, were considered to be contaminants from the distal urethra, the vestibulovulva, or the environment. Because of the variability in elephant urine, baseline values for elephants within captive herds should be obtained and regular assessments should be performed over time to allow trending of data. Establishment of normal urine values provides an important tool in elephant health care. © 2009 American Association of Zoo Veterinarians.

If you need additional information on any of the articles in the above section, please feel free to contact me. You can also let me know about new (2009-2010) publications on Asian elephants.

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Collared elephant "Tzu Chi", Sri Lanka
Photo by Jennifer Pastorini