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The journal is intended as a medium of communication on issues that concern the management and conservation of Asian elephants (*Elephas maximus*) both in the wild and in captivity. It is a means by which members of the AsESG and others can communicate their experiences, ideas and perceptions freely, so that the conservation of Asian elephants can benefit. All articles published in *Gajah* reflect the individual views of the authors and not necessarily that of the editorial board or the AsESG. The copyright of each article remains with the author(s).

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Cover: Dwarf elephant in Udawalawe National Park (Sri Lanka)
Photo by Brad Abbott

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Elephant Conservation Challenges

Alex Rübel (Editorial Board Member)

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In February this year I had the chance of visiting Nepal. On this visit I went to the Royal Chitwan National Park, the first park established in the country. I was greatly impressed by the attitude of the conservation community in this country in their caring for their last rhinos, tigers, wild and tamed elephants. I was also impressed by their habitats as well in this part of the foothills of the Himalayas. It also amazed me to find out how many elephant management issues there are in a range country, which are similar to those in our western zoos. I realized that there is much we can learn from each other in this regard, with personal contacts or our common journal *Gajah*.

Chitwan is primarily well known for its rhino population, which has grown over the last few years to over 500 animals. It is a place where 125 adult wild tigers and a population of around 60 wild elephants live. The elephants often travel from India into the park. For many years now, the conservation authorities have fought the poaching of rhinos and tigers. The spoils from this poaching are smuggled from Nepal over the passes to China. This well coordinated fight proved to be very effective. In 2011 there was zero rhinos poached in Chitwan, a major achievement of conservation community and Department of National Park and Wildlife Conservation (DNPWC) Nepal.

A major attempt is also dedicated towards the management and conservation of wild and captive elephant populations. Elephants are used traditionally in Nepal to go through the dense forests and which is often the only way to get to remote places in Chitwan. All of the 50 guard posts in the Chitwan National Park have two elephants to patrol their range. They are used to capture wild rhinos that are translocated to create a viable family group in other parks and to control the wild elephant population. Additionally an even bigger number of elephants are used to carry tourists into the community forests and the park.

Despite the successes, the population of the wild elephants, as well as the ones which are used by humans, face several challenges. Lately, a big tusker named 'Dhrube' has been identified as a man-killer. It has killed 15 people in the last month and in years before that. Nepal has witnessed a rising number of human deaths and property losses caused by wildlife. Even in a large park such as Chitwan it is difficult to keep the elephants inside the forest since their range is often bigger. Human-elephant conflict (HEC) is an issue, which needs increasing observation and attention. The most welcomed growing wild herds need observation and measures to control potential damage by them. Also follows adverse effects towards the elephants by the local communities. Nepalese officials understand that there is a need to limit several populations of endangered wildlife including elephants, rhinos and tigers.

Capturing and breaking in wild elephants for human use was often cruel and is not the state of the art anymore. New know-how and techniques regarding HEC and population control, which have proven themselves in other places as well as in captivity, have to be introduced.

A serious matter is that in the captive elephant population, which is used for patrolling or tourism, there is no breeding. The population is becoming old and tuberculosis amongst them is wide spread. Measures have to be taken to make sure that in the longer term there are still elephants available for duties in the forest. Reproduction is now planned in the elephant breeding facility at Khorsor. The centre was built in 1988 and now the first elephants have been born and are growing up at the centre.

However the centre faces the same issues as many zoos did and do over the last few years. Breeding and raising elephants is best done and most successful in a matriarchal family group. Several European zoos have built up such groups over the past decade. As the elephants in the centre have come from different sources, these groups have to be built up over time. Cooperation with other countries may be necessary to stabilize the actual population.

Another challenge is the widespread tuberculosis in elephants. The phenomenon of tuberculosis in captive elephants is well known in zoos around the world. Most of the affected elephants seem to be raised in a human environment and have acquired tuberculosis from humans or through infected cow milk. In Nepal now, a research group, under the leadership of Susan Mikota and in collaboration with DNPWC and the National Trust for Nature Conservation, is evaluating and tackling these problems and has screened a large number of elephants to bring this problem under control.

Conservation of our mega vertebrates has become more challenging over the last decades due to human population growth and land use. Despite buffer zones the pressure towards the conservation areas is still increasing. On the other hand the elephant population, used for tourism and conservation zone patrolling, is dwindling. The dilemma suggests that it is imperative that we put our knowledge regarding HEC together and work with local communities in disease control, population control in the wild and reproduction in the captive population to secure our last elephants on this planet.



Announcement

Gajah Goes 'Peer-review'

Jayantha Jayewardene (Editor)

Gajah will have a 'peer reviewed section' from the 40thissue on. Peer reviewed papers will carry a notation to that effect. Peer reviewed papers will be handled by an editoral board member. They will be sent out for review to those with expertise in the relevant area and the authors informed of the reviewers' comments and recommendations. The editor will make the final decision on whether to publish or not, based on two or more reviewers' comments.

Only original research papers will be considered for the 'peer reviewed section'. Papers submitted for considerationcan be up to 5000 words in total with an abstract of a maximum of 150 words. The main sections of the body of text should be: Introduction, Methods, Results and Discussion. Tables, Figures and References should follow the general guidelines for *Gajah* articles listed in the back cover in each issue and downloadable from <http://www.asesg.org/gajah.htm>.

Contributing authors to *Gajah* are requested to specify that they are submitting their paper to the 'peer reviewed section'. Papers submitted without such request will be handled as per current process, where members of the editorial board will send comments to authors and work with them to make the paper of publishable standard in *Gajah*. We encourage authors to submit their papers to *Gajah*'s new peer-reviewed section.

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Notes from the Co-chairs IUCN/SSC Asian Elephant Specialist Group

Ajay A. Desai and Simon Hedges

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Every species on earth requires space or rather habitat, for without that, no species can survive. Given human conversion of natural habitats for his own use, space has become one of the biggest constraints for conservation. While some species have adapted to man modified habitats or even to human habitat (e.g. pigeons, rats, numerous insects, etc.) others have not fared so well. In fact more sensitive species simply die out when their habitat is altered by humans. Some, like the elephant come into conflict with humans when their habitat is lost.

What is habitat loss? Very often, we tend to look at it primarily in terms of loss of forest cover, which surprisingly may not always be the right or only indictor of habitat loss. Habitat loss itself is easily visible and very easily measurable. But what about habitat degradation? Degraded habitat may no longer be suitable or adequate for some species that occupy them. Habitat degradation is not easily visible because tree cover remains (not necessarily, entirely) so forest cover remains. Take for example wild grazing herbivores (mammals), they can be very adversely impacted when there is overgrazing by cattle. In fact such overgrazing will certainly result in significantly reduced carrying capacity of wild grazing herbivores or even their local extinction. However, forest cover would remain intact for decades if not centuries because it may take that long or more before tree species are impacted. We need to recognize that the mere presence of tree cover does not constitute suitable habitat for some species. Here assessment of the impact would require ecological knowledge of a species and how degradation impacts the species' habitat. However, in the absence of such an assessment, forest cover equates to habitat and as such, most conservationists and managers do not see this as 'habitat loss'. People then tend to live under the illusion that there is adequate habitat remaining.

Human disturbance within a habitat, in the form of presence and noise are not fully understood. We do know that even species like elephants avoid roads and high human use areas. The mere presence of people and their cattle can deprive wild herbivores of grazing space during the day. While these areas will be accessible to wildlife, they remain unusable to wildlife during much of the day when people and cattle are present. Buffers (depending on the distance to which the disturbance extends) around roads, settlements and other developed areas are lost to elephants during much of the day. Similarly areas where there is cattle grazing, especially where cattle are accompanied by people, and NTFP collection areas may not be accessible to elephants during a certain part of the day. All this depends on the types of disturbance as also its intensity. However, as in the case of habitat degradation, tree cover remains intact and such loss is not taken into account. Again, we remain complacent believing that adequate habitat remains.

Habitat fragmentation, especially linear barriers, too is a very serious threat to wildlife habitat. They become particularly important where spatial requirements of a species are large and where the habitat available is small. For example, where home ranges of elephants are larger than 300 km^2 and the available habitat is 900 km^2, if that habitat is fragmented into three parts (200 + 200 + 500 km^2) by insurmountable linear barrier (e.g. water canals) which takes away only a small part of the habitat, then only one patch (500 km^2) will be suitable for the species concerned and the other two will be inadequate. So in real terms 400 km^2 of habitat is lost, as the species cannot survive in 200 km^2 patches, where it will become locally extinct in the long term. Unfortunately, here the habitat loss due to the canal could be very small, say a few sq. km. but the resultant impact is far greater. The persistence of a species

like the elephant, due to its long life and ability to subsist on poor habitat, would fool managers and conservationists into believing that they still have nearly 1000 km^2 of habitat.

When it comes to conserving elephants, we need to take all these factors, which affect their habitat and their potential long-term survival into account. Failure to do so would result in us securing inadequate habitat for their long-term conservation.

In addition to these 'space' related aspects, we also need to move away from myopic approaches to elephant conservation. We should not forget that one of the objectives of conservation of any species (other than the species itself) is to save the contained biodiversity of its habitat. So while we focus on elephant conservation we should not lose sight of the biodiversity, which is contained in the elephants' habitat. This is critical because we often project the elephant as a flagship species and umbrella species. These tags certainly apply to the Asian elephant as it has strong cultural and religious links to people in Asia and finds support globally. Failure to do so would be like trying to conserve the elephant in safari park or even a zoo. Such an approach is required because we also need to ensure that ecological functionality of elephants and their habitats are retained. This will automatically imply that elephant need to be conserved in all representative habitat types within which they currently occur. So conservation is not about saving one or a few populations here and there; it's about conserving a range of populations across as diverse a range of habitat types as possible. At the same time, conserving the contained biodiversity is an integral part of elephant conservation.

The challenge would be to understand elephant's spatial requirements in different habitat types. We would also need to understand the requirements of biodiversity conservation within elephant habitat. We also need to keep in mind the genetic requirements for long-term conservation. Who said conserving elephants was easy, we have a lot of work ahead and hopefully we will increase our knowledge of the species and its conservation requirements and do a good job of leaving behind a good and ecologically functioning elephant population for future generations.



Drawing by Arnab Roy

The Dangerous Myth of the Noble Beast

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I recently read a student's paper saying 'as more forests are cleared and fragmented, elephants have no choice but to encroach into plantations in their search for food, water, and mates' and the myth of *le bon sauvage* immediately came to mind.

The myth of the noble savage, popular in the 18th and 19th centuries, has to some extent impregnated conservation biology's philosophy in recent decades. This myth is an idealization of people living in traditional societies, attributing them a noble spirit and behavior. Accordingly, conservation biologists have often assumed that human traditional societies always live sustainably and in harmony with their environment. Now we know, however, that conservation by indigenous people is uncommon (Raymond 2007) and that, for example, stone-age societies wiped out over 90% and 70% of large mammal species when they reached Australia and the Americas (Barnosky *et al*. 2004).

The myth of the noble beast is very similar and also widely spread in conservation biology. Large herbivores and carnivores often come into conflict with people not because they have no other option but as part of their optimal foraging strategy (Stephens 1986). For example, food for elephants can be very limited in a pristine tropical rainforest yet abundant in nearby plantations and human-dominated landscapes (crops and early succession plants are excellent elephant forage). In this situation, elephants may choose to come out of the forest we consider their legitimate habitat and 'encroach' into human areas, resulting in the well-known human-elephant conflict. The key driver of conflict in this scenario is not the amount of forest available for the elephant but the amount of interface between forest and crops. Certainly animals are not to be blamed for human-wildlife conflicts. But the conservation of species like elephants and tigers in the 21st century requires effective mitigation of these conflicts and thus understanding the behavioral and ecological drivers leading to them. The myth of the noble beast has appealing emotional implications but can lead to ineffective mitigation policies and thus should be avoided in favor of a realistic understanding of wildlife ecological foraging behavior and ecology.

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Young elephant bull about to be translocated away from rubber and durian plantations in Kelanta, northern Peninsular Malaysia.

Does Moonlight Affect Asian Elephants?

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The recent publicity about the expanding ivory trade has once again obscured the fact that the ultimate determinant of elephant survival will be space. Elephants are wandering animals that need large ranges, and people need land as well.

Crop-raiding is the proximate manifestation of the competition between people and elephants for land. Most crop-raiding is nocturnal. In the fields one is very conscious of the moon and its passage across the heavens during the slow watches of the night. Yet, to my knowledge, the first report of the moon's effect on elephants was made by Bryan Dickinson (1998) in West Africa. This is odd, because other animal species, and even some aspects of human physiology, are known to be influenced by the moon (Pearson 2006; Cajochen *et al*. 2013). It is possible that there are mentions of this phenomenon in books or magazines in the elephant natural history or hunting literature, but I have yet to find them.

Dickinson was studying crop-raiding around the Kakum Conservation Area in the forests of south-west Ghana. Later we collected more data around Kakum and confirmed his observation: elephants emerged from the forest on dark nights; they were less likely to raid farms during the full moon (Barnes *et al*. 2007). Was this behavior shown only by forest-dwelling elephants? A team from Anglia Ruskin University and the Animal Behaviour Research Unit (Tanzania National Parks) studied crop-raiding by savanna elephants around Mikumi. They showed that savanna-dwelling elephants, or at least those in Tanzania, are also influenced by the moon (Gunn *et al*. 2013).

The nocturnal movements of elephants in both West and East Africa, in dense forest and savanna, are significantly associated with the phase of the moon. The question is now: do Asian elephants show the same patterns?

There are a number of ways to study this question:

- If sensitivity to the moon is an intrinsic feature of elephant biology, then it will be revealed by studies of captive elephants.



Elephant herd going for a drink in the moonlight (Sri Lanka)
Photo by Prithiviraj Fernando

- There must also be fieldworkers with old data tucked away in their filing cabinets that could be retrospectively analyzed - an interesting subject for a master's thesis perhaps. The paper by Gunn *et al*. (2013) provides information on where one can find moon phase on particular dates in the past, as well as suggestions for methods of analysis.
- The best answer may come from studies planned to separate the question of human activity, such as farmers guarding their fields, from the direct effect of the moon on elephants.
- Finally, there may also be researchers with radio-tracking data that could now be analyzed with respect to the phases of the moon. One could separate out the effects of moon phase and human activity by building statistical models that include human density (or proxies for human density such as road density, village density, etc.).

And so I throw down a challenge to the readers of *Gajah*. Are there descriptions of the effect of the moon on Asian elephants in the natural history literature? Do Asian elephants behave in the same way as African savanna and forest elephants? Can you disprove the hypothesis that Asian elephants' nocturnal movements are determined by moonlight? Can you disprove the hypothesis that it is human activity on moonlit nights that deters crop-raiding?

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Adult males leaving the forest at sunset (Sri Lanka)
Photo by Jennifer Pastorini

Research Article *Gajah 38 (2013) 8-18*

Birth Sex Ratio and Determinants of Fecundity in Female Timber Elephants of Myanmar

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Abstract. I assessed the reproductive patterns of captive-born and wild-caught Asian elephants managed by the Myanmar Timber Enterprise. Calving among all female elephants was seasonal with higher births in cool months (October to February) and late monsoon (September). Captive-born mothers have significantly higher fecundity rates with lower inter-birth intervals than wild-caught mothers, likely due to harsh capture and breaking procedures, and inadequate nutrition due to unfamiliarity of foraging grounds and fettering during night foraging. Fecundity peaks between 22 and 25 years, levels out between 25 and 39 years and gradually declines after 40 years in both wild-caught and captive-born females. Complete reproductive cessation is not observed until age 60 in wild-caught mothers and at least age 49 in captive-born mothers, suggesting reproductive senescence is not likely in either captive-born or wild-caught females. Offspring sex ratio is not different from unity and not influenced by birth order of calves, mother's birth origin or age.

Introduction

Large, long-lived mammals fall into the category of 'K-selected' species that exhibit slow life histories- characterised by slow metabolism and development, delayed reproduction with low levels of fecundity, delayed attainment of puberty (Rachlow & Berger 1998), long period of infant dependency and increased mortality especially during the first year of life (Clubb *et al*. 2009). The reproductive success in these species may be determined by a number of factors including seasonal availability of food resources, predation, adult survival rate, population density, social factors, group sex ratio, ecological, psychological and physiological stress or insult during early development, confinement-related stress, and capture-related trauma and stress or a combination of these factors (Clutton-Brock 1984; Saether 1997; Rachlow & Berger 1998; Gaillard *et al*. 2000; Coulson *et al*. 2001; Shanks 2002; Lummaa & Tremblay 2003; Wielebnowski 2003; Archie *et al*. 2006; Loveridge *et al*. 2006). In captive females, additionally, inadequate space, housing and enrichment, adverse environmental conditions, failure to provide compatible breeding pairs or social groups, frequent changes in group composition, inability to train animals properly and poor diet can limit reproductive success (Shepherdson 1989; Schulte 2000; Wielebnowski 2003; Allen & Ullrey 2004).

Like non-human primates, marine mammals and some human tribes, African and Asian elephants living in the wild are composed of highly-related matrilineal family groups. They have complex social societies with multi-levelled, fission–fusion social structures (Vidya & Sukumar 2005; Wittemyer *et al*. 2005; Archie *et al*. 2006; Couzin 2006). Hierarchy (rank) is determined by age (Douglas-Hamilton 1972; Vidya & Sukumar 2005). In natural free–ranging environments, older, larger female African elephants consistently dominate smaller, younger females (Archie *et al*. 2006a; Couzin 2006). In captivity, such forces are relaxed or eliminated (Schulte 2000; Vidya & Sukumar 2005).

The past four or five decades have witnessed the accumulation of basic descriptions of life-history strategies for an increasingly large number of terrestrial mammals. This accumulation

has fuelled a rich body of research in which evolutionary hypotheses are examined through a comparative approach (Harvey & Zammuto 1985; Hutchins & Kreger 2006). A few studies have explicitly compared within-species differences in life history strategies by comparing habitats, social groups or keeping systems, such as wild versus captive-born, farm versus zoo populations or zoo versus native populations (Kurt & Mar 1996; Snyder *et al*. 1996; Taylor & Poole 1998; Thévenon *et al*. 2003).

For elephants in particular, a few reports have been published on the differences of survival and reproductive patterns of captive elephants between zoo populations and those in the range states (Kurt & Mar 1996; Taylor & Poole 1998; Schmid 1998). Hutchins and Kreger (2006) argued that making direct comparisons between wild and zoo population is not appropriate, because there are too many differences in feeding ecology and diet, social organization and behaviour, reproductive biology and so forth between native habitats and zoo settings.

Some recent studies have compared reproductive endocrinology, ultrasonography, anatomy, disease outbreaks and drug efficiencies in Asian and African elephants from zoos (eg. Hildebrandt *et al*. 2006; Brown *et al*. 2004).

On the other hand, there are no previous studies on Asian or African elephants that directly compare the reproductive patterns of captive-born and wild-caught individuals. It is worthwhile to conduct such a comparison as most elephants kept in captivity, such as zoos, tourist camps, logging camps etc. are originally derived from wild-caught animals. Here, I present the reproductive pattern of captive-born and wild-caught Asian elephants (*Elephas maximus*) of Myanmar, living in the same predation-free ecological environment, in an extensively management system.

A female elephant, which can live well beyond the age of 60 years, has the longest reproductive life span among any terrestrial mammal. During her lifetime, she has the potential to produce up to 12 calves (Sukumar 2003). In captive elephants, work-related stress is likely to impose some constraints on reproductive patterns, depending on how well individuals adapt to captive conditions.

Based on the yearly birth and death data of Myanmar elephants, I will present the seasonality of calving and mortality rate. Then, I will focus on the following key questions, in an attempt to explore variability in components of reproductive tactics of captive-born and wild-caught female timber elephants of Myanmar.

1. How is female reproductive potential impacted by birth origin (wild-caught versus captive-born)? In this context, I explored potential fecundity differences between these two groups, including (a) age at first breeding, (b) age-specific reproductive rates, and (c) interbirth intervals.

2. Do captive-born or wild-caught elephant females adapt offspring sex ratio? Also, for either group, does maternal age, maternal birth origin or birth order have a significant impact on the production of male versus female calves?

Materials and methods

Study population

The original data set is from the timber elephant studbook of Myanmar Timber Enterprise, containing 5213 elephants (female = 3050, male = 2259, unknown sex = 4), including 3230 calves born to 1340 females.

For captive-born animals, ages were known precisely. For wild-born animals, age at capture was estimated by experienced elephant handlers based on shoulder height and other indicators, such as folding patterns of the earflap and dentition. This study is based on a subset of these records, involving females (n = 2841) with full survival histories (i.e., known ages at entry and departure from the population) and complete calving information. Elephants captured before 1950 are excluded because capture dates are recorded only to the nearest decade.

Individual working elephants have a log book, which is maintained and updated by local veterinarians and regional extraction managers at least bi-monthly to check the health condition and ability of each elephant to work, and to correct any entry errors made by previous officers. The multiple sources of data recorded by the Myanmar Timber Enterprise (annual extraction reports and end of the year reports from each region) allow effective cross-checking of any apparent errors. Between-individual variation in workload or rest periods is limited by law: all state-owned elephants are subject to the same regulations set by the central government for hours of work per week, working days per year, and tonnage to extract per elephant. For example, all mature elephants (>17-55 y) work 3-5 days a week (depending on weather and forage availability) 5-6 h a day (maximum 8 h) with a break at noon. The maximum tonnage of logs allowed to be dragged in a year per elephant was 400 in 2010.

The elephants live in forest camps, where they are used during the day as riding, transport, logging and draft animals. At night the elephants forage unsupervised in the forest as groups (an average 12 h, range 10-14 h per day) where they find food and encounter tame and wild conspecifics. Most calves are thought to be sired by wild bulls, and calves born in captivity are cared for by their biological mothers and allo-mothers, and suckled until lactation no longer supports their demands. All elephants finish their work season by mid-February each year, and work resumes around mid-June depending on the arrival of monsoon.

The ages of captive-born elephants are exact because precise dates of birth are recorded, and this study concentrates only on the records of captive-born mothers and their offspring in order to have accurate data on maternal age and previous reproductive history, which are incomplete for most wild-captured mothers. Dates of matings are recorded by the mahouts when they notice the mounting marks on the back of female elephants. In humans, parity is defined as the number of previous pregnancies of greater than 20 weeks gestation, which is about half term of a normal pregnancy (Bai *et al*. 2002) or the number of children a woman has already had (Hinde 1998). The term "primipara" is used to characterize mothers with a single previous pregnancy while "multiparity" refers to multiple pregnancies or births, and "birth order" refers to children in the order they are born (first births, second births and so on) (Hinde 1998). Sex ratio is the ratio of female to male (female/male) offspring. It is not always possible to know when an elephant is pregnant, at least in the early to mid-periods. Therefore, in this study, I use first born calving records and later born calving records, so that there are only "primiparous" mothers (with a single pregnancy) and "multiparous" mothers (with more than one pregnancy). All other terms are used similar to women.

Age-specific fecundity (m_x) is the average number of female offspring produced by an individual female aged x, calculated as the number of female live births (b_f) to the mid-year population of mothers at age x (M_x) and x-1 (M_{x+1}). The total number of female calves born alive from captive-born mothers and wild-caught mothers were 526 and 499, respectively.

$$m_x = \left(\frac{b_f}{M_x + M_{x+1}} \right) \text{ x } 0.5$$

Studbook data shows that the youngest age a female gave birth was 5.3 years. This was known because she was born in captivity. Sukumar (2003) stated that " There are reports of cows mating as early as 7-9 years old; even if these are exceptional, a mean age of maturity of 10-12 years old is likely here. In Southern India's Biligirirangans, I estimated the mean age of first calving in female (wild) elephants during 1981-1983 to be about 17-18 years". Based on this information, wild-caught females captured at ≤10 years of age are included in the analyses of calculating age-specific fecundity, assuming they are not likely to reproduce prior to capture. Those wild-caught females captured over 10 are excluded from analyses because it is impossible to trace the past breeding history before capture. The number of calves remaining for analysis of interbirth interval is 1378 (captive-born mothers = 999, wild-caught mothers = 379).

Methods

To explore the relationship between mothers' birth origin, mother's age at birth and birth order to sex ratio of calves, I conduct a binomial generalized linear model (GLM) using R-software (R version 2.8.1, released 22.12.2008). Significant main effects and interactions are included in the GLM using a stepwise procedure (Dalgaard 2002; Crawley 2003). For each regression analysis, a full model containing explanatory variables and first-order interaction terms are initially fitted. I then carry out model simplification with standard methodology through stepwise deletion (Dalgaard 2002; Crawley 2003). Significance is evaluated at the 5% error level using the likelihood ratio chi-square test.

Cox proportional hazard model is the most general of the regression models because it is not based on any assumptions concerning the nature or shape of the underlying survival distribution. The model assumes that the underlying hazard rate (rather than survival time) is a function of the independent variables (covariates); no assumptions are made about the nature or shape of the hazard function. In this paper, Cox regression analysis is used to test the effects of explanatory variables on age-specific reproductive rate and interbirth interval, using R-software (R version 2.8.1). In the case of reproductive rate, mothers' age at calving, entry to and departure from the population were analysed with histories split at calving (the event of interest), and censored at population departure. In the case of interbirth interval, time to event is measured by the difference in the age of mother between two consecutive live births of calves.

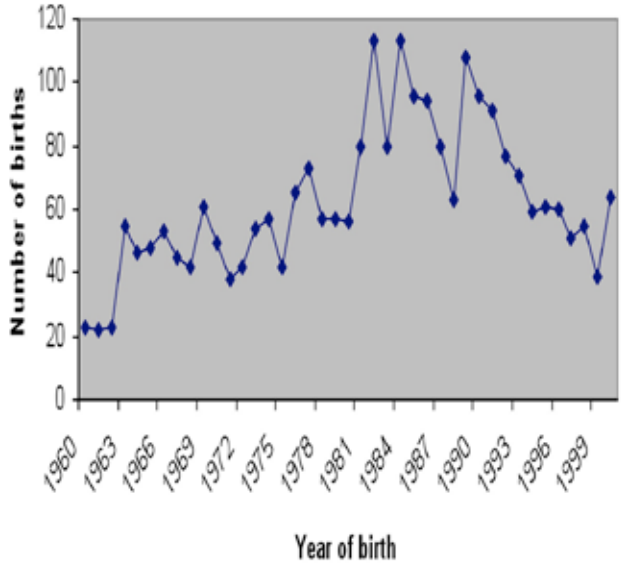


Figure 1. Yearly births between 1960 and 1999.

