GAJAH

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Number 46 (2017)

The journal is intended as a medium of communication on issues that concern the management and conservation of Asian elephants both in the wild and in captivity. It is a means by which everyone concerned with the Asian elephant (*Elephas maximus*), whether members of the Asian Elephant Specialist Group or not, can communicate their research results, 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 Asian Elephant Specialist Group.

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Editorial Note

Gajah will be published as both a hard copy and an on-line version accessible from the AsESG web site (www.asesg.org/gajah.htm). If you would like to be informed when a new issue comes out, please provide your e-mail address. If you need to have a hardcopy, please send a request with your name and postal address by e-mail to <jenny@aim.uzh.ch>.

Cover

Elephant herd at Wasgamuwa (Sri Lanka)
Photo by Chandima Fernando
(See article on page 14)

Layout and formatting by Dr. Jennifer Pastorini

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Editorial

Jennifer Pastorini (Editor)

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Gajah 46 presents three research articles and three short communications. Four papers are about elephants in Sri Lanka and the other two publications are from India. We also have four reports on meetings held in Indonesia, Myanmar, India and Thailand.

In *Research Articles*, A.M.D.B. Alahakoon and co-authors studied the feeding pattern of elephants in the Udawalawe National Park. They identified 63 elephant fodder plants in different habitats at different times of the year. Chandima Fernando *et al*. report on butterflies using elephant dung in Wasgamuwa. They found 26 different butterfly species puddling on dung piles with up to 15 species on the same dung pile. Kasun Abeysinghe and colleagues assessed gastrointestinal strongyle infections in 141 captive and wild elephants. All wild elephants had high numbers of strongyle larvae while captive elephants, being dewormed regularly, had less parasites.

In *Short Communications*, Sangita Mitra studied possible factors influencing elephant mortalities on railway tracks of northern West Bengal. In 40 years 82 elephants were killed in 56 train accidents. T.M.S.K. Piyadasa and co-authors used a GnRH vaccine on six captive elephant bulls to postpone musth. In the three elephants, which received all doses, the vaccine postponed musth by a few months. Arindam Kishore Pachoni *et al*. report on the treatment of a chronic abscess in a juvenile captive elephant. Two weeks after surgery the animal recovered fully.

In the *News and Briefs* section we hear from the "2nd Asian Elephant Range States Meeting", held in Indonesia this year. The meeting concluded with the "Jakarta Declaration for the Asian Elephant Conservation" agreed upon by all 13 range states. In June 2016 a "Workshop on Addressing Human-Elephant Conflict in Myanmar" was held, where different stakeholders discussed the national human-elephant conflict strategy under the national Myanmar Elephant Conservation Action Plan. The "Conservation Network of Asian Mahouts" keeps expanding with Indian mahouts from Karnataka joining force with mahouts from Indonesia. Awareness programs and exchange visits were held for mahouts to learn from each other. The "Elephant Conservation Group" held its fifth workshop in Kuiburi, Thailand. From nine countries 23 participants exchanged ideas and experiences and discussed collaboration on various projects.

A total of 63 abstracts of "Recent Publications on Asian Elephants" are provided in the abstract section and "News Briefs" presents 24 news clippings featuring elephants from across the range.

Vivek Menon, the chair of the Asian Elephant Specialist Group, provides information about his visits to Sabah and Sumatra and reports from the elephant range country meeting held in Jakarta. He further informs us about the 11 new working groups that have recently been set up and announces the next AsESG meeting to be held in April 2018 in Thailand.

A big thank you to all the authors who contributed articles about their work to this issue of *Gajah*. I would also like to thank the editorial team for their help with paper editing and working with the authors to improve their manuscripts. I would like to welcome Varun Goswami as a new editorial board member.

We are most grateful for the financial support from the Wildlife Reserves Singapore Group, enabling us to print this *Gajah* and mail it out free to its readers.

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Notes from the Chair IUCN SSC Asian Elephant Specialist Group

Vivek Menon

Chair's e-mail: vivek@wti.org.in

Dear members

This has been a particularly exciting few months for me and the AsESG. First, I have had the opportunity of representing all of you at the Asian Elephant Range States Meeting at Jakarta, Indonesia coordinated by the Indonesian government and our very active members Dr. Wahdi Azmi and Ms. Heidi Riddle. Mr. Ajay Desai and Dr. Simon Hedges also attended from the membership. We had very fruitful discussions and the Jakarta Declaration that you will see in this issue is the product of this conference.

When range countries come together and make unanimous statements, the future of the elephant is at least to that measure safer, one would presume. I followed that up by going with our new Programme Manager Dr. Sandeep Kr Tiwari to two ranges of the elephant in Sumatra and Sabah, Borneo. While I saw some very fine forests left in Gunung Leuser and Way Kambas in Sumatra and Kinabatangan in Sabah, the elephant itself seems to be on the decline and alarmingly so in Sumatra. Coupled with my previous visit to Vietnam I can only surmise that Sumatra and Vietnam are possibly two of our more endangered elephant populations.