Results

In this subset of data, the youngest and oldest captive-born and wild-caught mothers are recorded as 5.30 y and 53.00 y (median = 24.73 y) and 6.44 y and 60.84 y (median = 29.25 y), respectively. The maximum number of calves that a single mother has given birth to, is ten.

Seasonality of births and calving rate

The yearly number of births between 1960 and 1999 is presented in Figure 1. Twenty-five percent of today's living population of timber elephants in Myanmar were born in captivity before 1974. During the last four decades, the highest calving rate occurred in 1982 and 1984 with 113 calves per year. After 1990, the calving rate declined to an average of 53 calves/year.

Although births are recorded in each month of the year, a lower rate is found in the late summer months (May and June) and early (wet) monsoon season (July and August) (Fig. 2). Timber elephants prefer to give birth the cool season between December and March. Taking account of the mean gestation period of Myanmar elephants as 20-22 months (Hundley 1922; Flower 1943; Anghi 1962), the peak mating and conception is likely to have occurred in the summer rest period, one year previously.

Age-specific fecundity rate

Age-specific fecundity rate is calculated on the subset of studbook data containing 2841 females with full survival histories (i.e., known ages at entry and departure from the population) and complete calving information. Cox regression analysis showed that age-specific fecundity of captive-born mothers is significantly higher than that of wild-caught mothers (Fig. 3, test statistic χ^2 = -11.9, P<0.001), with significant non-proportionality (Cox proportional hazards

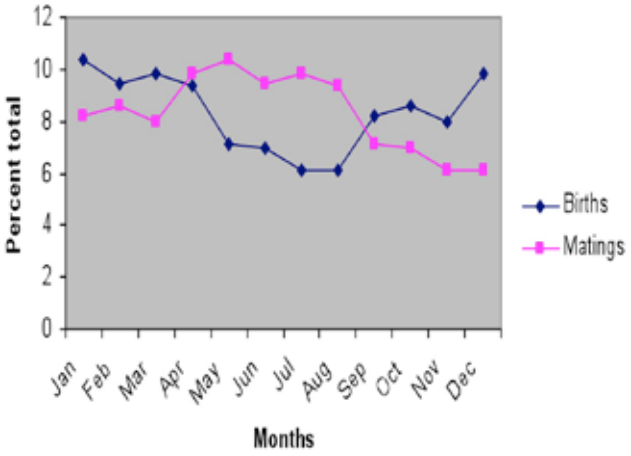


Figure 2. Births compared with matings by month.

test statistic $\chi^2 = 0.37$, p = 0.54). The first peak of fecundity is at age 22 and 25 y in captive-born and wild-caught females, respectively, with fecundity rate differing by half (m_x of captive-born = 0.083 vs. m_x of wild-caught = 0.041).

Although age-specific fecundity (m_x) varies from year to year the highest (m_x) value occured between 38 and 40 y for both captive-born and wild-caught female elephants. There are no reported births after age 50 in captive-born females. However, the oldest captive-born female elephant in my data set is 53 y old, and she is still alive at the end of the study period. So, there are no comparable records for fecundity of captive-born females beyond age 53. Evidence of calving until age 49 in captive-born females and until 61 y of age in wild-caught females indicates that complete reproductive cessation or menopause seems not to exist in captive Asian elephants

Interbirth interval

The number of calves remaining for analysis of interbirth interval is 1378 (captive-born mothers = 999, wild-caught mothers = 379). The shortest and the longest interbirth intervals are recorded as 1.52 and 21.44 y (median = 4.93 y) for captive-born mothers and 1.71 and 19.29 y (median = 5.28 y) for wild-caught mothers, respectively (Table 1). There are two females, with registration number recorded as 1804 and 1833, have given birth their second and fourth live-born calves at 1.52 and 1.62 y, respectively, after the birth of previous calves, indicating that (1) female elephants are capable of conceiving immediately after parturition and (2) the interbirth-interval period can be shortened to a minimum of 18 months. However, these inter-birth intervals are very short considering normal gestation length is 20-22 months.

Using a survival analysis of all potential females exposed to the "risk" of a birth, Cox regression analysis is used to examine the independent effects of explanatory variables (birth order, sex, birth origins of mothers) on interbirth interval. After systematic model simplification, the minimum adequate model indicates that dam origin is the only variable that significantly determined the birth interval (χ^2 = -5.36, P< 0.001, Cox proportional hazards test $\chi^2 = 0.30$, p = 0.58). There were no significant interactions between any of the main effects investigated. Wild-caught mothers show significant lower birth rates than captive-born mothers, with the possibility of a subsequent birth following an index calf 22% lower or longer than captive-born mothers (exponential coefficient = 0.78, 95% confidence interval 0.71-0.95).

Birth sex ratio (female/male)

One thousand nine hundred and twenty six calves with full information of maternal birth origin (captive-born = 387 and wild-caught = 464) and survival history are included in this analysis. In every birth order, captive-born and wild-caught mothers gave birth with a near even sex ratio, with the exception of a few male-skewed births in high parity (parity 8 and 9) in captive-born females. Birth sex ratio shows

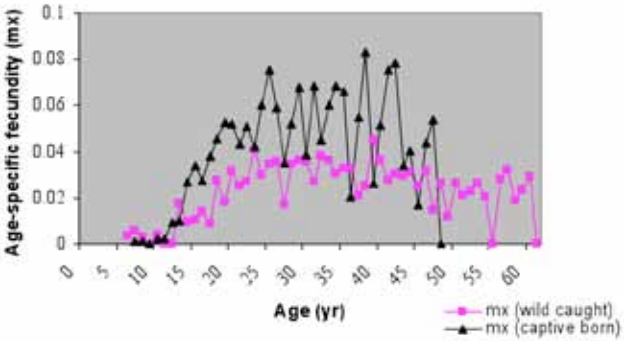


Figure 3. Age-specific fecundity rate of captive-born and wild-caught mothers.

Table 1. Birth intervals by parity.

Birth order	N	Min.	Max.	Median	Mean ± SE
1	877				
2	544	1.61	22.92	5.69	6.38 ± 0.15
3	315	1.52	17.08	5.25	5.80 ± 0.15
4	174	2.00	15.46	4.58	5.35 ± 0.20
5	88	1.88	11.20	4.50	5.14 ± 0.23
6	42	1.81	10.75	4.04	4.40 ± 0.30
7	21	1.84	9.79	5.35	5.30 ± 0.45
8	8	2.19	10.08	6.36	6.29 ± 0.96
9	3	3.00	4.59	3.03	3.54 ± 0,53
10	2	3.67	8.96	6.31	6.31 ± 2.65
Total	1378	1.52	22.92	5.21	5.89 ± 0.09

no significant difference between birth orders (binomial test statistics $\chi^2 = 0.418$, ns), between captive-born (n = 387) and wild-caught (n = 464) females (binomial test statistics $\chi^2 = 0.545$, ns), or between mothers' ages (binomial test statistics $\chi^2 = 0.785$, ns).

Discussion

Seasonality of births

Seasonal reproduction can happen in tropical animals, similar to temperate-zone animals and they display distinct seasonal peaks in reproductive activity if they do not reproduce year-round. In some cases, reproductive activity is spread out over weeks or months, but nonetheless is clearly seasonal rather than continuous (Bronson 1995; Aung *et al*. 2001). Even *Homo sapiens*, the archetypal example of a continuously breeding species, exhibit significant seasonality in births (Bronson 1995). Studies have shown that seasonal reproduction can be initiated by day length, temperature, rainfall and food supply or quality of habitats or interactions between these factors (Gaillard *et al*. 1993; Helm & Gwinner 2005; Perfito *et al*. 2005; Toigo *et al*. 2006).

Based on the supportive information from several studies, the reproductive output of timber elephants would correspond to the seasonal availability of good quality feed under the influence of rainfall. This was supported by the studbook data, where fewer calves were born during the summer months between May and August than the rainy and cold months. A similar calving pattern was reported by Sukumar (2003) where births peaked "towards the end of wet (rainy) season" and before the arrival of monsoon in both south India and Myanmar. Likewise, Moss (2001) identified a clear seasonality of conceptions in African elephants corresponding to rainfall.

Mean gestation period for Myanmar elephants is estimated as 20-21 months (Hundley 1922; Flower 1943; Anghi 1962) to recalculate the mating season in timber elephants. I report that peak mating and conception coincided with the summer resting months (Fig. 2). According to the studies of reproductive strategies of polygynous endemic tropical deer (*Cervis eldi thamin*) in central Myanmar, reproduction is seasonal, with mating seasons occurring during the hot-dry season and parturition in cool months in November-December (Aung *et al*. 2001). Elephants in my study show similar breeding pattern of tropical long-lived mammals living in similar habitats.

Age-specific fecundity rate

Wild-caught and captive-born mothers showed similar fecundity patterns, peaking between 38 and 40 years. However, the maximum fecundity of wild-born mothers was half that of captive-born mothers (Fig. 3). This may be due to a reduced availability of food, capture/training stress or a combination of the two. Resource availability affects the life history patterns of growth, maintenance and reproduction (Isaac 2005). Food deprivation or restricted food intake can suppress ovulation, oestrus behaviour and mothering ability in various mammals (Wade & Schneider 1992) including humans (Lummaa & Tremblay 2003).

Although no study has been conducted on feeding ecology of captive elephants, it is expected that captive-born and wild-caught elephants may differ in their abilities to extract high quality resources from their foraging environment.

Having been born in the area in which they live and forage, captive-born elephants are more likely to have knowledge of high quality resources. Wild-caught elephants, removed at a young age from their mothers and natal home are more likely to experience lower nutrition in the early post-capture period due to the unfamiliarity with good foraging areas. In addition, they may have difficulty competing with resident captive-born elephants for the best forage sites. This may be partly due to a restricted ability to move and walk because their front feet are fettered when they are released into the forest at night to forage. Captive-born calves are trained to forage alongside their mothers, and they are not fettered until they are weaned at or around taming age at around 4.5 years of age. Some captive-born calves continue suckling until 7 or 8 years, many years after taming, or as long as the mothers allow, or until the mothers are pregnant again. Fettering is practiced in both captive-born and wild- caught elephants only after taming. It is assumed that captive-born calves have more mobile in early ages, have enough opportunity to follow their mothers and aunts, and can more easily learn the better foraging patches and terrains.

Based on studies of ruminants and other livestock animals, it is well known that proper nutrition and dietary husbandry are fundamental to reproductive success (Allen & Ullrey 2004), and limited food availability is associated with infertility in humans (Wade & Schneider 1992). The same likely applies to wild-caught elephants used for work in the timber industry.

Wild-caught elephants also are more likely to suffer from stress than captive-born animals because they are selectively removed from their natal herd, usually (≈70%) at around 10 years of age. Here in this study, only wild elephants capture under ten is used. Research has shown that maternal separation and early life environmental stress predisposed to various pathologies (Lummaa & Clutton-Brock 2002; Shanks 2002). Growth, survival, and breeding success of individuals could be influenced by the environmental conditions that individuals experience during their early development and such effect had a permanent effect on reproductive success late in their life. The earlier an individual's development was disturbed, the stronger were the effects (Lummaa & Clutton-Brock 2002). As taming/breaking follows immediately after capture, the psychological and physical trauma sustained during the early days in captivity, compounded with restricted movement and living under the dominance of humans and residence captive-born elephants, could have a cumulative effect to suppress future fecundity.

Wild-caught females take some years to recover from the stress of capture and/or taming so that their reported age of first calving in captivity is older than captive-born females. For captive-born calves, breaking normally takes only a few days, whereas the breaking period for wild-caught animals lasts a minimum of 2 weeks to a maximum of 8 weeks depending on temperament. The longer the taming process, the harsher the punishments and more unpleasant the process generally is.

Interbirth interval

In general, it is widely accepted that a minimum intercalving interval is ≈ 2 years (Gee 1955; Yin 1962; Sukumar 2003), taking account of the average gestation period as 640-660 (±14) days (Schmidt 2006). However, earlier reports documented that the range of gestation period as 17 months 17 days to 24 months 13 days (Burne 1943). The shortest and the longest interbirth intervals in timber elephants are recorded as 1.52 and 21.44 y (median = 4.93 y) for captive-born mothers and 1.71 and 19.29 y (median = 5.28 y) for wild-caught mothers, respectively. Moreover, I provide evidence that in working elephants, mothers' birth origin was the main variable that governed the length of the intercalving interval. Wild-caught females tended to have fewer births than captive- born females, with longer birth intervals.

Numerous physiological and behavioural mechanisms link reproduction and energy metabolism. A complete reproductive cycle of ovulation, conception, pregnancy, lactation and offspring care is one of the most energetically expensive activities that a female mammal can

undertake. In other large mammals such as African elephants (*Loxodonta africana*) (Laws *et al*. 1975) and white rhinoceros (*Ceratotherium simum*) (Rachlow & Berger 1998), females in high-density populations exhibit longer intervals between births than those in lower-density areas, suggesting that food competition among individuals in high-density population affected body condition and thus affected the reproductive potential. Moss (2001) stated that median intercalving interval in African elephants in Amboseli was extended by about 1.3 years if the previous calf survived for more than 2 years.

Working animals need additional energy. High energy demands coupled with limited feed supply could easily deplete the body reserves of wild-caught females more than captive-born (resident) females, which should have better opportunity to enjoy a more reliable source of food. A reproductive attempt at a time when calories are not sufficiently available can result in a reduced return on the maternal energetic investment, maternal reproductive output (Osrin & de L' Costello 2000; Knackstedt *et al*. 2005). Wild-caught females may optimize long-term reproductive success by delaying pregnancies until energy supplies can be replenished and energy demands are less severe.

Birth sex ratio

In this study, I provide the first evidence that the offspring sex ratio of Myanmar timber elephants is not different from unity and is not influenced by birth order of calves, mother's birth origin and age. Similar findings were reported in captive Indian elephant (Sukumar 2003) and other large land mammals such as African elephant (Moss 2001). According to Sheldon and West (2004), in polygynous ungulate mammals, there was a weak but significant correlation between maternal condition and sex ratio. They also claimed that such a relationship was stronger when sexual size dimorphism was more male biased and when gestation periods are longer. Under the influence of work-related and capture/taming-related stress, timber elephants living in an extensive keeping system were presumed to adjust sex ratio differently in wild-caught and captive-born mothers. Having a better survival (Mar 2007, Clubb *et al*. 2009) and reproductive rate than wild-caught elephants, captive-born females were previously assumed to produce male-skewed sex ratio similar to other studies (Clutton-Brock 1984). Wild-caught females, due to their early stressful life combined with work-related stress and pressure of living under human and dominance of resident captive-born herd mates, would be more likely to produce female-biased offspring sex ratio (Rivers & Crawford 1974; Kojola 1997). Referring to the maternal investment in polygynous large mammals, namely elk (*Cervus elaphus*), Kohlmann (1999) stated that "if females in populations suffer from generally low body condition, intrauterine and neonatal mortality may further reduce the number of sons produced and produce a significant bias toward daughters". These findings are at variance with the findings in my study. The findings of the study demonstrate that Asian elephant females in Myanmar timber camps do not adapt offspring sex ratio regardless of body condition or in relation to social context or resource availability.

Conclusions

- In this sub-set of data, fewer calves are born during the late summer months between May and June, and in early monsoon season (July and August), indicating peak mating and conception coincide with summer.
- Captive-born mothers have significantly higher birth rates than wild-caught mothers, with fecundity rate differing by half.
- Wild-caught mothers exhibit a significantly lower birth rate than captive-born mothers.
- Fecundity peaks between 38 and 40 years in both wild-caught and captive-born females.
- Reproductive senescence is not likely to occur in female Asian elephants.
- The shortest and the longest interbirth intervals are found to be 1.52 and 21.44 y (median = 4.93 y) for captive-born mothers and 1.71 and 19.29 y (median = 5.28 y) for wild-caught mothers, respectively.
- In sum, evidence suggests that fecundity is greater among captive-born females. Given this, and the negative consequences of capturing and training wild-born females,

the most humane and efficient way to sustain working populations of Asian elephants is through well-planned and far-sighted captive breeding efforts.

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Research Article *Gajah 38 (2013) 19-24*

Diurnal Activity and Food Choice of Free-foraging Captive Elephants at the Seblat Elephant Conservation Center, Sumatra, Indonesia

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Abstract. Since the early 1980s, hundreds of "problem" elephants (*Elephas maximus*) have been captured and translocated to elephant training centres across Sumatra, Indonesia, yet there is little information on elephant activity patterns or food choices when being managed at such centres. Using the lead animal technique, 14 free-foraging, tame elephants at a centre in Seblat were observed for 4496 daytime hours to describe their activity and diet. The majority of their daily activity was feeding (82.2 ± 5.0%), followed by moving (9.5 ± 4.0%), resting (6.6 ± 2.1%) and drinking (1.7 ± 0.6%), and individual activity budgets varied among individuals for all activities. At least 273 plant species belonging to 69 plant families were eaten by elephants, but plants from five plant families (Moraceae, Arecaceae, Fabaceae, Poaceae, and Euphorbiacea) were most commonly consumed. Elephants browsed more frequently than grazed, especially in the wet season. Elephants at the Seblat Elephant Conservation Center compensate for night-time confinement by increasing activity during the day, appear to have normal dietary intake, and thus seem well-adapted to captive management. .

Introduction

Over the past three decades, human-elephant conflict and habitat loss have been the major factors causing the decline of Sumatran elephants (Nyhus *et al*. 2000; Sitompul 2004; Hedges *et al*. 2005). Conflict occurs when elephants enter human settlements and agricultural areas, causing property damage, crop-raiding and injuring/ killing people (Nyhus *et al*. 2000; Sitompul 2004). Since the early 1980s, the response of the Indonesian Government was to capture "problem elephants" and translocate them into Elephant Training Centres (ETCs) (Santiapillai & Jackson 1990; Lair 1997). By 1996, 570 elephants had been captured and moved to six ETCs across Sumatra (Lair 1997). Despite this intensive conservation intervention, there is little information on the suitability of these ETCs to adequately maintain elephants.

Two concerns of captive elephant management are activity patterns and diet choices. These elephants are kept confined at night, a period during which wild elephants often are active (and presumably foraging) for perhaps 50-69% of the time (van Schaik & Griffiths 1996; Grassman *et al*. 2006; Gray & Phan 2011). Thus, we wondered what compensation there might be in the captive elephants' diurnal foraging activity. Also, though elephants are known to be generalist feeders (Sukumar 1989), we wanted to find out if the translocated elephants maintained a broad diet under new circumstances, and the degree to which they continued to exhibit seasonal patterns in browsing versus grazing (Sukumar 1989). Thus, the purposes of this study were to describe the general foraging ecology and diet composition of Sumatran elephants at the Seblat Elephant Conservation Center and its adjacent lowland forest.

Methods

The study was conducted in Bengkulu Province on the west coast of Sumatra and included the Seblat Elephant Conservation Center (SECC) (lat 03°03'12" – 03°09'24"S, long 101°39'18"

– 101°44'50" E) and surrounding forested and developed areas that are 50-200 m above sea level. Annual rainfall typically exceeds 3000 mm, with somewhat less precipitation during a short dry season (June-September). The perennial Seblat River forms the northern boundary of the SECC, providing a reliable water supply for elephants. The SECC comprise 6865 ha of which 70% was in forest cover in 2007. These forests are regenerating following selective logging operations in the late 1980s. In addition to 23 elephants captured as part of the government's human-elephant conflict mitigation program and housed at the SECC, 40-60 wild elephants are believed to occur on the SECC. With extensive agriculture and human settlements surrounding much of the SECC, there is much human-elephant conflict in the area.

Fourteen tame elephants (2 males and 12 females) at the SECC were used for the study between April 2007 and August 2008. Although attended by a mahout throughout each observation period, the tame elephants were permitted to forage freely, consuming a natural diet. Using the lead animal technique (i.e., tame animals followed closely by the researcher, allowing accurate identification of the foods consumed; Litvaitis 2000) individual elephants or sometimes 2-3 elephants, were observed between 7:00 to 17:00 h.

The activity of each elephant was recorded at 5-min intervals (Altman 1974); feeding activity was considered all behaviours directly involved with gathering, manipulating, chewing and swallowing food items; moving was recorded only when elephants travelled from one place to another, but excluded movements while feeding; resting was recorded when elephants were standing or lying down and there was no feeding activity; and drinking was recorded when elephants drank water from streams or ponds. Samples of all food plants eaten by elephants during the study were collected and identified to species/family based upon comparisons with specimens in the herbarium collection in Bogor (Indonesia Institute of Sciences).

The daily activities of individual elephants were averaged providing an activity budget for each elephant observed, and pooled by sex. A one-way ANOVA (Sokal & Rohlf 1995) was used to test for differences in activity budgets between individual elephants. We used post hoc TUKEY-HSD statistical tests to identify differences between time-activity budgets of individual elephants.

Proportion of time spent browsing and grazing was based upon the plants utilized. Grazing occurred when elephants consumed grass and small herbaceous plants on the ground. Browsing occurred when elephants consumed foliage from shrubs, young trees, tree bark, and bamboo. We used a Pearson's statistical regressions analysis (Sokal & Rohlf 1995) to examine relationships between season and grazing/browsing feeding behaviours. All statistical tests were conducted using SPSS statistical software version 17.0 (SPSS. Inc).

Results

Activity budget

In total, 4496 hours of observation were made on the daily activities of 14 elephants. Most of their daily activity was feeding (82.2 ± 5.0%), followed by moving (9.5 ± 4.0 %), resting (6.6 ± 2.1%) and drinking (1.7 ± 0.6%). Individual activity budgets varied among individuals for all activities (feeding [$F = 23.55$, $df = 13$, $P<0.001$], moving [$F = 18.62$, $df = 13$, $P<0.001$], resting [$F = 21.38$, $df = 13$, $P<0.001$] and drinking [$F = 8.23$, $df = 13$, $P<0.001$]). Post hoc Tukey-HSD analyses indicated that the activity budget of each individual elephant differed from at least one other elephant (Sitompul 2010). Male elephants tended to spend more time feeding and drinking, but less time moving, compared to female elephants (Table 1).

Diet

At least 273 plant species belonging to 69 plant families were eaten by elephants (Fig. 1). The most common plant taxa consumed were in the Moraceae family (mulberry family-32 species), followed by Arecaeae (palm family-26 species), Fabaceae (legume family-25 species), *Poaceae*

Table 1. Mean (SD) percent diurnal activity exhibited by 2 male and 12 female elephants at SECC, April 2007 to August 2008.

Activity	All	Males	Females	Statistics
Feeding	82.2 (5.0)	86.8 (4.7)	81.6 (7.7)	$F = 48.80$, df = 1, $P<0.001$
Moving	9.5 (4.0)	4.7 (4.4)	10.2 (6.5)	$F = 77.13$, df = 1, $P<0.001$
Drinking	1.7 (0.6)	2.0 (1.3)	1.7 (1.3)	$F = 4.93$, df = 1, $P<0.05$
Resting	6.6 (2.1)	6.5 (2.1)	6.5 (3.6)	$F = 0.02$, df = 1, $P=0.892$

(grass family-21 species) and Euphorbiaceae (spurge family-11 species).

Elephants consumed mostly twigs, young leaves and sometimes bark (Fig. 2) from the Moraceae, Fabaceae, and Euphorbiaceae taxa. Fruit, primarily figs (Moraceae: *Ficus* sp.), was rarely consumed (Fig. 3). The leaves and, petioles of palms including spines, were eaten. Typically, entire grass clumps were consumed. Bamboo species (*Schizostachyum* sp. and *Gigantochloa* sp.) were commonly eaten, comprising 19% of the total diet, and 33% of the elephant browse diet (Fig. 4).

Foraging ecology

Elephants tended to browse (56.3%) more than graze (43.1%). Bamboo, shrubs, young trees, rattan (Fig. 5) and liana were typically browsed, whereas grass species, mainly in the Poaceae family, dominated the grazed plant taxa. Elephants tended to browse more during the wet months ($F = 6.35$, df = 13, $P<0.05$) versus the dry months when they tended to graze ($F = 6.62$, df = 13, $P<0.05$). Further, browsing increased with increasing rainfall ($r_s = 0.58$, df = 13, $P<0.05$).