I was fortunate to meet most of the members of Indonesia and Malaysia (this included meetings in Jakarta as well as in Kuala Lumpur) and also in Thailand on the way back home. I must thank all the members including Sen Nathan, Benoit Goossens, Marc Ancrenaz, Heidi Riddle, Wahidi Azmi, Salman Sabaan, Chatchote Thitaram, Mattana Srikrachang and Wayuphong Jitvijak "Aek" for making the meetings a grand success. Special thanks to non-members Rudi Putra (Sumatra), Nurzhafarina Othman (Sabah) and John Edwards (Thailand) for local hospitality.

If there is one thing I was wiser to after the tour was that Bornean elephants are not dwarfs by any means and not that safe either as people have postulated. Farina, Sandeep and I were mock charged at rather close distance by a makhna that demolished that hypothesis rather effectively!

I am happy that since my last writing to you some progress is there also in the formation of working groups as well as in the appointment of a Red List Coordinator. Dr. Christy Williams is now our Red List Coordinator for the group. I wish him all the best in that important task.

Elephant Range States Meeting in Jakarata, April 18-20, 2017 (Photo by REGAIN -KLHK).

Elephants in Sabah (Photo by Sandeep Kr Tiwari).

Following working groups have also been set up during this period:

1. Sumatra Elephant Conservation Action Plan
2. Arresting the decline of elephant population of Vietnam
3. Sabah Elephant Conservation Action Plan
4. Developing guidelines for rehabilitation of captive elephants in the wild as a possible restocking option
5. Developing manual for the management and care of captive elephant in musth
6. Developing guideline for the welfare and use of elephants in Tourism
7. Developing guidelines for creating artificial water holes in elephant habitats
8. Human-elephant conflict guidelines
9. Communications
10. Mapping the distribution of Asian elephants
11. Involving AsESG members to strengthen MIKE patrol information

As a group, we have also submitted a report to the CITES Standing Committee for their 69th meeting of the Standing Committee from 27th Nov to 1st December 2017 and held a consultation meeting for MIKE South Asia in India on 25th September 2017.

Finally while the Sri Lanka meeting is still not confirmed, I am pleased to announce that we will meet from 25th to 27th April 2018 followed by a two day field visit in Bangkok, Thailand and I would request all of you to keep your calendars free for this important second meet of the membership in this triennium.

Vivek Menon
Chair AsESG, IUCN SSC

Keep the dates

Meeting of the IUCN SSC
Asian Elephant Specialist Group

Bangkok, Thailand

25. – 27. April 2018

Research Article *Gajah 46 (2017) 4-13*

Food and Feeding Patterns of Asian Elephants in Udawalawe National Park, Sri Lanka

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Abstract. Asian elephants feed on a wide variety of vegetation but their preference for particular plant species maybe an important factor in determining seasonal movements. We identified 63 elephant fodder plants in Udawalawe, consisting of 19 trees and 44 herbs and grasses. Elephant fodder species mainly occurred in scrub forest (40%) and grasslands (31%). Elephants in Udawalawe were more grazers than browsers year round. Availability of seasonal vegetation is a possible factor, keeping elephants inside the park during the dry season.

Introduction

Sri Lanka supports a population of Asian elephants (*Elephas maximus*) estimated at 5879 individuals (DWC 2011). Asian elephants are globally threatened by rapid fragmentation and loss of habitat (Leimgruber *et al*. 2003). They prefer scrub forest and areas with grass, low woody plants and forest (Angammana *et al*. 2015). In Sri Lanka, elephants currently inhabit dry evergreen and thorn-scrub forests in the dry zone, having been largely extirpated from the wet zone rainforests by landuse changes over the last century (Fernando 2000).

Availability of food determines the size of home ranges and movement of elephants (Fernando *et al*. 2008). Elephants rarely forage in one area for more than a few days at a stretch (Kumar *et al*. 2010). Requiring a daily intake of about 150 kg, they feed on a wide variety of vegetation (Sukumar 1989). A study conducted on African elephants suggests that their preference for particular plant species is an important factor dictating their movement (Osborn 2002). Acording to Holdo (2003) relatively little is known about the nutritional factors influencing food and habitat selection of African elephants or Asian elephants. Details regarding food choice and seasonal diet composition of Asian elephants remain largely unknown. Relatively few studies have been carried out in Sri Lanka on the food and feeding patterns of elephants (Mueller-Dumbois 1972; McKay 1973; Ishwaran 1983; Santiapillai *et al*. 2003; Santiapillai & Jackson 1990; Samansiri & Weerakoon 2007; Angammana *et al*. 2015).

Methods

Study area

The Udawalawe National Park is located in southern Sri Lanka between latitude 6º 25' N and 6º 35' N and longitude 80º 45' E and 81º 00' E. The 308 km^2 park largely comprises of the catchments of Udawalawe and Mau Ara reservoirs. Since the park is located in the dry zone, conditions are characterized by an annual drought coinciding with the southwest monsoon from May to September. Mean annual rainfall is about 1524 mm received mainly through the northeast monsoon from December to March. Mean day and night temperatures are 29.4ºC and 23.9ºC, respectively (Angammana *et al*. 2015). The Udawalawe National Park supports about 804–1160 Asian elephants, resulting in a high population density (de Silva *et al*. 2011)

The vegetation of Udawalawe National Park is comprised of intermediate zone to dry zone