Discussion

During daytime foraging, the captive elephants were active >90% of the time. This contrasts with wild elephants, which apparently are more active at night than during the day (e.g., Grassman *et al*. 2006). Feeding was the dominant (82%) elephant diurnal activity for Seblat elephants, similar to that reported for African savannah elephants (*Loxodonta africana*; 70%-75% feeding; Lindsay

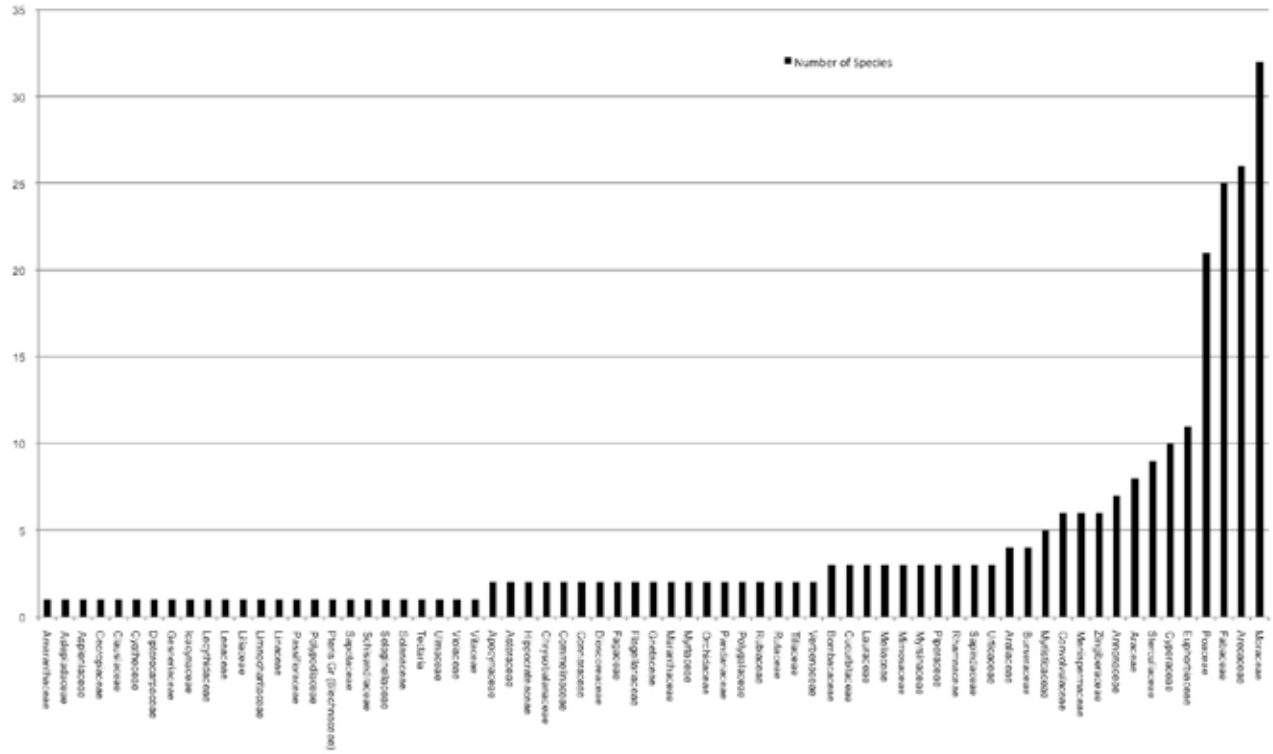


Figure 1. Numbers of plant species by taxonomic family consumed by 14 elephants at SECC, April 2007 to August 2008.

1994), and other Asian elephants (up to 91.1%; McKay 1973). The higher feeding time by male elephants probably was consequent to their larger size (~10%) and concomitant higher basal metabolic rate (Kleiber 1947). In Kenya, Lindsay (1994) also reported that the basal metabolic rate of adult male elephants could reach 1.5 times higher than for adult females.

The five plant taxa families (Moraceae, Arecaceae, Fabaceae, Poaceae and Euphorbiaceae) most frequently eaten by Seblat elephants were also reported as important in diets of elephants in Asia and Africa (Buss 1961; MacKay 1973; Guy 1976; Olivier 1978; Short 1981; Sukumar 1989; Chen *et al*. 2006; Campos-Arceiz *et al*. 2008). Elephant diet may be influenced by plant abundance, availability and palatability, but curiously, the same five plant families most frequently consumed by elephants are also important in the diets of other animals such as orangutans (Russon *et al*. 2009), hornbills (Kinnaird *et al*. 1996) and many ungulates (Schaller 1998; Baskin & Danell 2003).

The tendency of elephants to browse more than graze is probably related to the high availability and nutritional value of browse plants in Seblat. Lowland rainforest dominates Seblat and grassland habitat only occurs in small patches within the forest. Additionally, feeding behaviours of other large herbivores maximize their nutritive value while reducing the ingestion of secondary chemical compounds (Bryant & Kuropat 1980). This condition may occur for Seblat elephants where bamboo, with its low



Figure 2. Adult male feeding on tree's bark.



Figure 3. Adult female elephant feeding on figs fruit in the forest floor.

tannin levels (Easa 1989; Shuguang *et al*. 2009), is important in elephant diets.

In contrast to India and Africa where elephants tend to switch their foraging strategy from mostly browsing during dry seasons to grazing during the wet seasons (Barnes 1982; Sukumar 1989; Lindsay 1994), Seblat elephants tended to browse more during the wet season even though grass was seemingly more abundant in the dry season. The pattern in Seblat may be related to higher protein content and fatty acids reported in browse versus grass species during the wet season (Dougall & Scheldrick 1964; Field 1971).

Elephants at the SECC compensate for night-time confinement by increasing activity during the day, appear to have normal dietary intake, and thus seem well-adapted to captive management. Although selectively logged 20 years ago, the SECC and the surrounding forested areas appear to provide adequate nutritional quality for supporting elephant reproduction and growth. Thus, secondary forests of similar age should be considered suitable habitat in conservation planning for Sumatran elephants, and habitat management in other disturbed elephant habitats should focus on restoring/providing plants important in elephant diet.

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Figure 4. Adult female feeding on bamboo.

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Figure 5. Adult female feeding on rattan.

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Research Article *Gajah 38 (2013) 25-29*

A Comparison of Stereotypic Behaviour in Asian Elephants at Three Different Institutions in Sri Lanka

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Abstract. We assessed the level of stereotypic behaviour of captive elephants in three institutions in Sri Lanka. At each institution four animals were studied using focal animal sampling. The results showed that elephants at the National Zoological Gardens had significantly higher stereotypic behaviour than elephants at the other two institutions. The reason for this could be a higher level of stress consequent to the captive conditions at the National Zoological Gardens.

Introduction

Captive elephants have been kept in Sri Lanka since the time of its first king Vijaya in 483 BC, for reasons such as warfare, exhibition and religious ceremonies (Geiger 1950; Canon & Davis 1995). Currently captive elephants are maintained in different facilities using different management systems. Conditions under which a captive animal is held have a direct influence on the extent of stereotypic behaviour (Schmid 1995; Elzanowsky & Sergiel 2006), which presumably also reflects their stress levels.

Factors increasing behaviours indicative of stress in captive animals include, high noise levels (Morgan & Tromborg 2007), high light intensity (Pollard & Littlejohn 1994), presence of odour of predators (Morgan & Tromborg 2007) confinement (Elzanowsky & Sergiel 2006), poor welfare conditions (Clubb & Mason 2002), barren enclosures (Elzanowsky & Sergiel 2006) and being chained for over 20 hours a day (Kurt & Garai 2001).

Stress levels experienced by captive animals can be assessed using behaviour, physiological parameters and the levels of stress hormones such as cortisol. In this paper we assess whether captive conditions at different institutions may influence the amount of stereotypic behaviour in elephants.

Methodology

Three institutions holding captive elephants were chosen for the study. At the National Zoological Gardens (NZG) elephants are tethered by one fore foot and one hind foot for more than 18 hours a day and housed in an enclosure with a concrete floor. The animals are taken for a bath once a day to an artificial pond located about 80 m away from the enclosure and again once a day to an arena about 100 m away for the 'elephant show'. At the Pinnawala Elephant Orphanage (PEO) animals are allowed to walk about in the lawn for two hours in the morning and taken for baths twice daily to a nearby river approximately one kilometre away. There the animals are allowed to engage in social behaviour. Tethering is under coconut trees with soil and grass substrate and one hind foot is used to tether the animal. At the Millennium Elephant Foundation (MEF) animals are used for tourist rides within the premises from 8:00 h to 16:00 h daily. The number of rides per day varies depending on visitor arrivals. When tethered, it is done using one hind foot and the substrate is grass and soil under trees.

The study was conducted from May to August 2012. Four adult animals from each institution were used for the study (four females from NZG, four males from PEO, one male and three females from MEF). First, the animals of all three sites were observed for a period of one week and a

behaviour checklist prepared. This checklist was updated as the study progressed, if and when the animals showed a novel behaviour.

Focal animal sampling was used with a voice recorder to record events. Each animal in turn was sampled for 15 minutes at a stretch. Each sampling day, 3-4 h of sampling was done. Each site was sampled for 6 days giving a total of 22-25 h per site. The percentage time for each group per behaviour sub-category was calculated by using the formula:

$$\frac{\text{total time for behaviour sub-category}}{\text{total time of observation of the group}} \times 100$$

Minitab version 15 was used for the statistical analysis. The behaviour data were converted into square root values and a one-way ANOVA conducted. A post-hoc Tukey's test was performed to identify the groups responsible for significant differences.

All behaviours observed during the study were categorized into two main categories, 'non-stereotypic' and 'stereotypic (Table 1).

Results

The percentage time spent by study elephants showing each behaviour type in each of the three study sites is shown in Table 2.

Table 1. Non-stereotypic and stereotypic behaviours observed.

Type	Name	Behaviour description
Feeding	Feeding	Depositing food item in mouth, chewing and swallowing
	Foraging	Searching and picking up food item using trunk
Comfort	Leaning	Leaning entire or part of body on another elephant or object
	Rubbing	Rubbing body or trunk on an object
	Trunk Resting	Placing trunk on an object or another elephant's body or holding trunk in mouth
	Dust bathing	Collecting dust and spraying over body
	Water spraying	Collecting water in trunk and spraying on body
	Ear flapping	Flapping of ears
	Scratching	Scratching self with either trunk or legs
	Fly swatting	Swatting flies with object such as twig
	Chain pulling	Pulling on the chain by either trunk or leg
	Urinating	Urinating
	Defecating	Defecating
Intra specific	Touching	Touching another elephant with tip of trunk
	Trunk sucking	Placing trunk in another elephant's mouth and vice versa
	Pushing	Pushing another elephant using the trunk
Standing	Standing still	Showing no movements, simply standing still
Walking	Walking	Moving from one point to another using feet
Recumbency	Lying down	Lying flat on either side of body
	Squatting	Moving into a seated position
Stereotypic	Weaving	Moving body from side to side or back and forth
	Head bobbing	Moving head in a vertical axis
	Trunk swirling	Moving trunk in a circular axis
	Number 8	Head bobbing and weaving shown together

Table 2. Percentage values for each behaviour type for the three study groups.

Behaviour type	NZG	PEO	MEF
Stereotypic	11.53	0.93	4.45
Comfort	8.17	5.24	3.89
Feeding	9.85	9.38	14.94
Intra specific	1.24	4.19	< 1
Standing	60.58	57.81	41.64
Walking	< 1	10.58	34.78
Recumbency	8.63	11.86	< 1

A significant difference was shown (one-way ANOVA, $F=16.78$, $P<0.05$) for the stereotypic sub category. A post-hoc Tukey's test revelaed that the NZG group showed significantly high stereotypic behaviours compared to the other two groups ($P<0.05$). Intra specific behaviour was shown to be significantly different between the three groups (one-way ANOVA, $F=4.38$, $P<0.05$) and the post-hoc Tukey's test revealed that the PEO group showed significantly high amounts of this behaviour sub category than NZG and MEF groups ($P< 0.05$). The behaviour type recumbency was again shown to be significantly different (one-way ANOVA, $F=145.33$, $P<0.05$) with the MEF group showing the least amount (post-hoc Tukey's, $P<0.05$). Walking behaviour again was shown to be significantly different between the three groups (one-way ANOVA, $F=176.60$, $P<0.05$). The post-hoc Tukey's test revelaed that all three groups were significantly different from each other in this regard ($P< 0.05$).

Comfort behaviour was shown not to have a significant difference (one-way ANOVA, $F=2.53$, $P>0.05$) between any of the groups. This was also the case for feeding behaviour (one-way ANOVA, $F=2.00$, $P>0.05$) as well as standing behaviour (one-way ANOVA, $F=2.36$, $P>0.05$).

Discussion

The significantly high amount of intra specific behaviours displayed by the PEO animals (Figs. 1&2) can be attributed to their management conditions that allow for a diverse array of such behaviours with multiple animals. The significantly low amount of recumbency (Fig. 3) shown by the MEF group is due to the fact that the animals aren't made to assume a recumbent position during the brief visits to the waterway during the rides. The PEO and NZG animals spend more time in the water and are instructed to assume a recumbent position for the convenience of the mahouts.

The results show that the animals of the NZG are significantly more stressed than the animals of PEO or MEF in terms of streotypic behaviours expressed. The NZG animals being tethered by one fore foot and one hind foot for more than 18 hours of the day would have contributed to the significantly high level of stereotypic behaviours displayed by them. Further the NZG animals show significantly lower walking frequency compared to the other two institutions as they are prevented form this behaviour, which may also have contributed to a high level of stereotypic behaviour. It has been clearly shown in previous studies that there is a high positive correlation between chaining elephants and the level of stereotypic behaviours shown by them compared to animals that are kept in an enclosed area allowing at least a small degree of free movement (Schmid 1995; Gruber *et al*. 2000). Further, elephants have large home ranges (Sukumar 2003; Fernando *et al*. 2008) and a highly mobile lifestyle in the wild. Therefore, the almost complete lack or absence of 'Walking' in the NZG elephants could indeed be a large stress factor, which could lead to the significantly higher amount of stereotypic behaviours.

Another reason could be that the NZG elephants are tethered in a barren enclosure with a concrete



Figure 1. PEO elephants showing 'trunk sucking' behaviour at the bath..

floor compared to the other two institutions where elephants spend most of the day on a natural substrate. A positive correlation between barren enclosures and stereotypic behaviours has been shown for elephants by Elzanowski and Sergiel (2006). The natural surroundings where the PEO and MEF elephants are tethered in (Fig. 4), allows for natural behaviours such as pulling on the vegetation with the trunk and digging with the foot, the barren enclosure where the NZG elephants are tethered in does not allow for these. In addition to the stress, the relatively smooth and hard floor on which the NZG elephants spend most of their time could have adverse effects on the condition of their soles. Weissengruber *et al*. (2006a) have reported that the heel pad of the elephant is highly sensitive. Further, Schmidt (2002) has demonstrated that heel pads of elephants wear unevenly through long term standing on smooth surfaces such as concrete, leading to diseases such as 'foot-rot' (Weissengruber *et al*. 2006b). Therefore, the current conditions of the holding area of NZG elephants could be a large contributory factor to stress. Even though the regular veterinary care administered would keep such diseases from manifesting, the continuous stress on the animals due to the discomfort cannot be neglected as a 'stressor'.

The percentage of observed stereotypic behaviour in the NZG (where it is highest) is much less than the 45% observed by Gruber *et al*. (2000) in chained circus elephants. It is also less than the 40-55% observed by Schmid (1995)



Figure 2. PEO elephants showing 'intra spcific' behaviour.



Figure 3. NZG elephants showing 'lying down' behaviour at the bath.

for shackled elephants. Therefore, the amount of stereotypes shown by the animals of the NZG has not manifested into a serious welfare issue yet.

When reviewing the results of this study there are quite apparent trends and correlations. The animals that had the least opportunity to walk and were chained most of the time showed the greatest amount of stereotypic behaviour. Therefore, these aspects should be incorporated in devising better management practices for elephants especially at the NZG. Making the animals walk within the zoo premises daily before the opening of the zoo and after the closing of the zoo and even during zoo hours with human interactions would be a positive stimulus. Such activity could lessen the stress and boredom due to living a sedentary life. This method would also be cost effective, as it does not require any equipment or other costly measures. Enrichment is another approach for relieving captivity-induced stress. Giving the animals an opportunity to interact with new objects could help their mental stimulation. Also adding a rubbing post for them to scratch their backs could be another method of enriching the holding pens (Clubb & Mason 2002). The flooring of enclosures, even though prone to be neglected, plays an important role in the management of animals. The NZG animals are housed in a concrete/smooth floor whereas both the PEO and MEF elephants are tethered in a more natural environment. Changing of the floor by using rubber matting (Clubb & Mason 2002), could improve the living conditions of the animals at the NZG. With regard to feeding, if a feeding apparatus can be used instead of presenting the



Figure 4. MEF elephant feeding tethered on a soil substrate.

entire ration of food to the animal at one go, it could increase the amount of mental stimulation the animal receives. Incorporating these recommendations into management of captive elephants generally and at the NZG specifically can positively influence their wellbeing.

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Disproportionate Dwarfism in a Wild Asian Elephant

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Introduction

Dwarfism is unusual in wild animals. Individuals with disproportionate dwarfism are especially unlikely to survive in the wild as shorter limbs would impose severe fitness costs in predators or prey. As social mega-herbivores without predators, Asian elephants are one of the very few species in whom a dwarf phenotype may not be lethal. Here we report the first record of a free ranging adult wild animal - an Asian elephant (*Elephas maximus*), with disproportionate dwarfism (Fig. 1).

Observation of dwarf elephant

On July 7, 2013, at approximately 6:30 am, two elephants were observed 'sparring' on the main road of the Udawalawe National Park in southern Sri Lanka (Fig. 2). While this is not an unusual sight in itself, with around 1000 elephants in the 308 km^2 area of Udawalawe (de Silva *et al*. 2011), one of the protagonists was a mature male of just over five feet (1.5 m) in height. It had a normal sized upper body, with well developed male secondary sexual characteristics such as a large head, broad trunk-base, pronounced nasal bump and prominent temporal protuberances (Varma *et al*. 2012), but had very short, stubby legs. The other elephant was of normal stature. Both displayed temporal gland secretions (Fig. 3), indicative of 'musth' - an annual physiological state in male elephants with heightened aggression and increased ranging behaviour (Fernando *et al*. 2008). The 'dwarf' was by far the main aggressor in the altercation and appeared to be older than the other, a young-adult. Other than for the disproportionately short legs, morphologically and behaviourally the dwarf elephant appeared normal. Absence of previous records and body lumps from gunshot injuries indicative of crop raiding outside the park, suggest that he was not a resident but wandered into the park during musth ranging.

Forms of dwarfism

Two main phenotypic forms of dwarfism occur, proportionate and disproportionate. In proportionate dwarfism 'normal' allometric ratios of the body and limbs are preserved, whereas in disproportionate dwarfism the limbs are comparatively short. Both types of dwarfism are observed in humans. In domestic animals dwarf phenotypes have been selectively bred, creating a number of distinct breeds in dogs, cattle, horses, rabbits and other livestock. Selective breeding for proportionate dwarfism has produced a number of 'miniature' breeds of dogs and cats. Selection for disproportionate dwarfism has produced dog breeds such as the dachshund, basset hound and



Figure 1. Dwarf elephant in Udawalawe National Park, Sri Lanka.

bulldog; cat breeds such as the munchkin; cattle breeds such as the Japanese brown and Dexter; goat breeds such as the Ethiopian dwarf goat and pig breeds such as the Vietnamese pot bellied pig.

Disproportionate dwarfism occurs due to genetic defects involving cartilage and/or bone growth of long bones. Achondroplasia is the commonest cause of disproportionate dwarfism in humans. Inherited as an autosomal dominant disorder it originates from a single point mutation in the transmembrane domain of the Fibroblast Growth Factor receptor 3 (FGFR-3) gene (Shiang & Thompson 1994). The genetic mutation in osteochondrodysplastic dog breeds is not the same as in humans (Martinez *et al*. 2000) and is inherited as a polygenic trait (Minor & Farnum 1988). The Dexter phenotype of disproportionate dwarfism in cattle is shown by heterozygotes of an allele caused by a mutation in the Aggrecan gene that is lethal in homozygotes (Cavanagh *et al*. 2007). Chondroplastic dwarfism in Japanese brown cattle shows autosomal recessive inheritance and is due to a mutation in the Limbin gene (Takeda *et al*. 2002). Given the diversity of genetic mutations and inheritance patterns causing disproportionate dwarfism in different taxa, it is not possible to speculate on the provenance or likely inheritance of the character in elephants.

Dwarf and pygmy elephants

Anecdotal accounts of 'pygmy' or 'dwarf' elephants are common in elephant-lore of many countries (Groves & Grubb 2000; Das 2005; Saparamdu 2006). However such accounts are likely to have originated from cursory observations of juvenile groups. In contrast, Mediterranean dwarf elephants were a classic example of insular dwarfism. Proportionate dwarfism with 1.5-2 m adult height occurred in Mediterranean island elephantids in the Pleistocene (Orlando *et al*. 2007). Insular isolation of *Elephas antiquus* or *Mammuthus* and allopatric speciation is thought to have given rise to these dwarf taxa including *Elephas falconeri* and *Elephas creticus*. The last of these Mediterranean dwarf elephants may have survived till about 10,000 YBP (Orlando *et al*. 2007). Asian elephants in Borneo, isolated since the Pleistocene (Fernando *et al*. 2003) are also called pygmy-elephants. However, they are not significantly smaller than their Sundaic conspecifics (Othman *et al*. 2008). Although the occurrence of an African dwarf elephant (*Elephas pumilio*) has been suggested in the past, such references probably allude to the smaller size of *Loxodonta cyclotis*, in comparison with *L. africana* rather than actual dwarfism (Groves & Grubb 2000).

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Figure 2. Dwarf elephant interacting with 'normal' adult male. Video clips of the encounter can be watched online at <http://www.flickr.com/photos/54907779@N03/sets/72157634655101151>.



Figure 3. Dwarf elephant being in musth, as seen from the temporal gland secretions.

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Human-Elephant Conflict Due to Movement of Elephants between India and Nepal and WWF-India Initiatives to Address It

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Introduction

Asian elephant populations of the northern districts in the Indian state of West Bengal have become an issue of discontent between India and Nepal in recent times. The elephant habitat in the state extending from the Sankosh river in the east, to the Mechi river in the west, houses a great assemblage of biological resources in the protected and reserve forests lying very close to the Himalayan foothills. These forests and adjoining territory in Eastern Nepal, Sikkim, Western Bhutan, and Assam also display rich biological components including some flagship species, and provide trans-boundary corridors for gene flow enhancing the global significance of this tract for conservation. However the human population and its growing demands for land and biological resources affect this landscape to a great extent. Fragmentation of habitat, taking a heavy toll of grasslands in this region occurs primarily through infrastructure development, tea cultivation, large-scale construction of embankments and unregulated expansion of human settlements.

The escalation of human-elephant conflict due to seasonal movement of elephant herds from West Bengal to Nepal has generated mistrust among the locals, and such mistrust has caused casualties and injuries to elephant populations in the trans-boundary zone (Fig. 1). To ensure the current level of discontent and mistrust was brought down substantially over a period of time, a properly designed action plan and its implementation was needed.

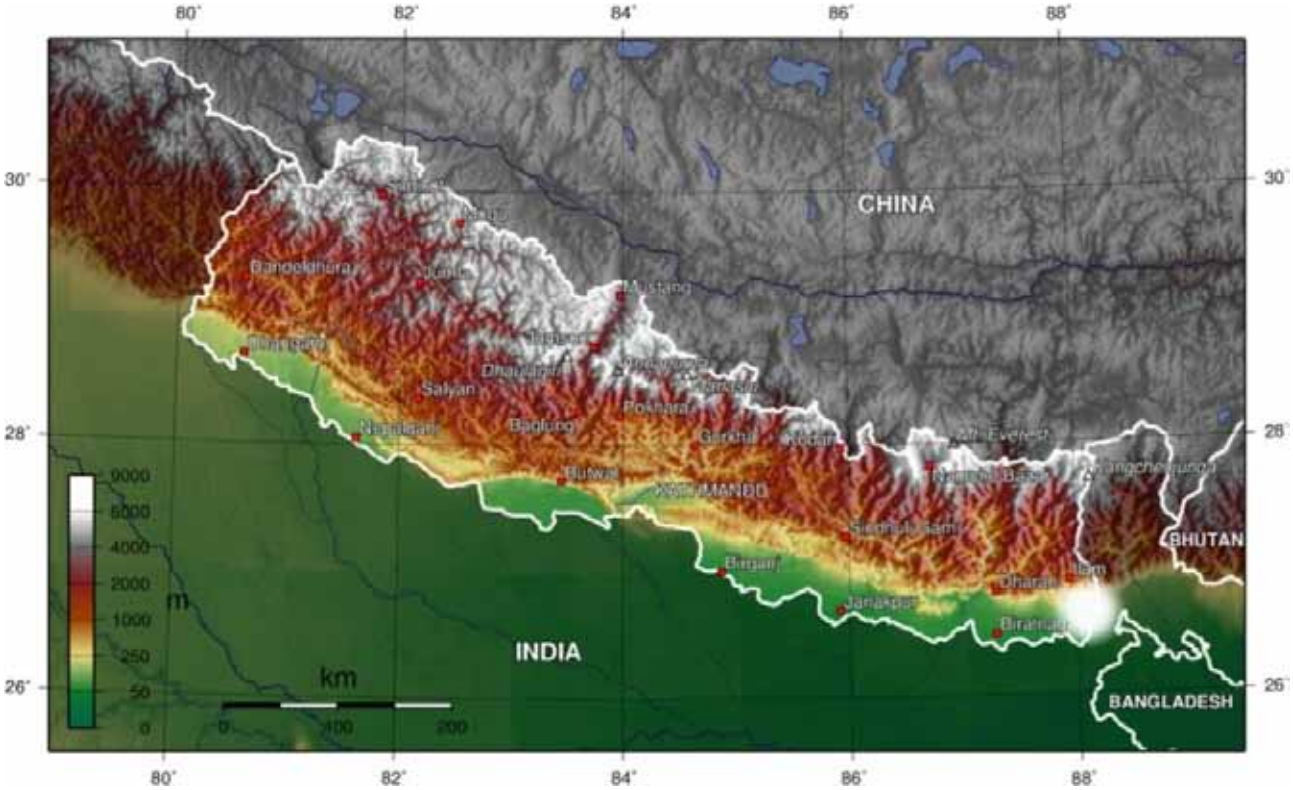


Figure 1. Indo-Nepal trans-boundary region (white spot in lower right corner).



Figure 2. Elephants crossing the Mechi river in the evening (photo credit: Koushik).

Pattern of elephant migration

A part of the elephant population of Northern West Bengal moves into Nepal crossing the River Mechi (Fig. 2). This movement of elephants is restricted to the two well-defined crop harvesting periods of paddy and maize in Nov-Dec and Jun-Jul respectively from India to Nepal.

In India, four ranges of Kurseong Division viz. Bamanpokhri, Tukriajhar, Bagdogra and Panighata, are the major conflict areas. Most of the paddy fields are located in the two forest ranges, Bamanpokhri and Tukriajhar. Big herds also migrate into Nepal, during the crop harvesting seasons through the Panighata (Kurseong Division) corridor via Mahananda-Lamagumpha-Bamanpokhri (Fig. 3).



Figure 3. Pattern of elephant movement in Terai, West Bengal (India) and points of entry to Nepal.

It has been reported by Baidya (2010) that the districts of Jhapa, Morang, and Sunsari (Fig. 4) used to be a contiguous forest area and a free movement route for wild elephants before eradication of malaria in the 1960s and destruction of forests in the eastern Terai of Nepal. The results from radio-collaring of elephants in North Bengal during 2005-2006 have indicated that parts of Jhapa district were included in the home range of certain elephant herds. Hence this landscape is an integrated habitat for elephants in spite of the existence of a political boundary between the two countries of India and Nepal.

Current status of the elephant population

Northern West Bengal in India holds nearly 300-350 resident and 150 migratory elephants (census in 2005). The exact population recorded from Northern West Bengal was 292 in 2002 (Government of West Bengal 2009). However, recent updates from the latest census (2010) by the Forest Department, Government of West Bengal show the presence of nearly 500-550 elephants in this region.

Seasonally migrating elephants that move from West Bengal, India to Jhapa in Eastern Nepal figure around 50-70 individuals, and a resident herd of 10-13 individuals (Government of Nepal 2007) has been reported in Eastern Nepal.

The elephant population in the Terai region (Kurseong Division, Mahananda WLS and Baikunthapur Div together) has experienced a steady increase from 46 (2000) to 164 (2010) as



Figure 4. Terai districts in Eastern Nepal.

recorded by the Forest Department, Government of West Bengal.

This steady rise in the size of the migrating elephant population over the last decade can be attributed to the expansion of paddy and maize cultivation in the Terai of eastern Nepal during the same period.

Present status of conflict

Conflict in the trans-boundary region dates back to the 1980's, but over the years this has worsened with the expansion of crop fields in close proximity to forests. Kurseong Division in West Bengal records a high number of human deaths due to human-elephant conflict (Table 1).

In Nepal, the Jhapa district recorded the maximum intensity of conflict. Unconfirmed reports indicate 5-8 human casualties and 3-4 elephant deaths every year in Eastern Nepal. However 20 people have been reported killed in Jhapa during 2003-07 (Table 2, Government of Nepal 2007). There have been reported killing of 24 elephants in the last two decades.

Recent initiatives for mitigation of the conflict by WWF-India

Since 2011 WWF-India has facilitated dialogue and consultation between the two countries to develop an agreement for ensuring conservation of elephants and reducing the intensity of the conflict. Developing an action plan to mitigate human-elephant conflict and conservation of elephants in this region has also been a part of this initiative.

Table 1. Recorded damage, human casualties and injuries in trans-boundary region (Source: Kurseong Division and Wildlife Div I, Forest Dept., Govt. of West Bengal).

Year	# killed	# injured	# huts damaged
2002-03	20	13	718
2003-04	9	2	-
2004-05	11	29	273
2005-06	15	23	252
2006-07	12	15	337
2007-08	10	9	515
2008-09	1	7	803
2009-10	15	21	249
2010-11	12	8	787
2011-12	12	1	587
Total	117	128	4521

Accordingly, a series of community meetings and seminars involving administrative authorities and other stakeholders were held. Consultations and joint meetings were organized in Nepal and India for identification of key issues. There have been four group level meetings, two workshops and a cross border visit. Official representatives from Nepal and India attended the final workshop held at Siliguri in February 2013 to formulate a draft action plan through identification of the gap areas in controlling HEC and formulating a conservation strategy for the next 10 years. The draft plan includes following suggestions based on feedback from the series of consultations between the two countries.

- Development of a joint protocol by India and Nepal

Table 2. Loss of life and properties in Jhapa district, Nepal during the last 3 years (Source: DFO Office, Jhapa, Nepal, 2012).

Records	2009-10	2010-11	2011-12
Elephant deaths	1	0	2
Human deaths	0	3	9
Human injuries	2	6	12
Domestic animals killed	1	0	2
Loss of property (mio NR)	1.1	2.1	4.0
Effected households	31	44	135

- Formation of voluntary elephant driving squads in Jhapa, Nepal
- Compensatory benefits for loss of human life and properties in Nepal
- Awareness generation in both the countries
- Habitat analysis and vegetation survey along with habitat improvement in West Bengal.
- Improvement of basic road infrastructure in affected areas of Jhapa district, Nepal
- Raising physical barriers like solar energized fences in Nepal
- Capture and training of Kunkee elephant in Nepal
- Radio-telemetric study on the selected individuals from the elephant herd
- Feasibility survey of corridor connectivity between India and Nepal

A copy of the draft action plan was circulated to all stakeholders. A review meeting involving representatives of both Governments was held to decide on the final version of the action plan to facilitate the process of development of a bilateral agreement between the two participating countries.

Developing public awareness and building trust are key requirements in minimizing human-elephant conflict in the short term. To achieve this display boards at prominent locations are being set up to convey conservation messages in local languages. A new section was developed in the WWF-India website to emphasize the critical conservation issues in Northern West Bengal with special emphasis on WWF's intervention and role in such cases. This includes updates on project activities in the trans-boundary region of Eastern Nepal-West Bengal. Awareness campaigns were organized for local NGOs, schools, Village Development Committees, and defence personnel to develop the capacity of local stakeholders. All these efforts are directed to generate a favourable climate for two-way communication between the stakeholders and forest / wildlife management authorities of both the neighbouring countries.



Elephants in West Bengal close to Indo-Nepal boundary (photo credit: Koushik).

Acknowledgements

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Patrolling and Law Enforcement for Elephant Management in Nam Pouy National Protected Area, Xayabouly Province, Lao PDR

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The Nam Pouy National Protected Area (NPNPA) has been identified as the second most important area in Laos for Asian Elephants (Khounboline 2011). Covering 1912 km^2 in Xayabouly Province NPNPA consists of a large complex of evergreen forest and bamboo. Large intact forest areas are becoming increasingly rare throughout Southeast Asia and are under constant pressure from agricultural and human encroachment as well as illegal hunting, in particular to support wildlife trade markets in Vietnam and China.

NPNPA has a contiguous, largely undisturbed forest cover (93%), mainly represented by mixed deciduous (88%) and dry evergreen forest (5%). Additional forest types (1%) include tropical montane evergreen and lowland semi-evergreen forest (Salter *et al*. 1991; Berkmüller *et al*. 1995). However, only 40% of the habitat comprises dense and mature forest. The landform is steep and rugged, with more than 90% lying above 500 m. The drainage is generally eastwards, into the Mekong river.

There are five established settlements within the NPNPA. Ban Na Sampan, Ban Na Nguen, Ban Na Ven, and Ban Pak Xong are located in the northern part of the NPNPA, along the Nam Phui river; and Ban Mai lies in the central region, just inside the eastern boundary. The majority of the villagers in the northern settlements comprise the Lao Theung and Lao Soung ethnic groups, while the community at Ban Mai is Lao Lum. All these villagers practice paddy and shifting cultivation, and gather a wide range of forest products. Besides villages, there are several military camps and outposts scattered throughout the NPNPA. Also, there is a nomadic group of primarily gatherers, known as 'Tong Leurng' (Yellow Banana Leaf People), present within the central part of the area. Nothing much is known about this group of 'forest' people. They have occasional contact with settled villages outside the NPNPA, which they visit periodically to trade forest produce such as bees' honey and edible shoots with clothes, salt, rice, etc. In the extreme southwest, a new district of 16 Lao Lum villages, Muang Thong, forms an enclave within the NPNPA.

In 2008 WWF Lao and the Provincial Agriculture and Forestry Office supported a Protected Area Management Workshop for managers and forestry staff working in the NPNPA. The focus of the meeting was to discuss the elephant management issues and steps required to address them. The primary threats identified were illegal elephant poaching, hunting and forestry activities, which have resulted in large declines in wildlife populations in the area. The workshop outcomes included an agreement by the Provincial Agriculture and Forestry Office and the protected area managers to improve coordination between all relevant government authorities in the area and that specific support was needed for increasing patrolling efforts in and around the national protected area.

The project started in February 2011 with the goal of improving protected area management in the NPNPA to maintain connectivity to support elephant populations. The objectives of the project were to increase patrolling (Fig. 1) and law enforcement capacity, assist military and local villagers to improve their management practices and to ensure that NPNPA staff and villagers are equipped to address issues of human elephant conflict and poaching. Staff were trained on patrol techniques, data collection, map reading, GPS techniques, compass reading. Some basic

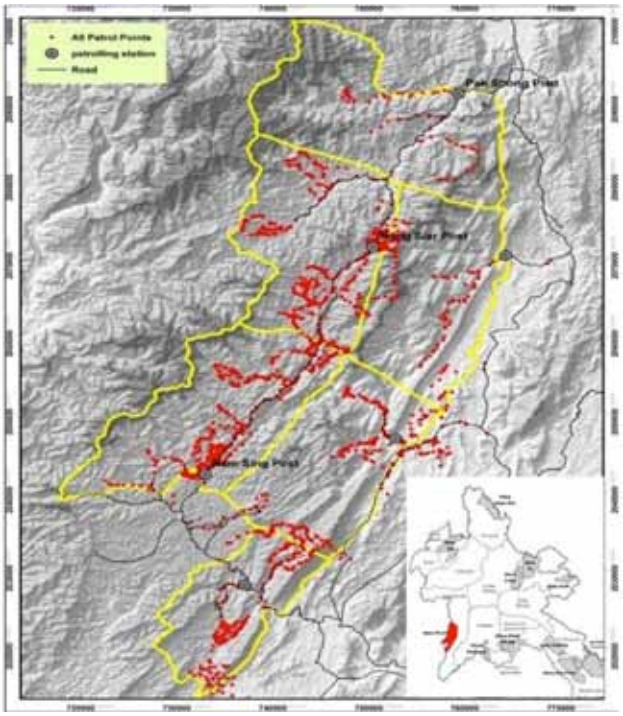


Figure 1. Map showing the patrolling trails in NPNPA.

infra structure, was added, including a patrolling post within the area, internet for the field office, and equipment for conservation outreach.

Illegal activities occurred throughout the year with some seasonal variation in particular activities (Fig. 2). During the dry season (January to March) food resources are low, and villagers undertake annual burning to increase the ease of hunting and plant collecting. The rainy season starts after June, when new vegetation start to grow, providing animals with sufficient food. Animals are usually found in open areas or grasslands during this time and breeding begins. Tree cutting increased in the latter half of the year (Fig. 2) and cut trees were transported in January to March. Most villagers said that they cut trees in the forest near rice fields rather than in far away forested areas because of difficulty of access.

The commonest methods used for hunting arboreal animals and medium to large terrestrial wildlife are crossbows and guns, followed by snares. Results of confiscated material and reports by rangers indicated that the animals hunted with guns were primarily small arboreal mammals and birds, and a few terrestrial mammals larger than 2 kg in size such as muntjac and pig. Those most commonly collected with snares were primarily terrestrial mammals and birds. Smaller animals such as turtles, frogs, pangolin, bamboo rats, and lizards are mostly hand collected.

Villagers reported that wildlife hunting is more difficult now compared to the past 20 years. They also said that all natural resources had reduced, due to increased rates of collection. For example, in the past they collected 1 kg of fish in an hour or two, but today they have to spend one day to collect the same amount.

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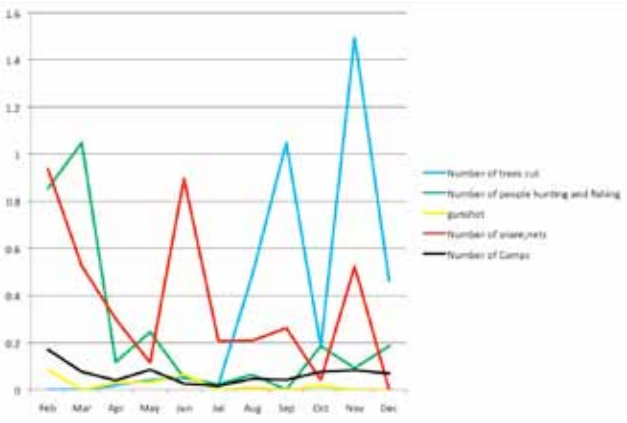


Figure 2. Number of illegal activities detected per km patrolled (February to December 2011).

Death of Elephants Due to Railway Accidents in Odisha, India

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Introduction

India holds the largest population of wild Asian elephants (*Elephas maximus*) with nearly 27,000–29,000 animals (Ministry of Environment and Forest, 2010). In India, a number of endangered wild animals including elephants, tigers (*Panthera tigris*), leopards (*Panthera pardus*), rhinoceros (*Rhinoceros unicornis*) and gaur (*Bos gaurus*) are killed annually by train hits. Since 1987, the country has lost 150 elephants due to train hits. These include 36% cases recorded from Assam, 26% in West Bengal, 14% in Uttarakhand, 10% in Jharkhand, 6% in Tamil Nadu, 3% in Uttar Pradesh, 3% in Kerala and 2% in Odisha (Roy *et al*. 2009; Rangarajan *et al*. 2010). The present paper deals with recorded cases of elephant deaths in Odisha during the period 2000 to 2013.

Methods

The study was conducted across the elephant distribution areas in Odisha. The state is located on the east coast and covers 155,707 km^2 constituting 4.47%of the geographical area of the country. The forest cover of the state is 48,855 km^2 (FSI, 2011). Reserve forests constitute 45.29%, protected forests 26.70% and unclassified forests 28.01% of forests, of which 7,060 km^2 is very dense forest, 21,366 km^2 moderately dense forest and 20,477 km^2 open forest.

Records of the Odisha Forest Dept. from 2000 to 2013, relating to elephant deaths due to train accidents were examined (Fig. 1). Additionally forest and other department staff, and local communities were interviewed to get site-specific local information. Locations of incidents were categorized into four broad groups as close to villages, agricultural areas in the fringe of villages, forest edges, and forest areas.

Results and discussion

During the period from 2000 to 2013, a total of 16 elephant deaths were reported due to train accidents in Odisha (Figs. 2 & 3). Of this, 11 deaths (5 in Keonjhar Forest Division and 6 in Berhampur Forest Division) occurred in 2011. The rising trend of elephant deaths due to train hits in Odisha calls for urgent and immediate intervention by the two concerned agencies; the Railways and Forest Departments.

General advisories to prevent train accidents involving elephants

(Jointly issued by Ministry of Railways & Ministry of Environment and Forests)

1. Clearance of Vegetation on the sides of railway track: Zonal Railways will identify in consultation with Forest Department the vulnerable areas and will arrange need-based cleaning of vegetation on the sides of railway track within railway land.

2. Underpasses/overpasses across the railway track to allow elephants to escape: Ministry of



Figure 1. Elephant deaths due to trains in Odisha.

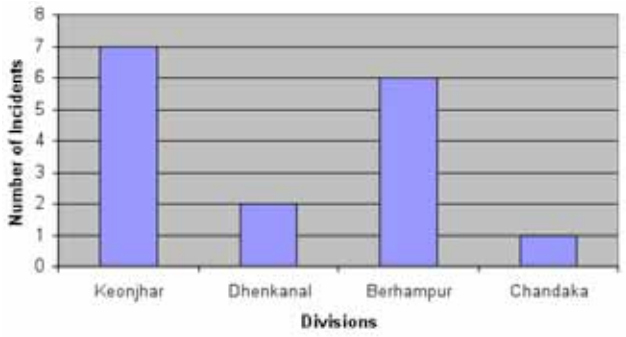


Figure 2. Elephant deaths due to railway accidents in Odisha (2000 to 2013; n=16).

Environment and Forest will provide a list of selected locations for underpasses/overpasses. The cost will be borne by the Ministry of Environment and Forest and the work will be executed by Railways on deposit terms.

3. Signage boards to pre-warn the train drivers: Signage boards will be provided by the railways on both sides of the track in identified locations to pre-warn the drivers.

4. Sensitizing programmes for train drivers/ guards/station masters: Train drivers, guards and station masters will be sensitized on wildlife conservation/protection during periodical refresher courses at nominated Zonal Railway Training Centres. The required training materials will be provided by Ministry of Environment and Forest. Also Ministry of Environment and Forest may depute staff for special lectures on wild life conservation. The Railway Board will furnish the list of such zonal institutes to the Ministry of Environment and Forest.

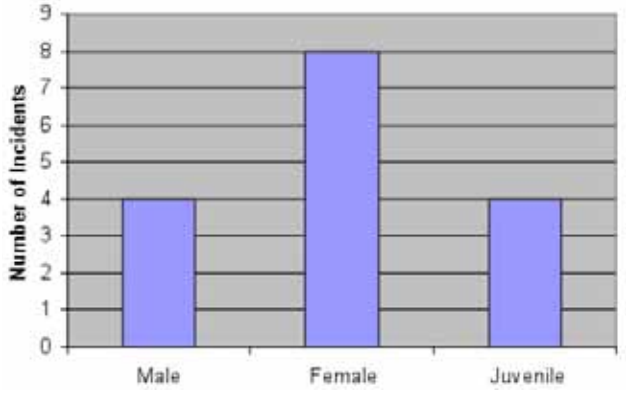


Figure 3. Categories of elephant deaths due to collision with trains in Odisha (2000-2013).

5. Engagement of elephant trackers by Ministry of Environment and Forest and communication with station masters: Ministry of Environment and Forest will engage elephant trackers equipped with mobile phone/walkies to receive/ pass on information regarding presence of elephant herds around track length. A separate wireless communication facility will be provided at stations falling within the vulnerable areas identified by Ministry of Environment and Forest. On receipt of information, station master will give "look out advice" to the train crew verbally or otherwise. The advice will be initially for two hours only unless or otherwise extended. Moreover the length of the section should be within 2 km.

6. Keep railway track free from waste that attracts elephants: Railways will advice Indian Railways Catering and Tourism Corporation (IRCTC)/ pantry car staff not to throw edible wastes in vulnerable areas. Announcement will be made at the stations located near vulnerable locations advising the passengers not to throw food waste.

Odisha State specific and general decisions for immediate implementation to ensure the safety of elephants

- No movement of goods trains between Jakhpura and Banspani passing through Keonjhar district from 5 pm to 5 am as the route is used only for iron ore transport.
- To have continuous hooting in the sensitive zones identified by the State Forest Department.
- To provide locomotives with powerful beams in the sections.
- To clear all vegetative growth in 30 m width on both sides of the track.
- State Forest Department will organize training programmes for locomotives drivers, cabin men etc. to sensitize them.
- State Forest Department and Railways will put in place a proper communication system so that drivers can be informed of the presence of elephant herds to enable trains to slow down.

Case histories

(a) On the night of 8.8.2012 at about 10 pm a goods train carrying coal and moving from Paradeep to Jamsedpur hit a group of elephants between Nayagarh and Jaroli station of Champua Range of Keonjhar Forest Division. Two elephants died on the spot and another elephant died on 28.8.2012 inside Gurtuan village forest area. The 4th, a juvenile elephant of shoulder height about 5 feet fell in to a ditch on impact and went into the forest after being rescued. It was observed moving inside the forest close to the main herd but on 27.8.2012, the animal was abandoned by the herd and moved inside the forest alone. Due to injury it could not move properly and was rescued from Gurtan village forest for treatment in captivity (Fig. 5).

(b) On 29.12.2012 at about midnight the Coromandal Superfast Express, which travels from Howrah (West Bengal) to Chennai (Tamilnadu) struck some elephants. Five elephants (3 females, 1 male tusker and 1 calf) along with one un-born foetus died on the spot. When the accident occurred the train was travelling at a speed of about 110 km/h. The impact in this accident was so huge that the railway tracks were damaged and the train was detained there for more than 7 hours. The area where the accident occurred was part of the vulnerable area



Figure 4. Elephant death due to collision with train in Nayagarh-Juridi station under Champua Range of Keonjhar Forest Division.



Figure 5. Juvenile elephant injured in train accident in Keonjhar Forest Division.

previously identified by the Forest Department & Railways and signage placed clearly showing that the area is an 'Elephant Crossing'. In spite of which the accident occurred.

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We are grateful to the Odisha Forest Department, Principal Chief Conservator of Forests (Wildlife) & Chief Wildlife Warden, Odisha. We also thank the Divisional Forest Officer, Berhampur, Dhenkanal, Keonjhar and the field staff for their help and cooperation in the field. The authors would like to express their gratitude to K.K. Panigrahi Assistant Conservator of Forests at Wildlife Organization headquarters for his valuable advice and all those that helped to complete this paper, including the reviewers.

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Assessment of Response of Elephants to Beehives Placed in a Paddy Field

K. Pavithra Shri*, C. Gunasekaran , M. Salahudeen , A. Asaikkutti and A. Agnes Deepa

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Introduction

India, with an estimated elephant population of 26,000 to 30,000 elephants supports over 60% of the global Asian elephant population (Riddle *et al*. 2009). Habitat loss and fragmentation, human elephant conflict, and poaching are the major threats to elephants in India.

The Coimbatore Forest Division covers an area of about 694 km^2 and forms the southern part of the Niligiri Biosphere Reserve. It is divided into six ranges: Sirumugai, Mettupalayam, Karamadai, PN Playam, Boluvampatty and Coimbatore. Human-elephant conflict is a major problem over much of the Coimbatore Forest Division with damage to crops, human deaths and injury (Thirunavukkarasu 2012). Even though preventive measures have been taken by the government and farmers, human-elephant conflict persists. Around 77 humans were killed in Coimbatore Forest Division from 2000 to 2012 of which 17 persons were killed in 2011 (Thirunavukkarasu 2012). There were 4 human deaths and 1 injury in the Aanaikati hill (Coimbatore Forest Range) within five days in January 2013. Crop raiding by elephants is frequent in all the ranges.

Beehive fences have been proposed as a human-elephant conflict measure (King 2010). In this study we assessed the response of elephants to beehives placed in a paddy field.

Methods

The study area, Muttathuvayal farm land falls between 10058' 27.67'' N and 76044' 37.56'' E in the Boluvampatti Forest Range, located in the foothills of Western Ghats about 35 km west of Coimbatore.

The beehives were placed at one corner of a 5 acre paddy field (Fig. 1) which lay in an elephant corridor area. The field has been raided by elephants every year. An electric fence was present at the boundary of the field around 2 km in length.

The beehives were placed at the corners of a 10 m rectangle within the field, 2 m from the electric fence. The beehives were hung under small thatched roofs supported by two poles (Fig. 2). The beehives swung freely at 1.5 m above ground, suspended by wire from the top. The hives were linked to each other with strong, taut, fencing wire.

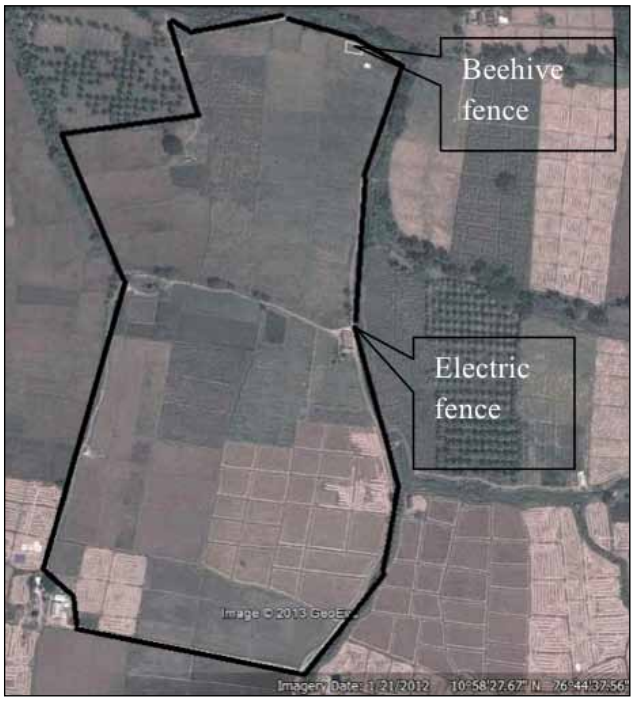


Figure 1. Placement of electric and beehive fence in study area.

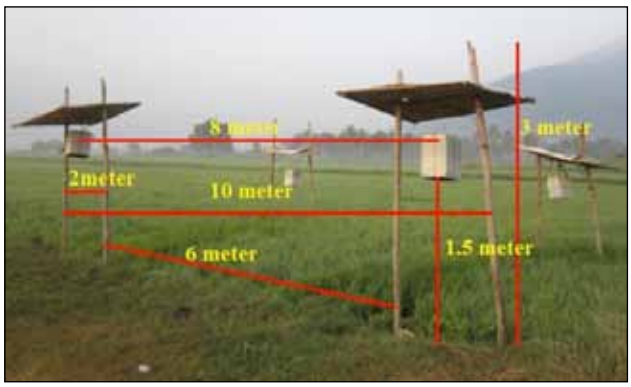


Figure 2. Experimental setup of beehives.

The experimental setup was placed in the field for three months during the crop growing season from November 2012 to January 2013.The field was monitored every day by a farmer who made observations and daily morning visits for the duration of the study period.

Results and discussion

In December 2012, elephants visited the field 4 times during the night. However, no damage was caused to the crops. In January 2013, one night around 10.30 pm, a tusker entered the field damaging the outer electric fence (Fig. 3). It walked through the field but stopped at 2.59 m from the beehives (Fig. 4). It stayed still for around 10 min and moved away from the beehives without damaging anything. The elephant may have recognized that the structure consisted of beehives and avoided it.



Figure 3. Damage of electric fence.

Around 500 ml of honey was harvested from the four hives during the trial period. The results of the study suggest that elephants may avoid beehives and do not damage them. Beehives may also enhance rural livelihoods through honey sales. Therefore, it may be possible to use them as a barrier to prevent crop raiding, assessment of which however, requires a larger scale study.

Acknowledgements

The authors are grateful to the Bharathiar University for help with the study, and Dr. Lucy E. King, Elephants and Bees Project Leader, Save the Elephants Balliol College, Kenya who provided advice. We also thank Mr. Velusamy for providing his farmland to conduct our study.

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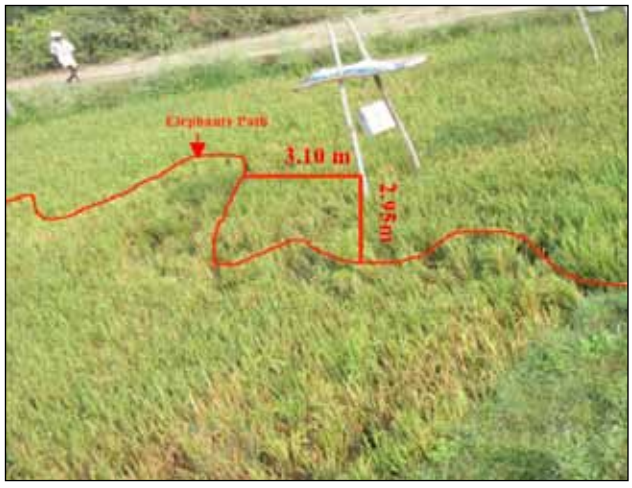


Figure 4. Undamaged beehive.