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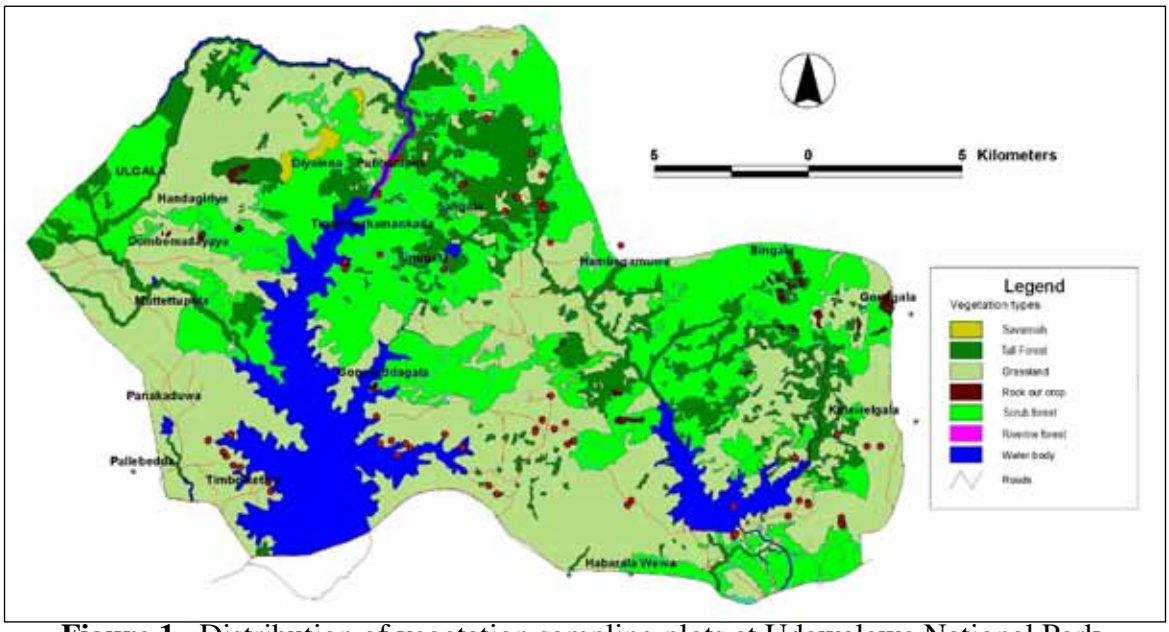

Figure 1. Distribution of vegetation sampling plots at Udawalawe National Park. The sampling plots are indicated in red circles.

transitional high forests in the northern part and interspersed areas of grass, scrub and stages of forest succession in the rest (Fig. 1). The park was originally forested, but anthropogenic activities have resulted in its change to grassland and scrub, which dominated a major part of it during the study period.

Data collection

The study was carried out from December 2005 to January 2007. Firstly, a pilot survey was done by driving through all accessible areas in the park to identify vegetation characteristics. On the basis of the pilot survey, the vegetation was categorised as tall forest, scrub forest, riverine forest, grassland, seasonal vegetation, and savanna land. The natural dry forests were dominated by tall trees with a well-developed canopy (Fig. 2). Vegetation dominated by small trees and shrubs were identified as scrub forests (Fig. 3) and tall buttressed, spreading trees arching over waterways were categorized as riverine foresets (Fig. 4). The grass dominated habitats with less trees were categorized as grasslands (Fig. 5) and grass dominated habitats with a conspicuous scattered tree component were categorized as savannah grasslands (Fig. 6). Seasonal vegetation was located in the reservoir beds, which became available only during the dry season when the reservoir water level receded. During the rainy season this area was under water (Fig. 7). These habitat types were differentiated using recent satellite images covering the park area and the extents of the different habitat types were estimated using ground-verified images. Based on this information, a habitat map was created using Arc GIS software version 9.1.

Observations were performed by vehicle from 6:00 to 18:30 h. Field sampling was carried out for 15 days per month over a period of one

Figure 2. Tall forest.

Figure 3. Scrub forest.

Figure 4. Riverine forest.

year. Driving routes were alternated in a random manner such that all parts of the road network across all habitat types were covered at least three times a month. An effort was made to make the sampling effort in every habitat similar in terms of number of days sampled.

Whenever an individual elephant was encountered, its feeding behavior was observed at 15 min intervals using binoculars. Habitat type, plant species consumed, its life form and part of the plant consumed were recorded. When a herd of elephants was encountered, the feeding behaviour of the entire herd was scanned at 15-minute intervals. The number of elephants feeding in each habitat (including adults, sub adults and calves), the type of feeding plant, its life form and the parts consumed were recorded. All data for individuals and herds were pooled and the relative frequency of feeding on a particular plant was calculated as the number of observations of feeding on a particular plant divided by the total number of observations for all plants observed feeding on.

Once the individual or the herd moved away, a 10 x 10 m plot was examined at the location. All plant species, which had signs of feeding and the parts consumed were recorded. Tree species (dbh > 5 cm), shrubs and saplings found within the quadrat were identified and counted. Grasses and herbs in the plot were identified and their percentages were visually estimated using five 1 x 1 m sub-plots established randomly within the larger plot. Relative cover was calculated and for tree species relative density was calculated from the data obtained. A specimen from each food plant species was collected to confirm identification by comparing with material available at the National Herbarium, Peradeniya. Plant life forms were identified based on Ashton *et al*. (1997).

Twelve 10 x 10 m permanent plots were established in grassland habitat to determine the species occurance in dry and wet seasons. In each plot, five 2 x 2 m sub-plots were laid randomly to observe the grasses and herbs. Sampling was carried out once a month throughout the study period. The types of grass species were identified and their relative cover within the plots was visually estimated.

A Pearson correlation test was performed to measure the relationship between the relative frequency of feeding on a particular plant and its availability in the area, to assess feeding preferences for grasses and herbs.

Results

Tall forests (Fig. 2) had a patchy distribution within the park and covered about 6.4% of the park area. Common tree species in the tall forests included *Diospyros ovalifolia, Chloroxylon swietenia* and *Drypetes sepiaria*. The understorey vegetation was characterised by *Psilanthus wightianus, Mallotus eriocarpus, Polyalthia korinti, Croton officinalis* and *Phyllanthus polyphyllus*.

Scrublands (Fig. 3) covered about 4.2% of the park area and were characterized by tree species such as *Chloroxylon swietenia, Mischodon zeylanicus, Memecylon umbellatum, Acacia leucophloes* and *Mallotus eriocarpus* and shrubs such as *Psilanthus wightianus, Phyllanthus polyphyllus, Carmona retusa, Lantana camara* and *Flueggea leucopyrs*.

Figure 5. Grassland.

Figure 6. Savanna grasslands.

Figure 7. Seasonal vegetation.

Riverine forests (Fig. 4) covered 1.13% of the park area. These forests were found along the banks of the Walawe river. *Dimorphocalyx glabellus, Walsura trifoliolata, Drypetes sepiaria, Diospyros ovalifolia, Hopea cordifolia* and *Pterospermum suberifolium* were common tree species and *Polyalthia korinti, Glycosmis* sp., *Polyalthia cerasoides, Mallotus philippensis, Carmona retusa, Tarenna asiatica,* and *Mallotus eriocarpus* were more abundant in the understory.

The grasslands were identified as a major component (39%) of the park vegetation. *Megathyrsus* grasslands (Fig. 5) with scattered trees were the most extensive grassland type. *Imperata* dominant grasslands were not very extensive and were found in the draw-down area of Seenuggala tank. Several patches of grasslands were also found surrounded by scrublands.

Savanna grasslands (Fig. 6) were located in hilly areas in the northern boundary of the park bordering Kapugala and Kaltota area. These forests were characterized by grasslands with scattered trees, most of which are fire resistant, such as *Anogeissus latifollus, Phyllanthus emblica, Flacourtia indica, Grewia damani* and *Pterocarpus marsupium*.

Seasonal vegetation is a temporary habitat formed during the dry season with the decline of the water level in the major reservoirs in the park (Fig. 7). This habitat was limited to the area between the maximum and minimum water levels of the reservoirs. *Cynodon dactylon, Panicum reptuns, Bracheira mutica, Eragrostis diplachoides, Cyperus paniceus, Kyllinga brevifolis* and *Megathyrsus maximum* were the most abundant grass species in the seasonal vegetation. Herbs such as *Coldenia procumbens, Alysicarpus glunaceus, Mollugo* sp., *Ludwegia* sp., *Xanthium indicum, Evolvulus* sp., and *Clitoria laurifolia* were also seen in the seasonal vegetation.

The data were collected over a period of 201 days. Elephant observation periods ranged from 8.26–123.58 min (mean 78.37 ± 12.54 min) for an individual per day. The number of days spent in each habitat and percent observations are shown in Table 1. Most of the elephant observations (69.7%) were made in grasslands and their feeding activities in *Megathyrsus maximum* grasslands were commonly seen. Comparatively less elephants were observed in other habitats such as natural forest, scrub forest and riverine forests. During the day time elephants were mainly found in the *Megathyrsus* grassland but in the evenings they moved to the seasonal vegetation on the reservoir bed where they gathered in large numbers. During the dry season elephants gathered more commonly in the reservoir bed seasonal vegetation than in other habitats (Fig. 8).

Table 1. Elephant feeding observations (EFO) in different habitats and sampling effort (SE).

Habitat	# days	% SE	% EFO
Tall forest	28	13.9	0.1
Scrubland	34	16.9	12.7
Riverine forest	27	13.4	0.2
Grassland	49	24.4	69.7
Seasonal veg.	35	17.4	17.2
Savannah	28	13.9	0.1

Altogether 63 elephant food plants belonging to 19 families were identified (Appendix I). Of these 44 were identified through direct observations of feeding and 19 from feeding signs. Elephants were found to feed more frequently on grasses such as *Megathyrsus maximus* (28.9%), *Cyrtococcum trigonum* (5.1%), and *Heteropogon contortus* (12.2%). Of the trees *Bauhinia racemosa* (7.1%)