Recent Publications on Asian Elephants

Compiled by Jennifer Pastorini

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Centre for Conservation and Research, Rajagiriya, Sri Lanka
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If you need additional information on any of the articles, please feel free to contact me. You can also let me know about new (2013) publications on Asian elephants.

F.N. Abbondanza, M.L. Power, M.A. Dickson, J. Brown & O.T. Oftedal

Variation in the composition of milk of Asian elephants (*Elephas maximus*) throughout lactation

Zoo Biology 32 (2013) 291-298

Abstract. We investigated milk nutrient composition from three Asian elephant cows over the first 3 years of lactation, including two consecutive lactations in one cow. Body mass gain is presented for three calves during the first year. Milk samples (n = 74) were analyzed for dry matter (DM), fat, crude protein (CP), sugar, ash, calcium (Ca), phosphorus (P), and potassium (K); gross energy (GE) was calculated. Concentrations of most nutrients changed over lactation: DM, fat, CP, Ca, P, and GE were positively correlated to calf age; sugar was negatively correlated to calf age. GE doubled between birth (1 kcal/g) and 2 years of age (2 kcal/g). After accounting for calf age, GE, fat, Ca, and P concentrations differed among the cows. Milk composition also differed between two lactations from the same cow. When milk nutrients were expressed on a mg per kcal basis, the pattern changes: CP, Ca, and P remained relatively constant over lactation on a per energy basis. Calf mass quadrupled over the first year of life; mass gain was linear at 0.9 kg/day. Asian elephant milk composition is variable, both across lactations and between cows, complicating efforts to determine representative values for comparative studies and for the formulation of elephant milk formulas. The fact that CP, Ca, and P were all relatively constant when expressed on a per energy basis may be of biological significance. The increase in nutrient density over lactation undoubtedly limits maternal water loss, reducing the volume of milk necessary to support the calf. © 2012 Reproduced with permission of John Wiley & Sons, Inc.

E. Albayrak & A.M. Lister

Dental remains of fossil elephants from Turkey

Quaternary Internat. 276-277 (2012) 198-211

Abstract. Turkey is at the crossroads of Africa, Asia and Europe, and occupies an important position for the migration of mammals such as elephantids. Nonetheless, there has been no detailed study of fossil elephants from Turkey. In this study, elephant remains from five localities were examined. *Mammuthus meridionalis*, *Mammuthus trogontherii*, *Elephas maximus* and probably *Palaeoloxodon antiquus* were identified. *M. meridionalis* remains from Yukarısöğütönü have some primitive features compared to typical meridionalis of the Upper Valdarno, which is consistent with the age of the locality. *M. trogontherii* was identified from Suluova and Dursunlu. Most of the mammoth remains from Dursunlu have features of typical trogontherii, but some have 'primitive' features evoking meridionalis. *E. maximus* was identified from Gavur Lake Swamp, but these remains were collected from agricultural areas by local people so there is no information about their exact location. However, new radiocarbon dates indicate that at approximately 3500 BP, the range of Asian elephant extended as far west as south-east Turkey. The *E. maximus* remains are mostly similar to recent Asian elephant in appearance and metrics, but some specimens show unexpected characters that might signal a distinct, now extinct population. Although remains of *E. maximus* include isolated teeth, skulls, mandibles and post-cranial bones, this study focused on only teeth.

L. Atkins, J.-C. Zong, J. Tan, A. Mejia, S.Y. Heaggans, S.A. Nofs, J.J. Stanton, J.P. Flanagan, L. Howard, E. Latimer, M.R. Stevens, D.S. Hoffman, G.S. Hayward & P.D. Ling

Elephant endotheliotropic herpesvirus 5, a newly recognized elephant herpesvirus associated with clinical and subclinical infections in captive Asian elephants (*Elephas maximus*)

Journal of Zoo and Wildlife Medicine 44 (2013) 136-143

Abstract. Elephant endotheliotropic herpesviruses (EEHVs) can cause acute hemorrhagic disease with high mortality rates in Asian elephants (*Elephas maximus*). Recently, a new EEHV type known as EEHV5 has been described, but its prevalence and clinical significance remain unknown. In this report, an outbreak of EEHV5 infection in a herd of captive Asian elephants in a zoo was characterized. In February 2011, a 42-yr-old wild-born female Asian elephant presented with bilaterally swollen temporal glands, oral mucosal hyperemia, vesicles on the tongue, and generalized lethargy. The elephant had a leukopenia and thrombocytopenia. She was treated with flunixin meglumine, famciclovir, and fluids. Clinical signs of illness resolved gradually over 2 wk, and the white blood cell count and platelets rebounded to higher-than-normal values. EEHV5 viremia was detectable starting 1 wk before presentation and peaked at the onset of clinical illness. EEHV5 shedding in trunk secretions peaked after viremia resolved and continued for more than 2 mo. EEHV5 trunk shedding from a female herd mate without any detectable viremia was detected prior to onset of clinical disease in the 42-yr-old elephant, indicating reactivation rather than primary infection in this elephant. Subsequent EEHV5 viremia and trunk shedding was documented in the other five elephants in the herd, who remained asymptomatic, except for 1 day of temporal gland swelling in an otherwise-healthy 1-yr-old calf. Unexpectedly, the two elephants most recently introduced into the herd 40 mo previously shed a distinctive EEHV5 strain from that seen in the other five elephants. This is the first report to document the kinetics of EEHV5 infection in captive Asian elephants and to provide evidence that this virus can cause illness in some animals.

K.K. Bonia & B. Dutta

Comparative serum biological constituents of captive Asian elephants (*Elephas maximus*)

Indian J. of Animal Sciences 82 (2012) 715-717

Abstract. none.

A.L. Brandt, Y. Ishida, N.J. Georgiadis & A.L. Roca

Forest elephant mitochondrial genomes reveal that elephantid diversification in Africa tracked climate transitions

Molecular Ecology 21 (2012) 1175–1189

Abstract. Among elephants, the phylogeographic patterns of mitochondrial (mt) and nuclear markers are often incongruent. One hypothesis attributes this to sex differences in dispersal and in the variance of reproductive success. We tested this hypothesis by examining the coalescent dates of genetic markers within elephantid lineages, predicting that lower dispersal and lower variance in reproductive success among females would have increased mtDNA relative to nuclear coalescent dates. We sequenced the mitochondrial genomes of two forest elephants, aligning them to mitogenomes of African savanna and Asian elephants, and of woolly mammoths, including the most divergent mitogenomes within each lineage. Using fossil calibrations, the divergence between African elephant F and S clade mitochondrial genomes (originating in forest and savanna elephant lineages, respectively) was estimated as 5.5 Ma. We estimated that the (African) ancestor of the mammoth and Asian elephant lineages diverged 6.0 Ma, indicating that four elephantid lineages had differentiated in Africa by the Miocene–Pliocene transition, concurrent with drier climates. The coalescent date for forest elephant mtDNAs was c. 2.4 Ma, suggesting that the decrease in tropical forest cover during the Pleistocene isolated distinct African forest elephant lineages. For all elephantid lineages, the ratio of mtDNA to nuclear coalescent dates was much greater than 0.25. This is consistent with the expectation that sex differences in dispersal and in variance of reproductive success would have increased the effective population size of mtDNA relative to nuclear markers in elephantids, contributing to the persistence of incongruent mtDNA phylogeographic patterns.

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K. Buranaamnuay, S. Mahasawangkul & K. Saikhuna

The in vitro quality of frozen-thawed Asian elephant (*Elephas maximus*) spermatozoa in semen supplemented with Equex STM paste and oxytocin during and after cryopreservation

Reproductive Biology 13 (2013) 169–171

Abstract. The effects of Equex STM paste (Equex) and oxytocin (OT) on the in vitro quality of frozen-thawed Asian elephant sperm were investigated in the study. The viability of frozen-thawed sperm was significantly higher in the Equex-treated (1 and 2%) groups than in the control group. There were no differences in the examined sperm parameters among the control and OT-treated (0.05–5 IU) groups. © 2013 Reprinted with permission from Elsevier.

K. Chakraborty & J. Mondal

Perceptions and patterns of human–elephant conflict at Barjora block of Bankura district in West Bengal, India: insights for mitigation and management

Environment, Development and Sustainability 15 (2013) 547-565

Abstract. Human–elephant conflict is an issue of great concern regarding the growing competition between people and wildlife for food and shelter throughout Asia and Africa. The situation the Asian elephant faces is much critical. According to IUCN (Big hopes for endangered Asian Elephants, News Release, Gland, 2006), one of the prime factors to the decline of elephant population in India is the increasing trend in human–elephant conflict. Barjora block of Bankura district in West Bengal is one of the severe conflict prone zones in West Bengal, where elephant raid in every year has now become an inevitable phenomenon. As a result, crop damage, infrastructural damages, disturbances of daily activities, occurrence of human death and injuries have no doubt annihilated and frustrated the social fabric of life. This paper is an empirical attempt to address various consequences of human–elephant encounters which have an adverse impact on social, economic as well as the cultural life of the people. Instead of pursuing some traditional mitigation techniques, we argued much on understanding peoples' perception to explore some sustainable mitigation measures to ensure the interest of both human and elephant and also to safeguard ecological integrity. © 2012 Springer Science+Business Media Dordrecht.

K. Chelliah, H. Bukka & R. Sukumar

Modeling harvest rates and numbers from age and sex ratios: A demonstration for elephant populations

Biological Conservation 165 (2013) 54–61

Abstract. Illegal harvest rates of wildlife populations are often unknown or difficult to estimate from field data due to under-reporting or incomplete detection of carcasses. This is especially true for elephants that are killed for ivory or in conflicts with people. We describe a method to infer harvest rates from coarse field data of three population parameters, namely, adult female to male ratio, male old-adult to young-adult ratio, and proportion of adult males in the population using Jensen's (2000) 2-sex, density-dependent Leslie matrix model. The specific combination of male and female harvest rates and numbers can be determined from the history of harvest and estimate of population size. We applied this technique to two populations of elephants for which data on age structure and records of mortality were available— a forest-dwelling population of the Asian elephant (at Nagarahole, India) and an African savannah elephant population (at Samburu, Kenya) that had experienced male-biased harvest regimes over 2–3 decades. For the Nagarahole population, the recorded numbers of male and female elephants killed illegally during 1981–2000 were 64% and 88% of the values predicted by the model, respectively, implying some non-detection or incomplete reporting while for the Samburu population the recorded and modeled numbers of harvest during 1990–1999 closely matched. This technique, applicable to any animal population following logistic growth model, can be especially useful for inferring illegal harvest numbers of forest elephants in Africa and Asia. © 2013 Reprinted with permission from Elsevier.

E.R.C. Davidar, P. Davidar, P. Davidar & J.-P. Puyravaud

Elephant *Elephas maximus* Linnaeus (Proboscidea: Elephantidae) migration paths in the Nilgiri Hills, India in the late 1970s

Journal of Threatened Taxa 4 (2012) 3284-3293

Abstract. The study presented was carried out in 1978 with the support of the Asian Elephant Specialist Group (AsESG) of the International Union for the Conservation of Nature (IUCN) Species Survival Commission (SSC). Its objective was to investigate the impediments to elephant movement in the Nilgiri Hills, in the Western Ghats of India, in an attempt to suggest positive steps to encourage movement through the provision of corridors. The report was left unpublished, but given its importance as a reference document for the conservation of the Asian elephant in the Nilgiris, in 2011 the last two authors decided to publish it. The process of habitat fragmentation has been going on ever since man started agriculture. But this problem has, of late, become much more acute due to mounting pressure on land. The corridor concept applied to wildlife is the provision of a free and, as far as possible, unimpeded way for the passage of wild animals between two wildlife zones. A corridor's more important function is to prevent wild animals from getting isolated in small pocket-like islands. Maintaining elephant habitat connectivity in and around the Nilgiris rests upon the understanding that elephant populations of the several protected areas of the now Nilgiri Biosphere Reserve must remain active. The first author surveyed the Nilgiris on foot and on elephant back for several months in 1978. It was concluded that four areas (the Nilgiri north slopes and Deccan Plateau, the south and southeastern slopes, the Gudalur Plateau, and the upper plateau) harboured together 10 corridors that needed to be maintained, or restored, or even partially restored. © 2012 The Authors.

R. Duffy

The international political economy of tourism and the neoliberalisation of nature: Challenges posed by selling close interactions with animals

Review of International Political Economy 20 (2013) 605-626

Abstract. This paper examines the inter-relationships between neoliberalism, tourism and nature. It argues that scholars of international political economy (IPE) need to engage more fully with the role of nature in driving forward the logics of neoliberalism. Most scholars view nature as a source of accumulation or as an object of governance, but this paper uses the neoliberalisation of nature debate to extend our understandings of neoliberalism. In particular, global tourism has targeted and opened up new frontiers in nature, which serves to expand and deepen neoliberalism to a wider range of biophysical phenomena. This paper uses the case of elephant tourism to demonstrate how tourism is not just reflective of neoliberalism, but is in fact a key driver of it, acting as an environmental fix for capitalism. Further, this paper takes up the challenge of research on 'actually existing neoliberalisms' via engagement with locally specific contexts and emerging forms of socio-nature in the Thai tourism industry. It reveals how neoliberalism redraws the boundaries of access to nature, thereby shifting the distribution of costs and benefits. Hence, nature is one of the primary ways in which neoliberalism is constituted, albeit in a highly differentiated way. This reminds us not to reify neoliberalism and accord it a greater degree of power and coherence than it really has. © 2013 Taylor & Francis.

R.C. Dunkin, D. Wilson, N. Way, K. Johnson & T.M. Williams

Climate influences thermal balance and water use in African and Asian elephants: physiology can predict drivers of elephant distribution

Journal of Experimental Biology 216 (2013) 2939-2952

Abstract. Elephant movement patterns in relation to surface water demonstrate that they are a water-dependent species. Thus, there has been interest in using surface water management to mitigate problems associated with localized elephant overabundance. However, the physiological mechanisms underlying the elephant's water dependence remain unclear. Although thermoregulation is likely an important driver, the relationship between thermoregulation, water use and climate has not been quantified. We measured skin surface temperature of and cutaneous water loss from 13 elephants (seven African, 3768±642 kg; six Asian, 3834±498 kg)

and determined the contribution of evaporative cooling to their thermal and water budgets across a range of air temperatures (8–33°C). We also measured respiratory evaporative water loss and resting metabolic heat production on a subset of elephants (N=7). The rate of cutaneous evaporative water loss ranged between 0.31 and 8.9 g min^{-1} m^{-2} for Asian elephants and 0.26 and 6.5 g min^{-1} m^{-2} for African elephants. Simulated thermal and water budgets using climate data from Port Elizabeth, South Africa, and Okaukuejo, Namibia, suggested that the 24-h evaporative cooling water debt incurred in warm climates can be more than 4.5 times that incurred in mesic climates. This study confirms elephants are obligate evaporative coolers but suggests that classification of elephants as water dependent is insufficient given the importance of climate in determining the magnitude of this dependence. These data highlight the potential for a physiological modeling approach to predicting the utility of surface water management for specific populations. © 2013 The Company of Biologists Ltd.

P.L. Falkingham

Acquisition of high resolution three-dimensional models using free, open-source, photogrammetric software

Palaeontologia Electronica 15 (2012) 15.1.1T

Abstract. The 3D digitisation of palaeontological resources is of tremendous use to the field, providing the means to archive, analyse, and visualise specimens that would otherwise be too large to handle, too valuable to destructively sample, or simply in a different geographic location. Digitisation of a specimen to produce a 3D digital model often requires the use of expensive laser scanning equipment or proprietary digital reconstruction software, making the technique inaccessible to many workers. Presented here is a guide for producing high resolution 3D models from photographs, using freely available open-source software. To demonstrate the accuracy and flexibility of the approach, a number of examples are given, including a small trilobite (~0.04 m), a large mounted elephant skeleton (~3 m), and a very large fossil tree root system (~6 m), illustrating that the method is equally applicable to specimens or even outcrops of all sizes. The digital files of the models produced in this paper are included. The results demonstrate that production of digital models from specimens for research or archival purposes is available to anyone, and it is hoped that an increased use of digitisation techniques will facilitate research and encourage collaboration and dissemination of digital data. © 2012 Palaeontological Association.

A.A. Farouq, D.K. Abdullah, N. Abdullah & F. Hooi-Ling

Cellulase enzyme production from lignocellulosic substrates by individual and consortium of new fungi isolated from Asian elephant (*Elephas maximus*) dung.

Journal of Enzyme Research 3 (2012) 34-38

Abstract. One of the major challenges of cellulosic bioethanol production is cellulase enzyme which is used in the hydrolysis of cellulose to sugars for fermentation to bioethanol. Commercial cellulase enzyme preparations are very expensive. Fungi are recognized for their ability to produce a large variety of extracellular enzymes. In this study, the potential of two new native fungi (*T. aureoviride* UPM 09 (JN811061) (UPMC 389) and *F. equiseti* strain UPM 09 (JN811063) (UPMC391) isolated from Asian elephant (*E. maximus*) dung to pro- duce cellulase enzymes from rice husk (RH), rubber wood saw dust (RW) and oil palm empty fruit bunch (EFB) using solid state cultivation (SSC) and submerged cultivation (SMC) was investigated. From the results of the statistical analysis, there is no significant difference ($P>0.05$) in cellulase production between the two methods for all the three substrates. However, there is significant difference ($P<0.05$) between the two fungi in cellulase enzyme production both SSC and SMC among the three substrates used. The result, therefore, indicates that any of the two fungi can be used for cellulase production. In addition, the type of substrate is influential in cellulase production by the fungi. The two new fungal strains may serve as good candidates for cellulase production in the cellulosic bioethanol industry. However, consortium of the two fungi produced relatively slightly higher cellulase enzyme in each of the methods than each when used alone. © 2012 The Authors.

M. Feldman, R. Isaza, C. Prins & J. Hernandez
Point prevalence and incidence of *Mycobacterium tuberculosis* complex in captive elephants in the United States of America
Veterinary Quarterly 33 (2013) 25-29
Abstract. Background: Captive elephants infected with tuberculosis are implicated as an occupational source of zoonotic tuberculosis. However, accurate estimates of prevalence and incidence of elephant tuberculosis from well-defined captive populations are lacking in the literature. Studies published in recent years contain a wide range of prevalence estimates calculated from summary data. Incidence estimates of elephant tuberculosis in captive elephants are not available. Objective: This study estimated the annual point prevalence, annual incidence, cumulative incidence, and incidence density of tuberculosis in captive elephants within the USA during the past 52 years. Animals and methods: We combined existing elephant census records from captive elephants in the USA with tuberculosis culture results obtained from trunk washes or at necropsy. This data set included 15 years where each elephant was screened annually. Results: Between 1960 and 1996, the annual point prevalence of tuberculosis complex mycobacteria for both species was 0. From 1997 through 2011, the median point prevalence within the Asian elephant population was 5.1%, with a range from 0.3% to 6.7%. The incidence density was 9.7 cases/1000 elephant years. In contrast, the annual point prevalence during the same time period within the African elephant population remained 0 and the incidence density was 1.5 cases/1000 elephant years. Conclusions: The apparent increase in new cases noted after 1996 resulted from a combination of both index cases and the initiation of mandatory annual tuberculosis screening in 1997 for all the elephants. This study found lower annual point prevalence estimates than previously reported in the literature. These discrepancies in prevalence estimates are primarily due to differences in terminology and calculation methods. Using the same intensive testing regime, the incidence of tuberculosis differed significantly between Asian and African elephants. Accurate and species specific knowledge of prevalence and incidence will inform our efforts to mitigate occupational risks associated with captive elephants in the USA. © 2013 Taylor & Francis.

A. Gall & A. Palser
An elephantine viral problem
Nature Reviews Microbiology 11 (2013) 512
Abstract. none.

A. Granados, R.B. Weladji & M.R. Loomis
Movement and occurrence of two elephant herds in a human-dominated landscape, the Bénoué Wildlife Conservation Area, Cameroon
Tropical Conservation Science 5 (2012) 150-162
Abstract. Increasing human settlement and disturbance adjacent to protected areas have intensified competition between people and wildlife for resources and living space. In northern Cameroon, over 60,000 people live in villages surrounding Bénoué National Park. In that same area, as in other parts of Africa, savanna elephants damage crops, homes, water provision infrastructures, and grain stores. Using almost 1000 satellite-derived positions for two matriarch female elephants from 2007 to 2009, movement patterns were analyzed with respect to a highway, secondary roads, unpaved park roads, rivers, and villages through the use of log linear modeling. More than half of all locations and core areas occurred outside the park, while seasonal and individual differences in home range size and distribution were found within the protected area. Elephant occurrence within approximately 7 to 9 km of villages showed a decreasing trend with proximity. The highway appeared to act as a barrier to movement for one elephant herd, while the other did not come within 11 km of it. On the other hand, elephants remained close to the Bénoué River and secondary roads. Our findings show that in the Bénoué Wildlife Conservation Area, perennial water availability and human disturbance from the presence of villages can influence elephant spatial distribution in the protected area, and overlap of villages with elephant home range indicates a high potential for human-elephant conflict. This highlights the need for more effective land use planning to reduce such conflict and for additional research into movement patterns of the Bénoué National Park elephant population. © 2012 The Authors.

S. Gubbi, H.C. Poornesha & M.D. Madhusudan

Impact of vehicular traffic on the use of highway edges by large mammals in a South Indian wildlife reserve

Current Science 102 (2012) 1047-1051

Abstract. India's phenomenal economic growth over the last decade has been accompanied by a much-needed expansion and improvement in transport and other infrastructure networks. While there are legally mandated assessments of the potential ecological impacts of such infrastructure projects prior to implementation, rarely are there post-implementation assessments of their real ecological impacts. In this communication, we present results of a preliminary study examining the impact of vehicular traffic on the usage of road edges by large mammals along a highway passing through Nagarahole Tiger Reserve, southern India. We estimated large mammal encounter rates at remotely triggered camera traps on two consecutive sections of the same highway – one closed to vehicular traffic and the other open to vehicles only during daytime. We observed lower encounter rates of chital, gaur and elephants at camera traps in the highway segment with higher vehicular traffic density, suggesting that these species avoided busy highways. Based on our findings, we emphasize the importance of continued ecological impact assessments of development projects to identify and mitigate unforeseen impacts. Further, an approach to development planning that integrates conservation concerns, especially where development projects coincide with ecologically critical areas, is urgently needed in India.

G.S. Hayward

Conservation: clarifying the risk from herpesvirus to captive Asian elephants

Veterinary Record 170 (2012) 202-203

Abstract. none.

R. Hazarika & Anup Saikia

The pachyderm and the pixel: an assessment of elephant habitat suitability in Sonitpur, India

International Journal of Remote Sensing 34 (2013) 5317-5330

Abstract. Remote sensing and geographic information systems (GISs) are increasingly being used in protected area monitoring and habitat suitability studies. In this article, Erdas Imagine's Expert Classifier tool was used to assess the specific trajectories of habitat suitability change during 1994–2007 in the Sonitpur elephant habitat, India. Sonitpur has been witness to increasing human–elephant conflict in the past decade. The suitability analysis took into account information relating to forest type and density, elevation, slope, source of water, human activities in terms of settlement, agriculture, tea plantations, roads, and railways. Satellite imagery, data from topographical maps, digital elevation data, and global positioning system readings formed the major data inputs that were incorporated into a GIS. Various decision rules were created and confidence levels assigned to the input layers to generate high, medium, and low habitat suitability. The area witnessed a sharp decline in suitability from 63% in 1994 to less than 38% by 2007. The high-suitability area declined by more than 50% during this period. The unique natural protected areas of Sonitpur, which are a mix of reserved forests, wildlife sanctuaries, and a national park, urgently need to be protected from further habitat degradation. © 2013 Taylor & Francis.

S. Hedges, A. Johnson, M. Ahlering, M. Tyson, L.S. Eggert, B. Ibler & R. Pankow

Accuracy, precision, and cost-effectiveness of conventional dung density and fecal DNA based survey methods to estimate Asian elephant (*Elephas maximus*) population size and structure

Biological Conservation 159 (2013) 101–108

Abstract. Non-invasive DNA-based capture–mark–recapture (CMR) methods have been developed to estimate population size and other parameters and have the advantage that samples can be collected without the need to see or disturb the animals. There are, however, few comparisons of DNA-based CMR estimates of animal population size with estimates from non-genetic methods. We compared the results of a dung-density based survey of an Asian elephant (*Elephas maximus*) population with a simultaneous fecal DNA-based CMR survey of the same population. We found 545 dung-piles along 116 line transects, converted dung-

pile density to elephant density using rates of defecation and dung disappearance, and derived a population estimate of 141 elephants. We collected 267 fecal samples during three CMR sampling sessions: 215 (81%) yielded sufficient genotypic information for analysis and gave an estimated population size of 132 elephants, closely matching the estimate produced by the dung-density method but with greater precision. The DNA-based method also provided information on population structure. We conclude that DNA-based CMR methods provide more precise abundance estimates, and more data about population structure and dynamics, than dung density-based methods. Fecal DNA-based CMR methods also require less time in the field and can be used when dung density methods are impracticable. Finally, fecal DNA based CMR methods are now cheaper than dung density based methods when line transect survey costs are approximately equal to CMR survey costs and dung decay rate monitoring costs are greater than laboratory costs (which will usually be the case). © 2012 Reprinted with permission from Elsevier.