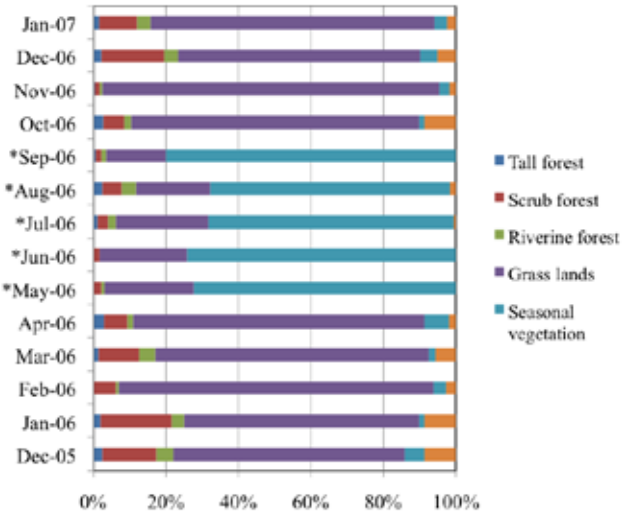

Figure 8. Observations of elephants feeding in different habitats. Dry months are indicated by *.

Table 2. Percentage of plant parts consumed by elephants in each life form category.

Life form	Trees	Shrubs	Herbs	Grass	Liana	Woody climber
All parts	-	-	72	58	-	-
Bark	35	-	-	-	-	-
Leaves, flowers	-	-	-	33	-	-
Stem	30	-	7	-	-	-
Bark, stem	20	-	-	-	-	67
Leaves, stem	5	-	21	-	100	-
Leaves	-	100	-	9	-	33
Bark, stem, leaves	5	-	-	-	-	-
Stem, fruits	5	-	-	-	-	-

and *Tectona grandis* (5.1%) had a higher feeding frequency (Fig. 9). Elephants were observed to feed more frequently on grasses (33%), trees (29%) and herbs (24%). Other plant forms such as lianas (3%), climbers (2%) and small trees (6%) were represented in small quantities in elephants' diet.

Elephants consumed different parts of different life forms of vegetation (Table 2). When feeding on trees they mostly consumed bark or stem (35% of observations for each) or both bark and stem (20% of observations). The bark of tree species such as *Bauhinia racemosa*, *Tectona grandis*, *Cassia fistula*, and *Grewea damani* was consumed regularly. Certain grasses (57%) such as *Megathyrsus maximus*, *Panicum repens* and herbs (35%) such as *Achyranthes aspera*, *Aerva javanica* were consumed whole. Elephants seemed to prefer leaves and flowers (33%) in grass species such as *Cyperaceae exaltatus*, *Cyperus procerus*, *Digitaria bicornis*, *Eragrostis tenella*, *Eriochloa procera* and *Heteropogon contortus*.

Most elephant fodder species were available in grassland and scrub forest habitats, where species such as *Megathyrsus maximum*, *Heteropogon contortus* and *Bauhinia racemosa* are abundant (Fig. 10). Availability of fodder species of elephants varied seasonally. Many species were available both in the dry season and in the wet season while a few species were confined to the seasonal vegetation in the reservoir bed and were available only in the dry period (Appendix I).

During the dry season, most fodder species in the park dry up and die, except for the grasses on the reservoir bed (Figs. 11 & 12) which elephants used extensively. A larger number of elephants were seen in the reservoir beds than in the grasslands or other habitats during the dry season. Common food plants such as *Cynodon dactylon, Eragrostis tenella,* and *Panicum repens* were found mostly in the seasonal vegetation during the dry season. Therefore, seasonal vegetation serves as the major dry season feeding ground for elephants.

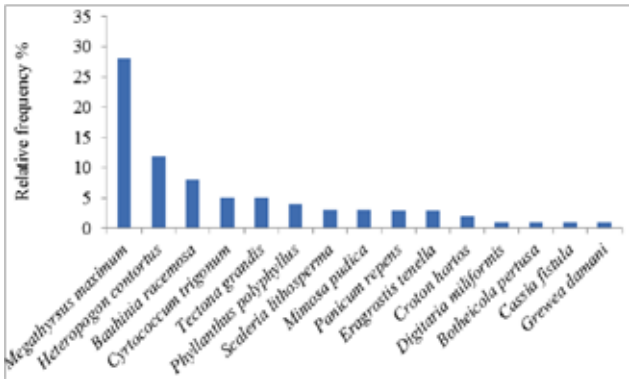

Figure 9. Relative frequency of food plant consumption based on observations.

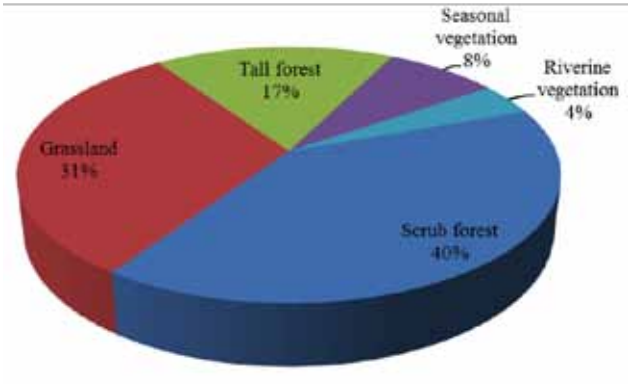

Figure 10. Availability of elephant fodder plants in different habitats.

Table 3. Availability of grasses and herbs in the seasonal vegetation (* = species consumed by elephants).

Family	Species	Life form	% cover
Poaceae	*Cynodon dactylon**	Grass	28.51
Poaceae	*Brachiaria mutica**	Grass	11.70
Poaceae	*Eragrostis diplachoides**	Grass	9.34
Poaceae	*Panicum repens**	Grass	9.24
Boraginaceae	*Coldenia procumbens*	Herb	7.73
Fabaceae	*Alysicarpus glunaceus*	Herb	5.97
Poaceae	*Megathyrsus maximus**	Grass	1.41
Cyperaceae	*Cyperus paniceus**	Grass	1.31
Molluginaceae	*Mollugo* sp.	Herb	1.20
Convolvulaceae	*Evolvulus* sp.	Herb	1.10
Asteraceae	*Xanthium indicum*	Herb	1.05
28 species with < 1% coverage each			8.58
Dry grass			4.37
Open space			8.48

The percent cover and availability of grasses and herbs in the seasonal vegetation are given in Table 3. Thirtyseven plant species in 14 families were recorded from the seasonal vegetation. These included 11 species of grasses, 25 herbs, two shrubs and one liana (Appendix I). *Cynodon dactylon, Panicum repens, Brachiaria mutica, Eragrostis diplachoides, Panicum repens, Megathyrsus maximus* and *Cyperus paniceus* were the most abundant grasses in the seasonal vegetation (Table 3). *Coldenia procumbens, Alysicarpus glunaceus, Mollugo* sp., *Evolvulus* sp. and *Xanthium indicum* were the most abundant herbs in this habitat (Table 3).

There was a strong positive correlataion (r = 0.9461; P < 0.05) between the relative feeding frequency and the percent cover of grasses and herbs (Fig. 13). Therefore, the most commonly consumed grasses and herbs were the most common plants in the area. The relationship between the relative feeding frequency and the relative density of tree species also showed a positive correlation (r = 0.5371; P < 0.05) (Fig. 14), but there seemed to be a preference for certain tree species as their consumption was not in proportion to their availability.

Figure 11. Grassland during the dry season.

Discussion

Asian elephants are well adapted to living in diverse habitats by exploiting a wide spectrum of plant species (Baskaran *et al*. 2010). In Uda-

Figure 12. Seasonal vegetation in the dry season.

walawe we found a higher presence of elephant food plants in grasslands and scrub forests. Elephants were also observed mostly in these habitats. Weerakoon *et al*. (2003) state that the preffered habitats of Asian elephants are grassland and scrublands, which is supported by the findings of the current study. Elephants also seemed to feed more frequently on seasonal vegetation in the reservoir bed in the driest periods of the year, making it an important resource during the dry period. Natumi *et al*. (2005) state that habitat use of elephants is mostly influenced by vegetation biomass, vegetation cover and water availability. All these needs seem to be fulfiiled within the park throughout the year, hence elephants are seen year round in Udawalawe.

Elephants have evolved to be generalist herbivores consuming a wide variety of vegetation of well over a hundred species (Vancuylenberg 1977; Sukumar 1989; Samansiri & Weerakoon 2007). Samansiri and Weerakoon (2007) recorded 116 plant species belonging to 35 families in northwest Sri Lanka, which included around 30 cultivated crops. Comparatively, Udawalawe elephants eat a less diverse diet, as they consumed only 63 plant species. The lower diversity of plants in Udawalawe maybe attributed to the regional availability of particular plants and their distribution. Samansiri and Weerakoon (2007) indicate a diet dominated by plants of families Fabaceae and Poaceae (50%) in northwest Sri Lanka, which was also the case in Udawalawe (28.6% Poaceae, 22.2% Fabaceae). However, these two plant families also dominate the natural vegetation in Udawalawe.

There seem to be a preference for particular plant parts by elephants. A higher feeding frequency was observed on entire plants in grasses and herbs, but for certain tree species only the bark was consumed. Elephant consumption of plants is positively correlated with their nutrient content, especially calcium, magnesium, potassium and protein (Holdo 2003; Angammana *et al*. 2005). Therefore, preference for certain plant parts might be attributed to their nutrient levels.

Results of the current study indicate that elephants feed on grass species in proportion to their occurence and that they do not have preference for particular grass species. But for the trees, elephants seem to show a degree of preference irrelevant to their availability. Asian elephants are mixed feeders, and there is seasonal variation in their food selection (Sukumar 1989). They feed on a wide variety of browse species when the availability of grasses decrease (Chen *et al*. 2006). Elephants tend to shift towards seasonal vegetation in the dry season to obtain crude protein, which is in short supply in old grass during the dry season. Previous studies have indicated that during the wet season elephants' diet is dominated by grasses while browse

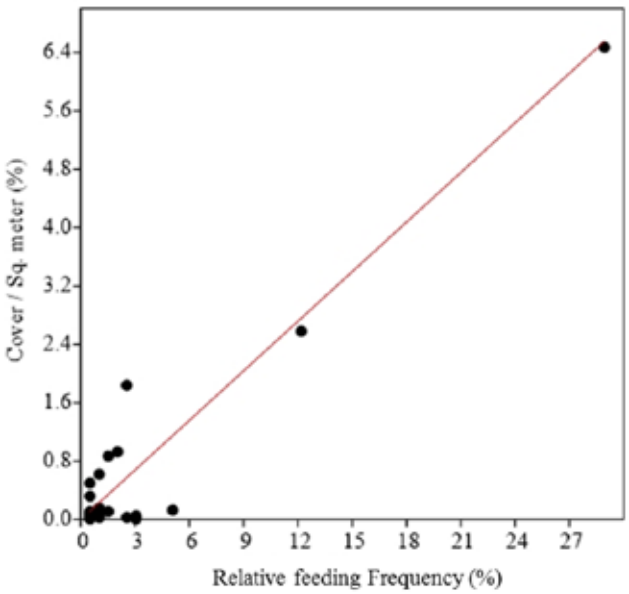

Figure 13. Correlation between relative feeding frequency and cover of grass and herb species.