B. Ibler & R. Pankow

Data on the sleep in the herd of Asian Elephants (*Elephas maximus*) at Berlin Zoological Garden

Der Zoologische Garten 81 (2012) 239–245

Abstract. Due to the night observations during the gravidity of the Asian elephant "Pang Pha" in 2005 it was possible to receive data on the sleeping behavior of 1.3 Asian elephants (*Elephas maximus*) at Berlin Zoological Garden. These elephants were the breeding bull "Victor" (born 22.10.1993 at Zoological Center Ramat Gan), "Pang Pha" (born 1987 in Thailand), "Drumbo" (born 1970) and "Iyoti" (born 1974 in India). Elephant "Pang Pha" slept only one and a half hour, whereas the two older cows lay nearly four hours. The bull lay longest. © 2012 Reprinted with permission from Elsevier. [Main text in German]

P. Imrat, P. Suthanmapinanth, K. Saikhun, S. Mahasawangkul, E. Sostaric, P. Sombutputorn, S. Jansittiwate, N. Thongtip, A. Pinyopummin, B. Colenbrander, W.V. Holt & T.A.E. Stout

Effect of pre-freeze semen quality, extender and cryoprotectant on the post-thaw quality of Asian elephant (*Elephas maximus indicus*) semen

Cryobiology 66 (2013) 52-59

Abstract. Semen cryopreservation and artificial insemination (AI) are potentially valuable methods for supporting the breeding management of endangered species like the Asian elephant. Cryopreservation of Asian elephant semen has however proven problematic with respect to maintenance of both adequate semen quality and fertility post-thaw. In this study, nine ejaculates from three adult bulls were used to compare the influence of extender (TEST versus INRA96®) and penetrating cryoprotectants (3% glycerol, 5% glycerol and 4% methylformamide) on post-thaw semen quality. We demonstrate that not only the freezing process, but also the quality of the semen before freezing, significantly influences the freezability of Asian elephant semen. Pre-freeze motility, viability, semen volume, semen pH, sperm concentration and the incidence of sperm mid-piece and tail abnormalities all significantly ($p < 0.05$) affected post-thaw semen quality. While extender and cryoprotectant did not significantly affect any of the above semen quality parameters post-thaw, the skim-milk based extender (INRA96®) preserved DNA integrity better ($p < 0.05$) than the egg yolk extender (TEST). Considerable between-ejaculate variation in all post-thaw semen quality parameters was also noted. It is concluded that strict criteria for semen quality is essential for the selection of Asian elephant bull ejaculates suitable for cryopreservation; stricter initial selection should improve the mean post-thaw quality. © 2012 Reprinted with permission from Elsevier.

P.S. Jothish

Frugivory and seed dispersal of woody species by the Asian elephant (*Elephas maximus*) in a mid-elevation tropical evergreen forest in India

Journal of Tropical Ecology 29 (2013) 181-185

Abstract. Frugivory and seed dispersal by the Asian elephant, *Elephas maximus*, in a mid-elevation tropical evergreen forest in India was studied by dung analysis and conducting seed

germination trials on ingested and control seeds. A total of 384 dung piles were observed during the period February 2007 to December 2008. Fruits/ seeds and seedlings of 27 woody species were observed from the dung piles. Seed germination experiments showed that seeds from dung were viable and germination time of ingested seeds was significantly lower than that of control seeds. It was observed that 43.6% of the seedlings in the dung piles established as saplings. The study suggests that the Asian elephant is a legitimate seed disperser in tropical forests in its range. © 2013 Cambridge University Press.

K. Karthik

Tuberculosis goes wild: Emphasis on elephants

J. of Veterinary Advances 2 (2012) 534-538

Abstract. Tuberculosis being a slow spreading disease has almost let its roots into all animal species. It does not have any discrimination between wild and domestic animals. Even though science has extended its view towards various aspects of TB yet it has to find out a solution to break the chain of TB spread. *Mycobacteria* even though a minute organism it strikes hard the mammoth. Even the elephants have no excuse to TB. Now there are lots of case reports about the occurrence of TB in elephants especially in zoos. From these elephants it spreads to the elephant handlers, thus playing a significant role in the zoonosis of TB. This article mainly deals with the historical aspect of TB in elephants, zoonotic and epidemiological aspects. This article also emphasis on the diagnosis and the treatment aspects of tuberculosis in elephants. Research in the zone of tuberculosis in elephants is required in order to save the elephants and also to prevent the spread of TB to humans and other animals.

W.K. Kiso, V. Selvaraj, J. Nagashima, A. Asano, J.L. Brown, D.L. Schmitt, J. Leszyk, A.J. Travis & B.S. Pukazhenthi

Lactotransferrin in Asian elephant (*Elephas maximus*) seminal plasma correlates with semen quality

PLoS ONE 8(8) e71033

Abstract. Asian elephants (*Elephas maximus*) have highly variable ejaculate quality within individuals, greatly reducing the efficacy of artificial insemination and making it difficult to devise a sperm cryopreservation protocol for this endangered species. Because seminal plasma influences sperm function and physiology, including sperm motility, the objectives of this study were to characterize the chemistry and protein profiles of Asian elephant seminal plasma and to determine the relationships between seminal plasma components and semen quality. Ejaculates exhibiting good sperm motility (≤65%) expressed higher percentages of spermatozoa with normal morphology (80.3±13.0 vs. 44.9±30.8%) and positive Spermac staining (51.9±14.5 vs. 7.5±14.4%), in addition to higher total volume (135.1±89.6 vs. 88.8±73.1 ml) and lower sperm concentration (473.0±511.2 vs. 1313.8±764.7x10^6 cells ml^{-1}) compared to ejaculates exhibiting poor sperm motility (≤10%; $P<0.05$). Comparison of seminal plasma from ejaculates with good versus poor sperm motility revealed significant differences in concentrations of creatine phosphokinase, alanine aminotransferase, phosphorus, sodium, chloride, magnesium, and glucose. These observations suggest seminal plasma influences semen quality in elephants. One- and two-dimensional (2D) gel electrophoresis revealed largely similar compositional profiles of seminal plasma proteins between good and poor motility ejaculates. However, a protein of ca. 80 kDa was abundant in 85% of ejaculates with good motility, and was absent in 90% of poor motility ejaculates ($P<0.05$). We used mass spectrometry to identify this protein as lactotransferrin, and immunoblot analysis to confirm this identification. Together, these findings lay a functional foundation for understanding the contributions of seminal plasma in the regulation of Asian elephant sperm motility, and for improving semen collection and storage in this endangered species.

E. Lee, Y. Lee, S. Moon, N. Kim, S. Kim, M. Yang, D. Choi & M. Han

The identification of elephant ivory evidences of illegal trade with mitochondrial cytochrome b gene and hypervariable D-loop region

Journal of Forensic and Legal Medicine 20 (2013) 174-178

Abstract. DNA analysis of elephant ivory of illegal trade was handled in this work. The speciation and geographical origin of nine

specimens of elephant ivory were requested by the police. Without national authorization, the suspect had purchased processed ivory seals from January to May, 2011 by Internet transactions from a site in a neighboring country. The DNA of decalcified ivory evidences was isolated with QIAGEN Micro Kit. The total 844–904 base pair sized sequences of mitochondrial cytochrome b and D-loop region could be acquired using direct sequencing analysis. They were compared with the sequences registered in GenBank. It was confirmed that most specimens were likely from African forest elephants (*Loxodonta cyclotis*), one from African savanna elephant (*Loxodonta africana*) and one from Asian elephant (*Elephas maximus*). Analysis of the mitochondrial hypervariable D-loop region sequence of elephants verified that one African savanna elephant might be from South Africa and one Asian elephant from Laos. Cytochrome b and D-loop region located in the mitochondrial DNA resulted in the successful determination of elephant DNA from nine processed ivory specimens. © 2012 Reprinted with permission from Elsevier.

J. Li, Y. Hou, Y. Li & J. Zhang

The latest straight-tusked elephants (*Palaeoloxodon*)? "Wild elephants" lived 3000 years ago in North China

Quaternary International 281 (2012) 84-88

Abstract. Large quantities of archeology and literature records indicate that during the Shang Dynasty and a part of the Zhou Dynasty of Chinese history, about 2000 BC to 1000 BC, there once were wild elephants living in North China. For a long time, it was believed that all of these elephants belonged to the species *Elephas maximus*. Many scholars suggested that this phenomenon could show a much higher temperature at that time. However, as the research of Chinese historical climate has already indicated, even in the Megathermal Maximum, most of the parts of North China were still controlled by the climate of the Warm Temperate Zone, not the Subtropic Zone. This paper presents evidence suggesting that the so-called "wild elephants" in North China during that time belonged to *Palaeoloxodon* sp., not *E. maximus*. © 2011 Reprinted with permission from Elsevier.

P.D. Ling J.G. Reid, X. Qin, D.M. Muzny, R. Gibbs, J. Petrosino, R.S. Peng, J.-C. Zong, S.Y. Heaggans, & G.S. Hayward

Complete genome sequence of elephant endotheliotropic herpesvirus 1A

Genome Announcements 1 (2013) e00106-13

Abstract. Elephant endotheliotropic herpesvirus 1A is a member of the Proboscivirus genus and is a major cause of fatal hemorrhagic disease in endangered juvenile Asian elephants worldwide. Here, we report the first complete genome sequence from this genus, obtained directly from necropsy DNA, in which 60 of the 115 predicted genes are not found in any known herpesvirus. © 2013 Ling et al.

A.M. Lister, W. Dirks, A. Assaf, M. Chazan, P. Goldberg, Y.H. Applbaum, N. Greenbaum & L.K. Horwitz

New fossil remains of *Elephas* from the southern Levant: Implications for the evolutionary history of the Asian elephant

Palaeogeography, Palaeoclimatology, Palaeoecology 386 (2013) 119-130

Abstract. We describe new fossil remains of elephant (*Elephas* cf. *hysudricus*) from archaeological sites in the Levant: Ma'ayan Baruch (Israel) and 'Ain Soda (Jordan). Both sites date to the Middle Pleistocene based on stone artefacts typical of Levantine Late Acheulian assemblages. The elephant remains show 'primitive' dental features reminiscent of *E. hysudricus* from the Plio-Pleistocene of the



Minneriya National Park (Sri Lanka)

Siwaliks (northern India), the species thought to be ancestral to Asian elephant *E. maximus*. Regionally, the new fossils are chronologically intermediate between an earlier (ca. 1 Ma) record of *Elephas* sp. from Evron Quarry (Israel), and Holocene remains of *E. maximus* from archaeological sites in NW Syria, Turkey, Iraq and Iran. It is unclear at present whether this represents continuity of occupation or, more plausibly, independent westward expansions. © 2013 Reprinted with permission from Elsevier.

K.K. Mohapatra, A.K. Patra & D.S. Paramanik

Food and feeding behaviour of Asiatic elephant (*Elephas maximus* Linn.) in Kuldiha Wild Life Sanctuary, Odisha, India

J. of Environmental Biology 34 (2013) 87-92

Abstract. The feeding behaviour of Asiatic elephant (*Elephas maximus*) with food reference was studied in Kuldiha Wildlife Sanctuary in Odisha during 2007 to 2009. Though the study area houses a good number of plant species only 71 species were identified as elephant fodder plants. The food trail of elephant was observed as twig breaking, bark peeling, branch breaking, stem twisting uprooting and flower plucking in different regions of study area during different seasons. Alteration of predominantly browsing strategy with that of grazing around the year was related to seasonal variation of food plants. Consumption of tree species (56%) was highest as compared to shrubs (20%), herbs (14%) and climbers (10%). A high degree of variation in dicot monocot ratio (61:10)) was marked during identification of elephant fodder plant by direct observation. Microscopic analysis of dung showing a high degree of variation in average dicot monocot ratio suggested that the food plant selection of elephant was highly opportunistic and seasonal. The elephants extensively fed on the plant species like *Careya arborea*, *Kydia calycina*, *Helicteres isora*, *Mallotus philippinensis*, *Aegle marmelos*, *Zizyphus mauritiana*, *Bauhinia racemosa*, *Bauhinia vahlii*, *Mimosa pudica*, *Asparagus racemosus*, *Smilax zeylanica* and *Diosporea* species. They were fond of *Madhuca indica* (Mahula) flowers in winter and fruits of *Mangifera indica* (Mango) in summer. They were never found feeding on *Tectona grandis* and *Eucalyptus maculate* inside the study area. © 2013 Triveni Enterprises. Reproduced with permission.

H.S. Mumby, A. Courtiol, K.U. Mar & V. Lummaa

Climatic variation and age-specific survival in Asian elephants from Myanmar

Ecology 94 (2013) 1131–1141

Abstract. Concern about climate change has intensified interest in understanding how climatic variability affects animal life histories. Despite such effects being potentially most dramatic in large, long-lived and slowly reproducing terrestrial mammals, little is known of the effects of climatic variation on survival in those species. Asian elephants (*Elephas maximus*) are endangered across their distribution, and inhabit regions characterized by high seasonality of temperature and rainfall. We investigated the effects of monthly climatic variation on survival and causes of death in Asian elephants using a unique demographic dataset of 1024 semi-captive longitudinally monitored elephants from four sites in Myanmar between 1965 and 2000. Temperature had a significant effect on survival in both sexes and across all ages. For elephants between 1 month and 17 years, maximal survival was reached at around 24ºC and any departures from this temperature increased mortality, whereas neonates and mature elephants had maximal survival at even lower temperatures. Although males experienced higher mortality overall, sex differences in these optimal temperatures were small. Because the elephants spent more time during a year in temperatures higher than 24ºC than in temperatures below it, most deaths occurred at hot (temperatures over 24ºC) rather than cold periods. Decreased survival at higher temperatures resulted partially from increased deaths from infectious disease and heat stroke, whilst the lower survival in the coldest months is associated with an increase in non-infectious diseases and poor health in general. Survival was also related to rainfall, with the highest survival rates during the wettest months for all ages and sexes. Our results show that even the normal-range monsoon variation in climate can exert large impact on elephant survival in Myanmar leading to extensive absolute differences in mortality: switching from favorable to unfavorable climatic

conditions within average years doubled the odds for mortality. The persistence of a long-term trend towards higher global temperatures, combined with the possibility of higher variation in temperature between seasons, may pose a challenge to the survival of species such as Asian elephants. © 2013 Ecological Soc. of America.

F. Nocete, J.M. Vargas, T.X. Schuhmacher, A. Banerjee & W. Dindorf

The ivory workshop of Valencina de la Concepción (Seville, Spain) and the identification of ivory from Asian elephant on the Iberian Peninsula in the first half of the 3rd millennium BC

Journal of Archaeological Science 40 (2013) 1579–1592

Abstract. During excavations in the huge ditched enclosure of Valencina de la Concepción (Seville, Spain), the main centre from the first hierarchical framework-settlement in the Guadalquivir Valley, a pit with remains of a context for producing ivory artefacts, dating from the first half of the 3rd millennium BC, was discovered in the large metallurgical nucleate workshops. Scientific (Optical Microscopy, FIRT and Raman Spectroscopy, C/N Isotope Ratio Mass Spectrometry) analyses revealed that the ivory belonged to Asian elephants and the archaeological study, which was made in a specialized workshop context. In this paper we present the archaeological context, the study of the ivory artefacts and the state of research on ivory in the Lower Guadalquivir Basin during the 3rd millennium BC. In a parallel way, this paper discusses the significance of this workshop context in the configuration and function of the long distance circulation of raw material and the specialized craft areas in the first political centres. © 2012 Reprinted with permission from Elsevier.

S.A. Nofs, R.L. Atmar, W.A. Keitel, C. Hanlon, J.J. Stanton, Jie Tan, J.P. Flanagan, L. Howard, P.D. Ling, R.P.V.J. Rajapakse, M. Iwagami, S. Wickramasinghe, S.M. Walker & T. Agatsuma

Prenatal passive transfer of maternal immunity in Asian elephants (*Elephas maximus*)

Veterinary Immunology and Immunopathology 153 (2013) 308-311

Abstract. Asian (*Elephas maximus*) and African (*Loxodonta africana*) elephants exhibit characteristics of endotheliochorial placentation, which is common in carnivore species and is associated with modest maternal to fetal transplacental antibody transfer. However, it remains unknown whether the bulk of passive immune transfer in elephants is achieved prenatally or postnatally through ingestion of colostrum, as has been documented for horses, a species whose medical knowledgebase is often extrapolated for elephants. To address this issue, we took advantage of the fact that many zoo elephants are immunized with tetanus toxoid and/or rabies vaccines as part of their routine health care, allowing a comparison of serum antibody levels against these antigens between dams and neonates. Serum samples were collected from 3 newborn Asian elephant calves at birth (before ingestion of colostrum); 2-4 days after birth; and 2-3 months of age. The findings indicate that the newborns had anti-tetanus toxoid and anti-rabies titers that were equivalent to or higher than the titers of their dams from birth to approximately 3 months of age, suggesting that the majority of maternal-to-fetal transfer is transplacental and higher than expected based on the architecture of the Asian elephant placenta. © 2013 Reprinted with permission from Elsevier.

G. Nogge

Elefantenhaltung in Europa und Indien – ein Vergleich

Elephant keeping in Europe and India – a comparison

Der Zoologische Garten 81 (2012) 231-238

Abstract. In none of the countries of origin Asian elephants are taken any more from the wild. Instead breeding stations arise. In India the methods of keeping elephants have become subject of scientific investigations. As a result elephants in the long run will be allowed to be held only in forest camps. The concepts of elephant husbandry are discussed and developed also outside the countries of origin. Under consideration of their biological, ecological and social requirements elephants have to be managed in groups. It is the author's opinion that protected contact will be the method of the future. © 2013 Reprinted with permission from Elsevier. [Main text in German.]

B.L. Ong, Y.F. Ngeow, M.F. Razak, Y. Yakubu, Z. Zakaria, A.R. Mutalib, L. Hassan, H.F. Ng & K. Verasahib

Tuberculosis in captive Asian elephants (*Elephas maximus*) in Peninsular Malaysia

Epidemiology & Infection 141 (2013) 1481–1487

Abstract. A cross-sectional study was conducted from 10 January to 9 April 2012, to determine the seroprevalence of tuberculosis (TB) of all captive Asian elephants and their handlers in six locations in Peninsular Malaysia. In addition, trunk-wash samples were examined for tubercle bacillus by culture and polymerase chain reaction (PCR). For 63 elephants and 149 elephant handlers, TB seroprevalence was estimated at 20·4% and 24·8%, respectively. From 151 trunk-wash samples, 24 acid-fast isolates were obtained, 23 of which were identified by hsp65-based sequencing as non-tuberculous mycobacteria. The *Mycobacterium tuberculosis*-specific PCR was positive in the trunk-wash samples from three elephants which were also seropositive. Conversely, the trunk wash from seven seropositive elephants were PCR negative. Hence, there was evidence of active and latent TB in the elephants and the high seroprevalence in the elephants and their handlers suggests frequent, close contact, two-way transmission between animals and humans within confined workplaces. © 2011 Cambridge University Press.

J.M. Plotnik, J.J. Pokorny, T. Keratimanochaya, C. Webb, H.F. Beronja, A. Hennessy, J. Hill, V.J. Hill, R. Kiss, C. Maguire, B.L. Melville, V.M.B. Morrison, D. Seecoomar, B. Singer, J. Ukehaxhaj, S.K. Vlahakis, D. Ylli, N.S. Clayton, J. Roberts, E.L. Fure, A.P. Duchatelier & D. Getz

Visual cues given by humans are not sufficient for Asian elephants (*Elephas maximus*) to find hidden food

PLOS ONE 8 (2013) e61174

Abstract. Recent research suggests that domesticated species – due to artificial selection by humans for specific, preferred behavioral traits – are better than wild animals at responding to visual cues given by humans about the location of hidden food. Although this seems to be supported by studies on a range of domesticated (including dogs, goats and horses) and wild (including wolves and chimpanzees) animals, there is also evidence that exposure to humans positively influences the ability of both wild and domesticated animals to follow these same cues. Here, we test the performance of Asian elephants (*Elephas maximus*) on an object choice task that provides them with visual-only cues given by humans about the location of hidden food. Captive elephants are interesting candidates for investigating how both domestication and human exposure may impact cue-following as they represent a non-domesticated species with almost constant human interaction. As a group, the elephants (n = 7) in our study were unable to follow pointing, body orientation or a combination of both as honest signals of food location. They were, however, able to follow vocal commands with which they were already familiar in a novel context, suggesting the elephants are able to follow cues if they are sufficiently salient. Although the elephants' inability to follow the visual cues provides partial support for the domestication hypothesis, an alternative explanation is that elephants may rely more heavily on other sensory modalities, specifically olfaction and audition. Further research will be needed to rule out this alternative explanation. © 2013 Plotnik et al.

R.P.V.J. Rajapakse, M. Iwagami, S. Wickramasinghe, S.M. Walker & T. Agatsuma

Morphology and surface topography of the schistosome *Bivitellobilharzia nairi* from the Asian elephant (*Elephas maximus maximus*) in Sri Lanka

Journal of Helminthology 87 (2013) 348–355

Abstract. *Bivitellobilharzia nairi* was first recorded from an Indian elephant (*Elephas maximus*) in Berlin. Infections with this parasite have become increasingly important in *E. maximus maximus* populations in Sri Lanka. The present work is the first morphological description of this schistosome from Sri Lanka. A number of adult worms were recovered from a dead Asian elephant near the elephant orphanage, Pinnawala, in Sri Lanka. The observed clinical features of the infected elephant included emaciation, subventral oedema and anaemia. Post-mortem results indicated that the liver was enlarged and adult schistosomes were found in the blood vessels of the liver parenchyma. The total number of

worms recovered from a portion of the liver was 129,870, which is an average of 22 worms per 100 g of liver. The present study uses both light microscopic and scanning electron microscope (SEM) techniques for the morphological and topographical characterization of this parasite and to permit comparison with other species of schistosomes. Morphologically, these worms correspond very well to the description of *B. nairi* by Dutt & Srivastava (1955). Moreover, it is clear that *B. nairi* is a distinctive species easily differentiated from other schistosomes. The SEM study of the tegument of male worms shows that the surface of *B. nairi* is smoother than in other schistosomes. © 2012 Cambridge Univ. Press.

A. Rizvanovic, M. Amundin & M. Laska

Olfactory discrimination ability of Asian elephants (*Elephas maximus*) for structurally related odorants

Chemical Senses 38 (2013) 107-118

Abstract. Using a food-rewarded two-choice instrumental conditioning paradigm, we assessed the ability of Asian elephants, *Elephas maximus*, to discriminate between 2 sets of structurally related odorants. We found that the animals successfully discriminated between all 12 odor pairs involving members of homologous series of aliphatic 1-alcohols, n-aldehydes, 2-ketones, and n-carboxylic acids even when the stimuli differed from each other by only 1 carbon. With all 4 chemical classes, the elephants displayed a positive correlation between discrimination performance and structural similarity of odorants in terms of differences in carbon chain length. The animals also successfully discriminated between all 12 enantiomeric odor pairs tested. An analysis of odor structure–activity relationships suggests that a combination of molecular structural properties rather than a single molecular feature may be responsible for the discriminability of enantiomers. Compared with other species tested previously on the same sets of odor pairs (or on subsets thereof), the Asian elephants performed at least as well as mice and clearly better than human subjects, squirrel monkeys, pigtail macaques, South African fur seals, and honeybees. Further comparisons suggest that neither the relative nor the absolute size of the olfactory bulbs appear to be reliable predictors of between-species differences in olfactory discrimination capabilities. In contrast, we found a positive correlation between the number of functional olfactory receptor genes and the proportion of discriminable enantiomeric odor pairs. Taken together, the results of the present study support the notion that the sense of smell may play an important role in regulating the behavior of Asian elephants. © 2012 The Authors.

M.F. Rowe, G.S. Bakken, J.J. Ratliff & V.A. Langman

Heat storage in Asian elephants during submaximal exercise: behavioral regulation of thermoregulatory constraints on activity in endothermic gigantotherms

Journal of Experimental Biology 216 (2013) 1774-1785

Abstract. Gigantic size presents both opportunities and challenges in thermoregulation. Allometric scaling relationships suggest that gigantic animals have difficulty dissipating metabolic heat. Large body size permits the maintenance of fairly constant core body temperatures in ectothermic animals by means of gigantothermy. Conversely, gigantothermy combined with endothermic metabolic rate and activity likely results in heat production rates that exceed heat loss rates. In tropical environments, it has been suggested that a substantial rate of heat storage might result in a potentially lethal rise in core body temperature in both elephants and endothermic dinosaurs. However, the behavioral choice of nocturnal activity might reduce heat storage. We sought to test the hypothesis that there is a functionally significant relationship between heat storage and locomotion in Asian elephants (*Elephas maximus*), and model the thermoregulatory constraints on activity in elephants and a similarly sized migratory dinosaur, Edmontosaurus. Pre- and post-exercise (N=37 trials) measurements of core body temperature and skin temperature, using thermography were made in two adult female Asian elephants at the Audubon Zoo in New Orleans, LA, USA. Over ambient air temperatures ranging from 8 to 34.5°C, when elephants exercised in full sun, ~56 to 100% of active metabolic heat production was stored in core body tissues. We estimate that during nocturnal activity, in the absence of

solar radiation, between 5 and 64% of metabolic heat production would be stored in core tissues. Potentially lethal rates of heat storage in active elephants and Edmontosaurus could be behaviorally regulated by nocturnal activity. © 2013 Reproduced with permission from the Journal of Experimental Biology.

S. Sadhu, P.K. Ghosh, T.K. De, T.K. Maiti

Optimization of cultural condition and synergistic effect of lactose with Carboxymethyl cellulose on cellulase production by *Bacillus* sp. isolated from fecal matter of elephant (*Elephas maximus*)

Advances in Microbiology 3 (2013) 280-288

Abstract. A cellulase producing bacterium (E3 strain) was isolated from fecal matter of elephant and identified as *Bacillus* sp. using 16S rDNA sequenced based molecular phylogenetic approach. While studying the effect of substrates like Carboxymethyl cellulose (CMC), avicel, starch, maltose, sucrose, glucose, fructose, galactose and lactose on cellulase production, it was found that CMC was best carbon source induced cellulase production followed by lactose in this bacterial strain. A positive synergistic effect of lactose with CMC was also observed with enhancement of 5 - 6 times in cellulase production. The optimum cellulase production was recorded with 1% CMC and 1% lactose when added individually in the Omeliansky's medium. The results showed that addition lactose with CMC greatly enhances the production and activity of various cellulase enzymes. The optimal fermentation conditions for the biosynthesis of cellulase by this strain were found to be temperature: 37˚C, pH 7.0. The nitrogen source NH4Cl at 0.15% was optimum for cellulase production by this bacterium. © 2013 The Authors.