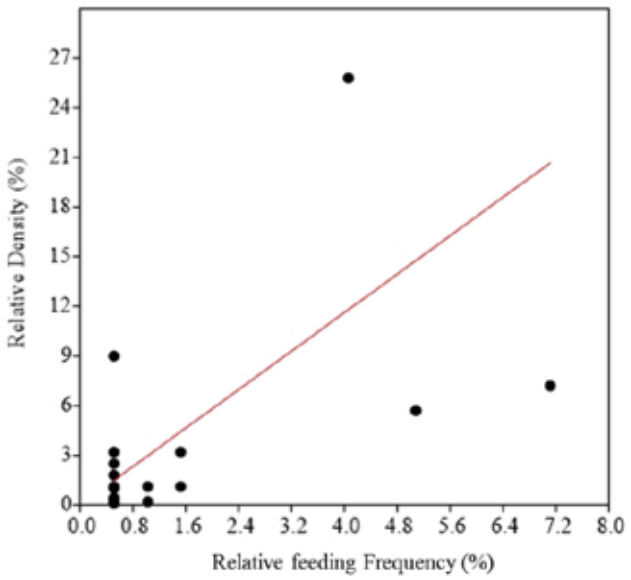

Figure 14. Correlation between relative feeding frequency and relative density of tree species.

dominates it in the dry season only if new grass is unavailable (Hettiarachchi *et al*. 2005; Prathan *et al*. 2008; Baskaran *et al*. 2010). A marked shift from graze to browse was not observed in Udawalawe, probably since new grass in seasonal vegetation were available during the dry season. McKay (1973) stated that grass dominates the diet of elephants in grass-dominated habitats of Sri Lanka, which is in accordance with our findings. Presence of higher amounts of grasses and herbs in the diet throughout the year observed by us, indicates that Udawalawe elephants graze more than they browse. The availability of seasonal vegetation may attract elephants to those habitats during the dry period since they remain the only lush areas.

Acknowledgements

We are grateful to the Department of Wildlife Conservation for granting permission to conduct this research. The helpful comments given by the reviewers are highly appreciated.

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Appendix I. List of plants consumed by elephants and their seasonal availability during the dry (D) and wet (W) season in different habitats (GL = grassland; TF = tall forest; SF = scrub forest; RF = riverine forest; S = savvanah; SV = sesonal vegetation).

Family	Species	Life form	Part consumed	GL	TF	SF	RF	S	SV
Amaranthaceae	*Achyranthes aspera*	Herb	All	W	WD	WD			D
Amaranthaceae	*Aerva javanica*	Herb	All			W			
Apocynaceae	*Ichnocarpus frutescens*	Liana	Leaves, stem	WD	WD	WD			
Arecaceae	*Phoenix* sp.	Small tree	Leaves			WD			
Caprifoliaceae	*Crateva adansonii*	Small tree	Leaves, stem	WD					
Convolvulaceae	*Ipomia* sp.	Liana	Leaves, stem			W			
Cyperaceae	*Cyperaceae exaltatus*	Grass	Leaves, flowers						D
Cyperaceae	*Scleria lithosperma*	Grass	All		WD	W			
Euphorbiaceae	*Phyllanthus polyphyllus*	Small tree	Stem	WD	WD	WD	WD		
Euphorbiaceae	*Croton hirtus*	Herb	All	W		W			
Fabaceae	*Acacia leucophloea*	Tree	Bark			WD			
Fabaceae	*Alysicarpus glunaceus*	Herb	All			W			D
Fabaceae	*Bauhinia racemosa*	Tree	Bark, stem, leaves	WD	WD	WD			
Fabaceae	*Cassia fistula*	Tree	Bark	WD	WD	WD			
Fabaceae	*Cassia mimosoides*	Herb	All	W		W			
Fabaceae	*Cassia tora*	Herb	All	W		W			D
Fabaceae	*Clitoria laurifolia*	Herb	Leaves, stem	W					D
Fabaceae	*Derris scandens*	Woody liana	Leaves	WD	WD	WD	WD		

Appendix I. Continued.