P. Sarkar, S. Verma & V. Menon

Food selection by Asian elephant (*Elephus maximus*) in Kameng Elephant Reserve in Northeast India

The Clarion 1 (2012) 70-79

Abstract. A study was conducted to find out the food selection by Asian elephant (*Elephus maximus*) in Kameng Elephant Reserve (KER) during 2001-05. For this, two methods were followed viz (i) twelve trails were surveyed 42 times covering different seasons to record the feeding sign of elephant and (ii) another six trails were laid for vegetation sampling to know the abundance and distribution of different food plant on the habitat. A total of 36 quadrats each with 10 x 10m were plotted at every 500 meter interval of each trail. The vegetation data (food plants) was processed using computer programs Biodiversity Pro and EstimateS 8.0. Species diversity, evenness, spatial distribution, and similarity matrix were calculated. The study found that the Asian elephant selected 46 species of plant as food belonging to 26 families. Plant family Arecacea (Calamus sp.) was selected more as food followed by Moracea (Artocarpus, Ficus species). Although only 18% food plants show significant random distribution (out of 77% species random distribution) and most of the food plants seem to have scattered distribution. The relative abundance of the food species consumed by elephant appeared to be on an average only 0.8 % (SE = 0.3) of the total number of tree species found in the sampled region. This random distribution and relatively low abundance of food species may result in wider movement or distribution of elephants in search of food plants.

W. Schaftenaar

Delayed postpartum fetotomy in an Asian elephant (*Elephas maximus*)

J. of Zoo and Wildlife Med. 44 (2013) 130-135

Abstract. A 37-yr-old Asian elephant (*Elephas maximus*) started parturition after 640 days of pregnancy but no fetal parts entered the birth canal. Despite veterinary intervention, the calf was not delivered. After 13 mo calving resumed and a full-term dead calf advanced into and lodged within the vagina. With standing xylazine tranquilization, the dam received a vagino-vestibulotomy to permit total fetotomy of the calf, which presented with bilateral carpal arthrogryposis. Severe infection of the caudal vaginal vestibulum complicated wound healing, and over the following year two corrective surgeries were performed, which resolved the fistula 3 mo after the second debridement. The elephant not only survived the procedures but also resumed normal estrous cycles, as demonstrated by blood progesterone concentration monitoring.

A.F. Sitompul, C.R. Griffin , N.D. Rayl & T.K. Fuller

Spatial and temporal habitat use of an Asian elephant in Sumatra

Animals 3 (2013) 670-679

Abstract. Increasingly, habitat fragmentation caused by agricultural and human development has forced Sumatran elephants into relatively small areas, but there is little information on how elephants use these areas and thus, how habitats can be managed to sustain elephants in the future. Using a Global Positioning System (GPS) collar and a land cover map developed from TM imagery, we identified the habitats used by a wild adult female elephant (*Elephas maximus sumatranus*) in the Seblat Elephant Conservation Center, Bengkulu Province, Sumatra during 2007–2008. The marked elephant (and presumably her 40–60 herd mates) used a home range that contained more than expected medium canopy and open canopy land cover. Further, within the home range, closed canopy forests were used more during the day than at night. When elephants were in closed canopy forests they were most often near the forest edge vs. in the forest interior. Effective elephant conservation strategies in Sumatra need to focus on forest restoration of cleared areas and providing a forest matrix that includes various canopy types.

A.F. Sitompul, C.R. Griffin & T.K. Fuller

Sumatran elephant ranging behavior in a fragmented rainforest landscape

International Journal of Biodiversity and Conservation 5 (2013) 66-72

Increasingly, habitat fragmentation by agricultural and human development has forced Sumatran elephants (*Elephas maximus sumatranus*) into relatively small areas; yet, there is no information on the movements and home range behaviors of elephants on Sumatra. Using a GPS collar, we estimated the home range sizes of an adult female elephant (one of a herd of 40 to 60) in the Seblat Elephant Conservation Center (SECC), Bengkulu Province of Sumatra in 2007 to 2008. We assessed the level of autocorrelation among elephant locations, and used correlation and logistic regression analyses to examine relationships between elephant movements and monthly rainfall, and elephant locations with the remotely sensed enhanced vegetation index (EVI), and distance to roads and rivers. Overall home range size was 97.4 km^2 for the minimum convex polygon (MCP), and 95.0 km^2 for the 95% fixed kernel (FK), estimator. There were no relationships between average monthly elephant home range sizes or movement distances with rainfall. Distances to rivers and ex-logging roads had little effect on elephant locations, but EVI, an index of canopy photosynthetic capacity, did correspond with elephant locations, occurring predominately in forests with intermediate canopy cover versus closed canopy forests. Consistent food and water availability in the lowland forests of the SECC in combination with high human development surrounding the center probably affect the small home range size.

N.M. Srinivasaiah, V.D. Anand, S. Vaidyanathan & A. Sinha

Usual populations, unusual individuals: Insights into the behavior and management of Asian elephants in fragmented landscapes

PLoS One 7 (2012) e42571

Abstract. Background: A dearth in understanding the behavior of Asian elephants (*Elephas maximus*) at the scale of populations and individuals has left important management issues, particularly related to human-elephant conflict (HEC), unresolved. Evaluation of differences in behavior and decision-making among individual elephants across groups in response to changing local ecological settings is essential to fill this gap in knowledge and to improve our approaches towards the management and conservation of elephants. Methodology/Principal Findings: We hypothesized certain behavioral decisions that would be made by Asian elephants as reflected in their residence time and movement rates, time-activity budgets, social interactions and group dynamics in response to resource availability and human disturbance in their habitat. This study is based on 200 h of behavioral observations on 60 individually identified elephants and a 184-km^2 grid-based survey of their natural and anthropogenic habitats within and outside the Bannerghatta National Park, southern India during the dry season. At a general population level, the behavioral decisions appeared to be guided by the gender, age and group-type

of the elephants. At the individual level, the observed variation could be explained only by the idiosyncratic behaviors of individuals and that of their associating conspecific individuals. Recursive partitioning classification trees for residence time of individual elephants indicated that the primary decisions were taken by individuals, independently of their above-mentioned biological and ecological attributes. Conclusions/Significance: Decision-making by Asian elephants thus appears to be determined at two levels, that of the population and, more importantly, the individual. Models based on decision-making by individual elephants have the potential to predict conflict in fragmented landscapes that, in turn, could aid in mitigating HEC. Thus, we must target individuals, in addition to populations, in our efforts to manage and conserve this threatened species, particularly in human-dominated landscapes.

S. Sripiboon, P. Tankaew, G. Lungka & C. Thitaram

The occurrence of elephant endotheliotropic herpesivrus in captive Asian elephants (*Elephas maximus*): First case of EEHV4 in Asia

J. of Zoo and Wildlife Med. 44 (2013) 100-104

Abstract. Elephant endotheliotropic herpesvirus (EEHV) is a type of herpesvirus that causes acute hemorrhagic disease in Asian elephants (*Elephas maximus*) and is often fatal, especially in calves. This study describes the postmortem evaluation of two captive-born Asian elephants (2 and 3 yr of age, respectively) diagnosed with EEHV in Thailand. Both elephants presented only mild depression, lethargy, and anorexia before death within 24 hr of symptom onset. Necropsies were performed, and tissue samples were tested for EEHV viral presence using polymerase chain reaction. Molecular and phylogenetic evidence illustrated two types of EEHV, which were closely related to EEHV1A in Case 1 and EEHV4 in Case 2. Pathologic findings differed between the cases. More specific organ tropism was found in Case 1, where mainly the cardiovascular system was affected. In contrast, in Case 2, hemorrhages were noted in most organs, including in the gastrointestinal, respiratory, and cardiovascular systems. This report is the first to document EEHV4 in Asia and the second case of this strain to be identified in an elephant worldwide.

J.J. Stanton, J.-C. Zong, C. Eng, L. Howard, J. Flanagan, M. Stevens, D. Schmitt, E. Wiedner, D. Graham, R.E. Junge, M.A. Weber, M. Fischer, A. Mejia, J. Tan, E. Latimer, A. Herron, G.S. Hayward & P.D. Ling

Kinetics of viral loads and genotypic analysis of elephant endotheliotropic herpesvirus-1 infection in captive Asian elephants (*Elephas maximus*)

J. of Zoo and Wildlife Medicine 44 (2013) 42-54

Abstract. Elephant endotheliotropic herpesviruses (EEHVs) can cause fatal hemorrhagic disease in juvenile Asian elephants (*Elephas maximus*); however, sporadic shedding of virus in trunk washes collected from healthy elephants also has been detected. Data regarding the relationship of viral loads in blood compared with trunk washes are lacking, and questions about whether elephants can undergo multiple infections with EEHVs have not been addressed previously. Real-time quantitative polymerase chain reaction was used to determine the kinetics of EEHV1 loads, and genotypic analysis was performed on EEHV1 DNA detected in various fluid samples obtained from five Asian elephants that survived detectable EEHV1 DNAemia on at least two separate occasions. In three elephants displaying clinical signs of illness, preclinical EEHV1 DNAemia was detectable, and peak whole-blood viral loads occurred 3–8 days after the onset of clinical signs. In two elephants with EEHV1 DNAemia that persisted for 7–21 days, no clinical signs of illness were observed. Detection of EEHV1 DNA in trunk washes peaked approximately 21 days after DNAemia, and viral genotypes detected during DNAemia matched those detected in subsequent trunk washes from the same elephant. In each of the five elephants, two distinct EEHV1 genotypes were identified in whole blood and trunk washes at different time points. In each case, these genotypes represented both an EEHV1A and an EEHV1B subtype. These data suggest that knowledge of viral loads could be useful for the management of elephants before or during clinical illness. Furthermore, sequential infection with both EEHV1 subtypes occurs in Asian elephants, suggesting that they do

not elicit cross-protective sterilizing immunity. These data will be useful to individuals involved in the husbandry and clinical care of Asian elephants.

N. Stephens, L. Vogelnest, C. Lowbridge, A. Christensen, G.B. Marks, V. Sintchenko & J. McAnulty

Transmission of *Mycobacterium tuberculosis* from an Asian elephant (*Elephas maximus*) to a chimpanzee (*Pan troglodytes*) and humans in an Australian zoo

Epidemiology and Infection 141 (2013) 1488-97

Abstract. *Mycobacterium tuberculosis* is primarily a pathogen of humans. Infections have been reported in animal species and it is emerging as a significant disease of elephants in the care of humans. With the close association between humans and animals, transmission can occur. In November 2010, a clinically healthy Asian elephant in an Australian zoo was found to be shedding *M. tuberculosis*; in September 2011, a sick chimpanzee at the same zoo was diagnosed with tuberculosis caused by an indistinguishable strain of *M. tuberculosis*. Investigations included staff and animal screening. Four staff had tuberculin skin test conversions associated with spending at least 10 hours within the elephant enclosure; none had disease. Six chimpanzees had suspected infection. A pathway of transmission between the animals could not be confirmed. Tuberculosis in an elephant can be transmissible to people in close contact and to other animals more remotely. The mechanism for transmission from elephants requires further investigation. © 2013 Cambridge University Press.

N. Sthitmatee, T. Warinrak & W. Wongkalasin

Susceptibility of *Clostridium difficile* isolated from healthy captive Asian elephants to metronidazole and vancomycin

Thai J. of Veterinary Med. 43 (2013) 313-316

Abstract. Susceptibility to metronidazole and vancomycin, drugs of choice for *Clostridium difficile* infection, of 15 *C. difficile* isolates from 6 healthy Asian elephants was determined. All of the isolates belonged to only 1 ribotype pattern and carried both toxin A and B genes. The Minimal inhibitory concentration range of metronidazole and vancomycin, drugs of choice for treatment of *C. difficile* infection, was 0.125-4.0 μg/ml and 0.125-2.0 μg/ml, respectively. Moreover, MIC50 and MIC90 for metronidazole were 0.75 and 1.5 μg/ml while vancomycin was 1.0 and 2.0 μg/ml. There was no evidence of resistance to these antimicrobials. These results might be a preliminary data for further study of animal *C. difficile*.

S.J. Sugumar & R. Jayaparvathy

An early warning system for elephant intrusion along the forest border areas

Current Science 104 (2013) 1515-1526

Abstract. Man–animal conflict has been on the rise in the forest border areas with herds of wild pachyderms straying into human habitation. The surveillance and tracking of elephant herds are difficult due to their size and nature of movement. In this article, we present an analytical procedure to study the behaviour of elephants along forest border areas by taking migration data into consideration using a three-state Markov chain. The migration data over the whole year is divided into four different periods for the study. We also develop an intrusion detection system to detect the intrusion of herds of wild elephants from the forests into the human habitation and to send an early warning through SMS to the forest officials to take necessary action. We validate the analytical results in comparison with the data obtained from the Forest Department. We also present a multi-class classification algorithm for providing zero false alarm rate. Species classification accuracy percentage is found to be 91.25.

S. Sulandari & M.S.A. Zein

Mitochondrial DNA variation of the Sumatran elephant populations in Sumatera, Indonesia

Biotropia 19 (2012) 92-102

Abstract. Genetic analysis of Mitochondrial DNA diversity in Sumatran elephant (*Elephas maximus sumatranus*) was conducted. A 630 bp segment of mitochondrial DNA was amplified from 105 different Sumatran elephant samples from 5 locations in Sumatera (Bentayan, Sugihan, Bukit Salero Lahat, Seblat, Way Kambas) using a set of primers: MDL3 (5'-CCCACAAT-TAATGGGCCC-GGAGCG-3') and MDL5 (5'-TTACATGAATTGGCAGCCA-ACCAG-

3'). The objectives of this study were to generate mitochondrial DNA D-loop sequences for all available Sumatran elephant samples and to define haplotypes and nucleotide sequence diversity of the different Sumatran elephant populations. The nucleotide sequence of a total of 105 PCR products were successfully determined with an average length of 616 bp. However, mitochondrial DNA fragments for this analysis used the first 601 bases. Six different haplotypes (BP, BT, BS, BR, BX and BY) were identified in Sumateran elephant populations. The majority of the sampled individuals carried haplotype BT. BX and BY are most likely novel derived haplotypes. All haplotypes, except for the haplotype BP belong to the Sumatera clade. The haplotype BX was derived from the haplotype BT, and the haplotype BY was derived from the haplotype BS by one transversion, respectively. All the other substitutions identified in this network were transitions. The haplotype BP is widely distributed from Sri Lanka, Sumatera, Peninsular Malay and China. Although reported to be distributed in Sumatera and Peninsular Malay the haplotype BU was not detected among the samples analysed in this study. Genetic distances within populations in Bentayan, Bukit Salero Lahat, Seblat, Sugihan and Way Kambas ranged from 0.0000 - 0003, and the genetic distance between the populations that is 0.0000 - 0.0022. The distance between haplotypes of different Sumatran elephant populations was shown to be low. The diversity of haplotypes and nucleotides in Sumatera Island were low, the highest diversity was found in elephants sampled in the region of Bukit Salero Lahat and the lowest was found in elephants from Bentayan and Sugihan. Overall, the results of analysis of Fu and Li's F*test statistic indicates that the population of Sumatran elephants in Sumatra is -0.78871, which suggests that there is no inbreeding. However, the results are not significant (P>0.10) and additional studies are required to confirm this finding.

I.C. Suter, M. Hockings & G.S. Baxter
Changes in elephant ownership and employment in the Lao PDR: Implications for the elephant-based logging and tourism industries
Human Dimensions of Wildlife 18 (2013) 279-291

Abstract. Communities in the Lao People's Democratic Republic (PDR) have been utilizing captive Asian elephants (*Elephas maximus*) for centuries. The elephant handler (mahout) profession has remained fundamentally unchanged. Captive elephants, however, are no longer necessary in roles where they were once considered vital, particularly the logging industry. To gauge mahout demographics and assess problems associated with elephant industries, we surveyed 133 mahouts in the Lao PDR. We found that mahoutship is an aging industry with a vanishing family association. Contrasts between logging and tourism mahouts were apparent when observing family tradition, finances, and industry-related experiences. Logging mahouts rely on tourism to provide them with future employment; however, tourism cannot currently employ elephants on a scale similar to that of logging operations. The need for the traditional mahout and a large population of captive elephants may have reached its finality in Laos. © 2013 Taylor & Francis Group, LLC.

G.S. Wilkie, A.J. Davison, M. Watson, K. Kerr, S. Sanderson, T. Bouts, F. Steinbach & A. Dastjerdi
Complete genome sequences of elephant endotheliotropic herpesviruses 1A and 1B determined directly from fatal cases
Journal of Virology 87 (2013) 6700-6712

Abstract. A highly lethal hemorrhagic disease associated with infection by elephant endotheliotropic herpesvirus (EEHV) poses a severe threat to Asian elephant husbandry. We have used high-throughput methods to sequence the genomes of the two genotypes that are involved in most fatalities, namely, EEHV1A and EEHV1B (species *Elephantid herpesvirus 1*, genus *Proboscivirus*, subfamily Betaherpesvirinae, family Herpesviridae). The sequences were determined from postmortem tissue samples, despite the data containing tiny proportions of viral reads among reads from a host for which the genome sequence was not available. The EEHV1A genome is 180,421 bp in size and consists of a unique sequence (174,601 bp) flanked by a terminal direct repeat (2,910 bp). The genome contains 116 predicted protein-coding genes, of which six are fragmented, and seven paralogous gene families are present.

The EEHV1B genome is very similar to that of EEHV1A in structure, size, and gene layout. Half of the EEHV1A genes lack orthologs in other members of subfamily Betaherpesvirinae, such as human cytomegalovirus (genus Cytomegalovirus) and human herpesvirus 6A (genus *Roseolovirus*). Notable among these are 23 genes encoding type 3 membrane proteins containing seven transmembrane domains (the 7TM family) and seven genes encoding related type 2 membrane proteins (the EE50 family). The EE50 family appears to be under intense evolutionary selection, as it is highly diverged between the two genotypes, exhibits evidence of sequence duplications or deletions, and contains several fragmented genes. The availability of the genome sequences will facilitate future research on the epidemiology, pathogenesis, diagnosis, and treatment of EEHV-associated disease. © 2013 American Society for Microbiology.

G. Wilson, A.A. Desai, D.A. Sim & W.L. Linklater

The influence of the invasive weed Lantana camara on elephant habitat use in Mudumalai Tiger Reserve, southern India

Journal of Tropical Ecology 29 (2013) 199-207

Abstract. Invasive weeds like *Lantana camara* have a range of effects on animals such as elephant. These plants are not edible by the Asian elephant (*Elephas maximus*). They also compete for space with elephant food plants and take over large areas of elephant habitat. We tested whether the addition of *L. camara* to a model consisting of measured environmental variables improved predictions of habitat use by elephant in Mudumalai Tiger Reserve, India. Elephant dung density was used to assess elephant habitat use from 62 line transects 1-km in length. Results indicated that habitat and impact of human settlements significantly influenced elephant habitat use at a landscape scale. However, we found no evidence for the hypothesis that the addition of *L. camara* significantly predicted elephant habitat use at the landscape level. We then tested the association of *L. camara* on elephant habitat use in the dry deciduous forest (DDF) where there was a significant interaction between DDF and *L. camara*. In the DDF, *L. camara* significantly predicted elephant habitat use. We conclude that while no significant effects of *L. camara* were seen at the level of an entire reserve, at a finer scale and in specific habitats negative effects of this invasive plant on elephant habitat use were observed. © 2013 Cambridge University Press.

S. Yasui, A. Konno, M. Tanaka, G. Idani, A. Ludwig, D. Lieckfeldt & M. Inoue-Murayama

Personality assessment and its association with genetic factors in captive Asian and African elephants

Zoo Biology 32 (2013) 70-78

Abstract. Elephants live in a complex society based on matrilineal groups. Management of captive elephants is difficult, partly because each elephant has a unique personality. For a better understanding of elephant well being in captivity, it would be helpful to systematically evaluate elephants' personalities and their underlying biological basis. We sent elephant' personality questionnaires to keepers of 75 elephants. We also used 196 elephant DNA samples to search for genetic polymorphisms in genes expressed in the brain that have been suggested to be related to personality traits. Three genes, androgen receptor (AR), fragile X related mental retardation protein interacting protein (NUFIP2), and acheate-scute homologs 1 (ASH1) contained polymorphic regions. We examined the association of personality with intraspecific genetic variation in 17 Asian and 28 African elephants. The results suggest that the ASH1 genotype was associated with neuroticism in Asian elephants. Subjects with short alleles had lower scores of neuroticism than those with long alleles. This is the first report of an association between a genetic polymorphism and personality in elephants. © 2012 Reproduced with permission of John Wiley & Sons, Inc.



Wild elephants waiting to be fed (Sri Lanka)

News Briefs

Compiled by Jayantha Jayewardene, Editor

1. Thorough probe over death of elephants: Musa (Malaysia)

New Straits Times - 30.1.2013

Sabah Chief Minister Datuk Seri Musa Aman wants the State Wildlife Department and Forestry Department to immediately and thoroughly investigate the death of 10 elephants in Tawau recently. He said the state government viewed this matter seriously as Borneon pygmy elephants were an endangered species.

Yesterday it was reported that 10 Bornean elephants had been found dead within two weeks in a forest reserve in Tawau. The elephants, seven males and three females, were from a single herd while a three-month calf was found alive next to what appears to be its mother.

Expressing shock over the death of Borneo pygmy elephants, Musa said that these elephants were part of Sabah's rich and exotic wildlife and should therefore be protected. "People come from all over the world just to catch a glimpse of these animals. It is unfortunate that there are people who would resort to such a horrific act, " he said.

2. Thermo-scan to predict elephant musth

Deccan Chronicle - 30.7.2013

Thanks to newly developed non-invasive diagnostic equipment, elephant handlers and festival organisers will soon be able to forecast the 'musth' period of tuskers without having to physically restrict verify it. The device, called Thermo-scan, measures the heat emitted by the elephant's body with its high sensitivity to visualise pathological changes in the animal. The device absorbs the radiated heat emitted from the elephant's body and converts it into a colour image. The spectrum of colours depicts the temperature patterns. The system, with a sensitivity of 0.1 degrees centigrade, enables daily measuring of temperature of the musk gland area, enabling the estimation of the onset of musth at the initial stage.

3. Electronic fence to safeguard elephants (Vietnam)

TuoiTre News - 16.2.2013

The Natural and Cultural Reserve in Dong Nai Province has set up a project to build an electronic fence around a forest to protect the living environment of both local residents and the dwindling elephant population. The fence, which is expected to be 30 kilometers long, will be built in the forest areas in Phu Ly and Ma Da Communes, Vinh Cuu District with a total cost of about VND 9 billion (US$432,000). The project is aimed at preventing a herd of more than 10 wild elephants from attacking or causing damage to locals, while also protecting the animals from being harmed by poachers.

However, the project has yet to be developed since many households have objected to it. They complain that the fence will block the normal paths to their cultivation areas in the communes. According to statistics, Vietnam now has between 75 and 130 wild elephants, mainly in Dong Nai, central Nghe An Province and the Central Highlands province of Dak Lak.

4. Tuskers feast on Umling maize fields (Bhutan)

Kuensel Online - 1.7.2013

A week ago, three elephants, a cow and two calves, entered the maize fields in Umling. The elephants were initially spotted in Dungmin village a week ago, and were found to have

moved to Dangling village two days later. Gup Ugyen Norbu said they don't know how much of the maize fields have been destroyed by the three tuskers. He said it had been some time since they didn't face problems from elephants, especially after the community forest was started.

"We didn't even send domestic animals to that side of the forest where elephants are spotted, thinking it would protect their area and to prevent them from coming to villages," said the villagers. Ap Gyeltshen said one from each household goes to the field every evening to chase the elephants after an early dinner. "We use burning torches to chase the elephants whenever we spot them."

Karma, another villager said the situation now is nothing compared to what they used to experience less than a decade ago. However, she said with electricity, and an increasing number of people in the village, wildlife attacks have decreased. Elephants mostly attack maize, paddy fields, banana and millet, said Karma.

5. Wild jumbos threat to tame ones (India)

The New Indian Express - 23.2.2013

Not ready to take any chances, the state Forest Department has asked mahouts and kavadis not to take tame elephants, especially those who participate in the Mysore Dasara, deep into the jungle, fearing attacks by wild pachyderms. Attacks on tame elephants have become a common feature as they are generally freed after sunset for grazing. If wild elephants are in 'musth,' they get aggressive and attack whoever comes their way. Killing of tame elephants by wild ones has been reported in the past.

This follows last week's tragic death of Rajendra, a 33-year-old tusker, when a wild elephant attacked him near Sakrebail elephant camp. Usually, the tame elephants fight back, but Rajendra was helpless, resulting in his gory death.

The biggest worry is that the elephants that participate in the Mysore Dasara every year are also housed in various camps. The department is not ready to take any chances, especially with the Jumbo Savari elephants. Chief Conservator of Forests of Project Elephant Ajay Mishra said that he has instructed officials to be careful while releasing pachyderms for grazing. The mahouts have been asked to look out for wild elephants before releasing the tame ones in forests.

6. Wildlife dept scotches myth of 'pygmy' jumbo in Kerala (India)

Manorama Online - 8.2.2013

The now-on-and-now-off claims of the presence of a 'pygmy' elephant in Kerala forests has once again been put to an end by the Forest Department. Wildlife authorities recently took an elephant into custody for observation after a nature photographer claimed to have spotted and videoed a 'pygmy' elephant at Manithukki sector on slopes of the Western Ghats.

After observing the small jumbo closely for the last five days, experts concluded that it is just an ordinary calf and not the dwarf variety as claimed by the lensman and local tribals. The claims of existence of dwarf elephants in the area are just a "folklore myth," a senior wildlife official said.

"What we found was a lean male jumbo, suffering from malnutrition near Manithukki area on February 1. It is a six-year-old calf, not the pygmy as claimed by tribes people. The existence of the dwarf elephant is just a folklore myth," said V Gopinath, Principal Chief Conservator (Wildlife).

7. Understanding elephants' needs to reduce conflicts (Malaysia)

Borneo Post - 17.2.2013

Scientific information is extremely important and valuable for both conservation managers and research scientists in their effort to manage and save the Bornean elephants. Among the major threats facing the Bornean elephants presently are the degradation and fragmentation of their habitat, which incidentally raises their risk of genetic isolation from other elephant

populations, particularly when their traditional seasonal migratory routes are blocked.

Herds were found to cover greater distances under three circumstances. 1) When the elephants were affected by elephant control activities' such as the use of firecrackers and drums to scare them off the plantations; 2) When the elephants enter unsuitable forest habitats such as swamp areas and upland forest probably due to limited food resources and 3) When elephants were forced to travel through narrow habitat corridors, sometimes as narrow as 30 to 50 meters along rivers that were bordered by oil palm plantations.

Studying their feeding behavior, Raymond Alfred has recorded at least 140 species of plants. Five of the main families consumed by the elephants were Palmae (13%), Moraceae (13%), Euphorbiaceae (10%), Leguminoceae (9%) and Graminaeae (8%). All the evidences collected supports the fact that food sources from woody climbers, grasses, trees and bamboos dominated the elephants' diet in the rainforest area.

8. Ten wandering pygmy elephants in Sabah translocated to Tabin elephant range (Malaysia)

The Star Online - 27.2.2013

Ten Borneo pygmy elephants that had ventured more than 45 km from the Tabin Managed Elephant Range, ending up 10 km from Lahad Datu town, were rescued over a period of one week from Jan 18. The effort coordinated by the Wildlife Rescue Unit (WRU) under the Sabah Wildlife Department saw nine female elephants taken back to the Tabin Wildlife Reserve, while a sole young male aged about four years was sent to Lok Kawi Wildlife Park near Kota Kinabalu due to severe injury to his trunk, which was probably caused by a snare trap.

Establishing corridors within plantations and between forest reserves can be a solution to mitigate conflicts. There is also an urgent need to stop any land conversion in elephant ranges as stated in the recently launched State Elephant Action Plan.

9. Camera fixed trains to detect elephants on tracks (Sri Lanka)

Daily News - 1.3.2013

Sri Lanka Railways has taken measures to rescue wild elephants that stray onto railway tracks and risk being hit by moving trains. Transport Minister Kumara Welgama yesterday commenced a project to install video cameras on engines of trains plying across elephant infested areas in the country. The project commenced at the Fort railway station with the fixing of a new video camera on the engine of the Batticaloa bound train, yesterday morning, as a pilot project.

The cost incurred to fix one night vision camera on a train engine is around Rs. 2.7 million. The project will be sponsored by Dialog and carried out by the Sri Lanka Railways together with the Wildlife Conservation Department. These night vision video cameras will be fixed on engines of trains plying across elephant corridors in areas,such as, Trincomalee, Habarana, Vavuniya, Galoya, Baticaloa and Galgamuwa.

The camera has the capacity of capturing the images of elephants and other animals based on their heat sensitivity within a range of one kilometre and the clear image of the animal would be displayed on monitors with a range of 300 meters. Between 10 to 15 wild elephants are knocked down by trains every year.

10. 49 elephants killed on railway tracks since 2010 (India)

Times of India - 1.3.2013

The highest number of 20 elephant casualty on rail tracks took place in 2010, followed by 15 last year. Nine such incidents were reported in 2011. As many as 49 elephants have been killed on railway tracks since 2010 including five in January this year, the Rajya Sabha was informed on Friday.

In a written reply, Railway Minister Pawan Kumar Bansal said his ministry is holding regular meetings with the Environment Ministry to take

remedial measures for controlling elephant casualties. "Elephant corridors have been identified by the Forest Department and on such corridors speed restrictions have been imposed and signage boards provided to pre-warn the train drivers," he said. He also said that advisories have been issued to zonal railways to sensitise train crew and station masters on regular basis.

11. China pledges to fight against ivory trade

Xinhua - 5.3.2013

China is determined to work with the international community to curb ivory trade and protect wild elephants, officials said on Monday. In its Ivory Trade Report submitted to the ongoing 16th Convention on International Trade in Endangered Species (CITES), the Chinese delegation outlines the nation's effort in combating illicit ivory trade and the measures for protecting wild elephants.

China has not completely banned its domestic ivory market but sets the limit on the amount of legal consumption at six tons per year. The ivory that are allowed for sale in the market come from two sources: those that were imported before CITES took effect and those bought by China from four African countries' stocks as permitted by CITES in 2008. All other elephant tusks circulated in the market are labelled as illegal, according to Meng.

12. Pungent paste to keep jumbos at bay (India)

Times of India - 4.3.2013

The Athagarh forest division has come out with a bulwark prepared with paste of red hot chillies, tobacco leaves and used engine oil to prevent marauding elephants from straying into human habitats and paddy fields. The paste will be smeared on cotton rope fences around paddy fields to keep the pachyderms away. The acrid smell of the paste will keep the jumbos at bay.

The project will be implemented at Sarkoli village on Monday on a pilot basis, and if it works the forest officials will extend it to other parts of the division. Sarkoli village is prone to frequent elephant attacks. The method has been successfully experimented in states like Assam and Karnataka.

The aim is to reduce man-animal conflict in the region. Farmers in villages around Athagarh have been suffering massive agricultural losses owing to elephant menace. Herds of elephants recently entered Tangi and Choudwar area and wreaked havoc.

According to 2012 census, the population of elephant in Athagarh division is 131. In that year, the elephants had destroyed 2400 acres of paddy fields in the division. Since April, 2012, at least three elephant deaths have been recorded in the division. Due to shrinking habitats, the elephants are venturing out of forests in search of food.

13. Ivory trade threatens Myanmar's elephants

Myanmar Times - 4.3.2013

The thirst for illegal ivory is killing Myanmar's Asian elephants. Over the past 20 years, the population of these rare creatures has declined by nearly 2000, the Ministry of Environmental Conservation and Forestry's anti-trafficking official said. Just 2500 to 3000 Asian elephants are thought to survive in the wild in Myanmar, down from 6000 in 1960-1970 and 4639 in 1991.

"The main reason is the declining population of male elephants," said U Win Naing Thaw, director of the department's Nature and Wildlife Conservation Division. The picture is likely to get worse because of illegal ivory poaching, human encroachment on natural habitats, and hunting for medicinal or other purposes. Male elephants are the main targets because only they have tusks – females don't.

Asian elephants are listed as "completely protected" under the 1994 Protection of Wild Animals, Wild Plants and Conservation of Natural Areas Law, as well as enjoying international protection under the Convention on International Trade in Endangered Species of Wild Fauna

and Flora (CITES). Myanmar is a member of CITES, which prohibits commercial trade in live specimens, their parts or derivatives. However, ivory can be found on sale in retail outlets in Yangon, Mandalay, Tachileik, Myawaddy and Muse, and is openly sold, often to buyers from China and Thailand.

14. New plantation concessions threaten Borneo pygmy elephants (Indonesia)

Mongabay - 10.3.2013

Borneo pygmy elephants (*Elephas maximus borneensis*) are under threat in Indonesia's new North Kalimantan province, where their habitat is set to be converted for rubber, jabon and sengon plantations. Experts worry that if the planned conversion goes ahead, the entire elephant population in Indonesian Borneo could be lost.

Two forest plantation companies – PT Borneo Utara Lestari (PT BUL) and PT Intracawood Manufacturing (PT IWM) – have been granted Industrial Plantation Forest (HTI) concessions in Tulin Onsoi in North Kalimantan's Nunukan district. Both concessions fall within the Heart of Borneo, an area the Indonesian, Malaysian, and Brunei governments have committed to manage sustainably, and overlap significantly with pygmy elephant habitat.

The International Union for Conservation of Nature (IUCN) has classified Asian elephants, of which the Borneo pygmy elephant is a subspecies, as endangered. Research indicates an estimated 20-80 pygmy elephants are living in North and East Kalimantan.

15. Tracking wild elephants to identify conservation areas and corridors (Malaysia)

Borneo Post - 18.3.2013

The Wildlife Rescue Unit (WRU) from Sabah Wildlife Department darted two female elephants, one adult and one juvenile in Gunung Rara Forest Reserve. The two females were part of the herd from which 14 individuals died from unknown cause. The adult female, named Dara by WRU rangers, was set up with a satellite collar provided by Danau Girang Field Centre.

"We also collected blood from Dara and a juvenile female from the same herd, following a request by the State Wildlife Enforcement Task Force. One of the causes of death of the 14 elephants could be an emerging or unknown disease. By analysing the blood of the living elephants from the same herd, it could help identifying the disease, if any," explained Ramirez.

Danau Girang Field Centre (DGFC) director Dr Benoit Goossens said by collaring an adult female from the herd, they hope to identify the movements of the herd within the changing landscape in Gunung Rara/Kalabakan region, and try to understand what could have happened to the 14 elephants that died last January.

16. 'Alpha Male' gores 20 female elephants to death (India)

Deccan Herald - 1.4.2013

As the wild jumbo, Alpha Male, is thought to have gored to death seven female elephants while in musth in the months between November 2012 and February this year, demand is growing for it to be shot down. But Periyar Tiger Reserve authorities say they don't have enough evidence to hold the elephant responsible for the deaths, although it has in the recent past allegedly killed 13 other female elephants in similar fashion. According to reports, the elephant turned violent in 2008-2009 and in 2012, killing the female elephants by goring them with his tusks.

"The issue should be settled either by shooting down the elephant or absolving him of the killings altogether. However there is no assurance that the elephant will not turn violent again during the musth period that falls between November and February and cause more deaths. So we should consider shooting it down," said a wildlife enthusiast, explaining that a special order from the Chief Wildlife Warden was necessary for bringing down the killer elephant.

17. Crime 'gangs shot elephant' (Thailand)

The Nation - 13.3.2013

At least three organised criminal gangs are suspected to be behind the illegal killing of a wild elephant in Kaeng Krachan National Park in Phetchaburi province, investigators said yesterday.

The first suspected gang was previously sentenced for killing wild elephants and has eluded arrest. The second suspected gang is a group of local people who shoot at wild elephants; and the third is a group of officials who have guns and hunt wild animals for sport. According to the investigator, some police officers might be involved in these organised criminal groups.

The primary investigation found that the bullets in the dead elephant came from AK47 rifles or M16 rifles. Local officials and investigators has set up a working group to track the criminal gangs. There is concern among international and local environmentalists - now convening at the 16th CITES conference in Bangkok - over illegal killing of wild elephants and the ivory trade.

Thailand has been designated with other eight countries as a watch-list nation for the illegal killing of elephants and ivory trade. The country is also classed as a destination for illegal ivory. Last week, Prime Minister Yingluck Shinawatra vowed to end ivory trade in Thailand.

18. Summer separates jumbos, calves (India)

The New Indian Express - 3.4.2013

The acute water scarcity in Bandipur forests is now leading to a pathetic situation — 'separation' of elephant calves from their mothers. At least three calves were 'deserted' by their mothers on the fringes of Bandipur in the last month when the herds strayed into agricultural fields in search of water and were scared by villagers who burst firecrackers.

In each case, the elephants ran towards the forest leaving the calves behind. The calves were spotted in villages near Hunsur, Periyapatna and Gopala Swamy Betta. Forest officials waited for a couple of days for the return of the elephants. But as the jumbos did not come back near the villages, the officials sent the calves to the Bandipur elephant camp.

They said elephants would stray into villages on the fringes of the forests in search of water during the summer, and this year the problem had become serious as the summer set in early. Veterinary doctor Nagaraj said the deserted calves could be the first babies of elephants, which did not know how to take care of them.

19. Over 12 jumbos die in Mudumalai (India)

Deccan Chronicle - 6.4.2013

While more than a dozen wild jumbos were said to have died due to dehydration and shortage of fodder in the Mudumalai Tiger Reserve (MTR) in recent times, the greens here accuse the MTR administration of poor water management and lack of care for animal health, for the jumbos' death.

These are not happy times for MTR as the dry weather has been prolonging since December. But, it appears that the MTR administration and chief wildlife warden (CWW) in the state failed to take up the challenge posed by the testing weather to protect the jumbos.

Though officials in MTR attributed natural causes for the jumbos' death, it is a fact that they died due to dehydration, lack of fodder and infections caused by contaminated water in slushy pools. It is learnt that the administration does not have sufficient facilities to provide tanker water in all the vulnerable areas. The TNGM would seek the intervention of the judiciary if the forest officials in Chennai failed to act to set right things in MTR for healthy animal life.

Jayachandran said MTR should learn lessons from the adjacent Bandipur tiger reserve in Karnataka where water management is good and the animals are taken care of. As officials in MTR declined to talk to the media,

citing instructions from the CWW, sources said the infighting and factions among the top officials and lack of planning were the reasons for the present situation.

20. Endangered Vietnam elephant 'skinned, disemboweled'

Agence France Presse - 6.4.2013

The skinned and mutilated corpse of one of Vietnam's dwindling population of endangered wild elephants has been discovered in a forest in central Quang Binh province, state media said Friday. The female elephant's skin, tail, tusks, ears and many internal organs had been removed, the Tuoi Tre newspaper said, quoting local forest rangers. It was not immediately clear why it was mutilated, but elephant ivory and other body parts are prized in Vietnam for decoration, as a talisman, and for use in traditional medicine.

Vietnam is home to some 100 wild elephants, according to state media, but habitat loss, human-animal conflict and poaching are seen as responsible for a sharp decline in the population in recent decades.

Environmental group WWF says Vietnam is one of the world's worst countries for trade in endangered species. Vietnam outlawed the ivory trade in 1992 but shops can still sell ivory dating from before the ban.

21. Karnataka high court dismisses PIL challenging translocation of 23 elephants to Madhya Pradesh (India)

Times of India - 12.4.2013

In an interesting development, the Karnatakka high court has dismissed a public interest litigation (PIL) challenging the proposal of the Karnataka government to translocate/transfer 23 elephants to Madhya Pradesh.

"In the instant case, the state government in its wisdom has taken a policy decision for the translocation of the elephants having regard to the expenditure to be incurred by in maintaining the said elephants and other considerations. These matters are within the realm of the state government. This court in exercise of its jurisdiction of article 226 of the constitution cannot sit in judgment over the decision of the state government to translocate the elephants concerned. It is also brought to our notice that the state had already brought this issue to the notice of the Ministry of Environment and Forest (central government). If that is so, then it is the matter between state government and the Madhya Pradesh government with central government having jurisdiction. We do not think that we can interfere, " a division bench headed by Chief Justice D. H. Waghela has observed while dismissing the PIL filed by animal rights/ welfare organizations. The petitioners have claimed violation of Wild life (protection) Act, 1972.

22. Sumatran elephants found dead, poisoning suspected

France 24 - 3.6.2013

Two critically endangered Sumatran elephants were found dead in an Indonesian national park and it is believed they were poisoned. It takes to three the number of the elephants found dead in Tesso Nilo National Park on Sumatra island in the last month. The carcasses of a male aged around five and a young female were found on Friday about a kilometre (0.6 miles) apart, said WWF spokeswoman Syamsidar, who goes by one name.

A Sumatran elephant was discovered dead in the park early last month, also from suspected poisoning. Fifteen Sumatran elephants were found dead last year in Riau province, where the national park is located, with around half them found to have been poisoned.

Fewer than 3000 Sumatran elephants remain in the wild, according to IUCN. Rampant expansion of palm oil and paper plantations and the mining industry have destroyed nearly 70 percent of the elephant's forest habitat over 25 years, according to the WWF, and the animals have been targeted by poachers.

23. In Assam, a village makes way for elephants (India)

NDTV - 5.6.2013

Now, for the first time in India, an entire village in Assam's Karbi Anglong district has decided to move out of an elephant corridor that supports as much as eight per cent of the total elephant population of India. It is a small step, but will go a large way towards helping more than 2000 elephants live a little more securely, with humans out of the way of their already fragile habitat.

At the Ram Terang village, deep inside Assam's heavily forested Karbi Anglong district, families say they are happy to get out of the way of elephants, literally. This village, falls in the middle of the Kalapahar-Daigurung elephant corridor in the district - a crucial connection for the area's 2000 elephants from the adjoining Kaziranga National Park to Karbi Anglong, which form more than eight per cent of the total elephant population of the country.

Moving freely across this corridor is a vital step to preserve an already shrinking elephant habitat, and the 19 families in the area are now preparing to become the first in the country to allow forest officials and the Wildlife Trust of India to relocate the entire village elsewhere, out of the corridor.

In return for relocation, the villagers get concrete homes with electricity and water, agricultural land, and assured livelihood promotion activities. The biggest challenge, though, will be to carry out the shifting without too many hitches.

24. Unmanned plane to help in jumbo hunt (Thailand)

Bangkok Post - 29.4.2013

Officials will install 20 cameras and use unmanned aerial vehicles (UAV) to locate a pachyderm, which officials believe might be a baby white elephant. They are undertaking the search in Kaeng Krachan National Park in Phetchaburi province after a photographer had reported seeing one in a herd on April 10.

Apichart Puangnoi spotted the calf from still photos of an elephant herd he took and then reported the sighting to park chief Chaiwat Limlikhit-aksorn. Mr Chaiwat has sent a unit of forestry guards to track down the elephant calf in a race to keep it safe from possible poachers.

Theerapat Prayurasiddhi, deputy chief of the Department of National Parks, Wildlife and Plant Conservation said cameras will be installed along elephant trails inside the park to help in the search. Officials would also send camera-mounted UAVs into the forest.

25. Accused elephant killers arrested (Thailand)

Bangkok Post - 6.6.2013

Two men suspected of killing two elephants in Kaeng Krachan National Park were arrested on Thursday, police said. Sanya Tuansap, 37, and his brother, Veerapong, 25, were caught in Hua Hin district, Prachuap Khiri Khan. They face charges of illegally killing the elephants inside the borders of the park in Kaeng Krachan district of Phetchaburi, police said.

They were apprehended under arrest warrants issued by the court after police found evidence, including forensic checks on bullets and witness testimony, indicating that their rifles fired the shots that killed the two animals. Mr Sanya and Mr Veerapong denied the charges.

The two elephants were killed, one in March and another in April, close to Krarang 3 reservoir deep inside the park's boundaries.

26. 'Mourning' elephants refuse to leave accident site (India)

Times of India - 5.8.2013

Around 15 elephants, who are mourning a member of their herd after it was hit by a train near Matari railway station under Dhanbad division of the East Central Railway on Howrah-New Delhi main railway route a couple of days ago, have attacked villages and demolished parts

of a school and several houses. Villagers have been keeping night-long vigil, but haven't been able to drive away the herd.

Elephants have a strong sense of family bonding and often resort to revenge attacks. They often try to return to the site of such accidents as they believe that their mate has only been injured and could be rescued by them. Even when an elephant dies a natural death, their friends cover the body with bushes and small tree branches.

A herd of elephants had stopped several trains on the main Delhi-Howrah route near Matari railway station on Wednesday night after one member of the herd was killed by the Kolkata-Delhi Duronto Express. The elephants left the area only after the railway's disaster management team with foresters arrived on the spot and burst crackers. The herd, however, did not go very far. Experts in chasing the jumbos and tried to chase them away but they did not go.

27. Villages under siege by herds of wild elephants (Myanmar)

Myanmar Times - 9.7.2013

Village residents in Thapeikyin township along the Ayeyarwady River say they have faced recent attacks from wild elephants. "At 11 pm on July 3, our village was spoiled by some five wild elephants. They destroyed houses and harmed the villagers. An old man aged of 68 years is now hospitalized after he was hit by the trunk of an elephant. The villagers are very frightened now," U Maung Naing from Kyaut Kwal village told The Myanmar Times on July 4.

U Kyaw Htay, the 68-year-old, was initially taken for medical treatment in Kyar Inn Sit Hospital and was moved on July 4 to the Neuro Medical Department at Mandalay Hospital. The residents said they have kept their villages guarded in order to threaten the wild elephants by shouting at them with torches and fires as the animals usually raid the villages in herds or individually by night.

The villagers from affected areas said they have had to reconsider their crop-growing strategies, as they fear danger from the wild elephants. "We have given education about wild elephants to the inhabitants. We asked them just to threaten by shouting but not to fight the animals with weapons such as knife, stick or catapult.

28. Growers find novel ways to keep away wild elephants (India)

Deccan Herald - 20.6.2013

Wild elephant menace in the coffee plantations in various parts of Kodagu has been increasing. The reason for the increase in the elephants entry into coffee plantations are the jackfruits and bananas grown in the plantations. In order to save their coffee plantations from elephants, coffee growers have begun to destroy banana and jackfruit yields in their plantations.

Wild elephant menace is rampant in Aiguru, Kandanakolli, Kodlipet in Somwarpet taluk and Srimangala, Ammathi, Ponnampet in Virajpet taluk. Forests in these areas mostly comprise of teak wood which is why elephants are falling short of food. In addition, the water pits dug to supply water to coffee plants too are inviting elephants to enter coffee plantations to drink water. Repeated requests of the villagers to the forest department to chase elephants back to the forest have gone futile.

Speaking to Deccan Herald, coffee plantation labour Murugesh said that with the broken solar fences, the coffee growers have no other option but to cut jackfruit and banana plantations.

29. Wild elephants wander into southwest China village

NTDTV - 21.6.2013

Six wild elephants recently wandered into a village in Mengla County in southwest China's Yunnan Province, surprising villagers. The villagers called local police at 12:30 on Wednesday, telling them that wild elephants had appeared all around the village and that one of the young elephant's legs was injured.

"After the call, I immediately organized the police and rushed to the spot. We brought the villagers to a safe area, and sent officers to follow and watch over the elephants. I came here after 12:00, only to see six elephants coming out from the rubber plantation."

According to villagers, this herd of elephants lives on the nearby mountains and often comes down to search for food. They may not have gone back up the mountain to wait for the baby elephant with a hurt leg. The elephants are still hanging around near the village.

30. Warning system to track elephant movement installed (India)

The Hindu - 29.6.2013

Forest Department personnel have installed two 'early warning systems' close to two settlements in the Anthiyur forest range to track movement of tuskers and to alert the people living there when the animals were nearing their localities.

Department sources said that the system that has already been installed in a few pockets in Sathyamangalam range has now been introduced in Anthiyur range to put an end to man-animal conflict and the loss of life and property. "The system has two laser cameras that are installed on either side of the path through which elephants could reach the village, speakers and BSNL SIM cards distributed to different stake holders," an official said.

He said that a censor connected to the cameras will send an sms alert to the mobile numbers of the District Forest Officer, Forester, Ranger, Forest Guard and to a member of the Village Forest Committee which have been registered with the censor.

"Anyone of them can give a blank call to a BSNL number given to them that is connected to the speaker near the village that is about a kilometre away from the place where the laser cameras have been installed, which will make repeated announcements of the movement of elephants in that locality to help people ready to guard themselves or move to a safer place, in a timely manner," the official said.

"The system functions with electricity supply. Steps are underway to make it function with rechargeable batteries so that it will function throughout the day even when there is a power cut," he added.

31. Fences, trenches have failed to check the human-elephant conflict in Karnataka (India)

Times of India - 26.6.2013

Approximately Rs 1200 crore: that's the money spent over the past eight years to check the human-elephant conflict in Karnataka and its bordering states. The project involved digging elephant-proof trenches, erecting solar fencing and creating fodder and water facilities in the forests.

Not surprisingly, the fences and trenches to prevent wild elephants straying out of their habitat either do not exist or have simply proved ineffective. "Crores of rupees have gone down the drain because of a lack of monitoring and poor maintenance," said a senior forest official, presenting in-house data. The figures reflect the expenditure on fencing and trenching since 2005 by five states -- Karnataka, Tamil Nadu, Kerala, Andhra Pradesh and Maharashtra.



Elephants in Pokunutenne (Sri Lanka)
Photo by Trevor LaBrooy

Instructions for Contributors

Gajah welcomes articles related to Asian elephants, including their conservation, management, and research, and those of general interest such as cultural or religious associations. Manuscripts may present research findings, opinions, commentaries, anecdotal accounts, reviews etc. but should not be mainly promotional.

All articles will be reviewed by the editorial board of *Gajah*. *Gajah* also has a peer reviewed section. Peer reviewed papers will carry a notation to that effect. Authors are requested to specify that they are submitting their paper to the "**peer reviewed section**". Word limits for submitted articles are for the entire article (title, authors, abstract, text, tables, figure legends, acknowledgements and references).

Correspondence: Readers are encouraged to submit comments, opinions and criticisms of articles published in *Gajah*. Such correspondence should be a maximum of 400 words, and will be edited and published at the discretion of the editorial board.

News and Briefs: Manuscripts on anecdotal accounts and commentaries on any aspect of Asian elephants, information about organizations, and workshop or symposium reports with a maximum of 1000 words are accepted for the "**News and Briefs**" section.

Research papers: Manuscripts reporting original research with a maximum of 5000 words are accepted for the "**Research Article**" section. They should also include an abstract (100 words max.). Shorter manuscipts (2000 words max.) will be published as a "**Short Communication**" (no abstract).

Tables and figures should be kept to a minimum. Legends should be typed separately (not incorporated into the figure). Figures and tables should be numbered consecutively and referred to in the text as (Fig. 2) and (Table 4). The lettering on figures must be large enough to be legible after reduction to final print size. Include tables and line drawings in the MS WORD document you submit. In addition, all figures must be provided as separate files in JPEG or TIFF format.

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Avoid if possible, citing references which are hard to access (e.g. reports, unpublished theses). Format citations in the 'References' section as in the following examples, writing out journal titles in full.

Baskaran N & Desai AA (1996) Ranging behavior of the Asian elephant (*Elephas maximus*) in the Nilgiri biosphere reserve, South India. *Gajah* **15:** 41-57.

Olivier RCD (1978) *On the Ecology of the Asian Elephant*. Ph.D. thesis, University of Cambridge, Cambridge, UK.

Rajapaksha RC, Mendis GUSP & Wijesinghe CG (2004) Management of Pinnawela elephants in musth period. In: *Endangered Elephants, Past Present and Future*. Jayewardene J (ed) Biodiversity & Elephant Conservation Trust, Colombo, Sri Lanka. pp 182-183.

Sukumar R (1989) *The Asian Elephant: Ecology and Management*. Cambridge University Press, Cambridge, UK.

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Deadline for submission of manuscripts for the next issue of Gajah is 30. November 2013.

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