Family	Species	Life form	Part consumed	GL	TF	SF	RF	S	SV
Fabaceae	*Desmodium heterophyllum*	Herb	All	W		W			D
Fabaceae	*Desmodium triflorum*	Herb	All	W		WD			D
Fabaceae	*Leucaena leucocephala*	Tree	Bark, stem, leaves	W		W			
Fabaceae	*Mimosa pudica*	Herb	All	W		W	D		D
Fabaceae	*Tephrosia villosa*	Herb	Stem	W		W			D
Fabaceae	*Vigna trifolia*	Herb	All			W			WD
Lamiaceae	*Tectona grandis*	Tree	Bark, stem	WD					
Lamiaceae	*Premna tomentosa*	Tree	Bark	WD		WD	WD		
Malvaceae	*Abutilon indicum*	Herb	Leaves, stem	W		W			
Malvaceae	*Abutilon pannosum*	Herb	Leaves, stem			W			
Malvaceae	*Grewia orientalis*	Woody climber	Bark, stem			WD			
Malvaceae	*Sida cordifolia*	Herb	All			W			D
Meliaceae	*Azadirachta indica*	Tree	Bark, stem	WD		WD			
Meliaceae	*Chukrasia tabularis*	Tree	Bark			WD	WD		
Moraceae	*Ficus mollis*	Tree	Bark, stem	WD	WD				
Moraceae	*Ficus* sp.	Tree	Bark	WD	WD				
Moraceae	*Streblus asper*	Tree	Stem			WD			
Poaceae	*Bothriochloa pertusa*	Grass	All	W					
Poaceae	*Brachiaria mutica*	Grass	All					WD	
Poaceae	*Brachiaria* sp.	Grass	All	W		W			
Poaceae	*Cymbopogon nardus*	Grass	Leaves					WD	
Poaceae	*Cynodon dactylon*	Grass	All	W		W			D
Poaceae	*Cyrtococcum trigonum*	Grass	All		WD	W	WD		
Poaceae	*Dactyloctenium aegyptium*	Grass	All	W		W			
Poaceae	*Digitaria bicornis*	Grass	Leaves, flowers	W					
Poaceae	*Eragrostis* sp.	Grass	Leaves, flowers	W		W			
Poaceae	*Eragrostis tenella*	Grass	Leaves, flowers	W		W			D
Poaceae	*Eriochloa procera*	Grass	Leaves, flowers			W			
Poaceae	*Heteropogon contortus*	Grass	Leaves, flowers	WD		WD	WD		
Poaceae	*Imperata cylindrica*	Grass	Leaves	WD		WD			
Poaceae	*Megathyrsus maximus*	Grass	All	WD		WD	WD		
Poaceae	*Panicum repens*	Grass	All			WD			D
Poaceae	*Paspalidium flavidum*	Grass	All			W			D
Poaceae	*Paspalidium punctatum*	Grass	All						WD
Poaceae	*Setaria* sp.	Grass	All			W			
Rhamnaceae	*Ziziphus oenoplia*	Woody liana	Bark, stem	WD	WD	WD	WD		
Rubiaceae	*Mitragyna tubulosa*	Tree	Stem	WD		WD			
Rutaceae	*Chloroxylon swietenia*	Tree	Bark	WD	WD	WD			
Rutaceae	*Limonia acidissma*	Tree	Stem, fruits	WD		WD			
Rutaceae	*Murraya koenigii*	Small tree	Stem			WD			
Sapindaceae	*Sapindus emarginatus*	Tree	Stem	WD	WD	WD			
Sapotaceae	*Manilkara hexandra*	Tree	Bark	WD		WD			
Sapotaceae	*Schleichera oleosa*	Tree	Stem	WD	WD		WD		
Tiliaceae	*Grewia damine*	Tree	Bark, stem	WD		WD			

Research Article *Gajah 46 (2017) 14-20*

Puddling in Elephant Dung by Lepidopterans in Wasgamuwa, Sri Lanka

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Abstract. We recorded puddling of lepidopterans on elephant dung in Wasgamuwa. In 148 days of observation, puddling was observed on nine days, on 9 of 978 dung piles examined, suggesting that the behaviour was uncommon. We identified 26 butterfly species from six families who engaged in this behaviour, indicating that elephant dung puddling was much more wide spread among butterfly species than recognized previously. All puddling occurred on fresh dung, was more in the wet season and male butterflies tended to puddle more than females, supporting the notion that dung puddling by butterflies is for obtaining minerals, especially sodium.

Introduction

Lepidopterans are mainly nectar feeders, yet they can have extremely diverse food habits especially in the tropics (Adler 1982; Sourakov *et al*. 2012). The diversity of food habits is related to ecological and biological differences within the group. Unlike the larvae which have specific food requirements, adult butterflies are opportunistic feeders and in addition to flower nectar, are capable of obtaining nutrients from a variety of substrates such as mud, carrion, rotten fruits, tree sap, perspiration and dung (Downes 1973; Boggs & Jackson 1991; Molleman 2010).

The phenomenon of feeding on non-nectar sources by lepidopterans is termed "puddling", presumably derived from reference to feeding on mud-puddles (Molleman 2010).

Puddling provides butterflies with nutrients, which are scarce in nectar (Molleman *et al*. 2005). Lepidopterans acquire a limited amount of minerals during the herbivorous caterpillar stage that is sequestered and used in subsequent life stages. Behavioural adaptations such as puddling enable them to obtain a balanced mineral intake, overcoming shortfalls in larval nutrition. One of the main minerals obtained through puddling is sodium, which is important for neuromuscular function and regulating fluid balance (Fraústo da Silva & Williams 2001) but also plays a role in the reproductive behaviour of some butterflies.

An important criteria in food selection by herbivores is the nitrogen content of plants (Ball *et al*. 2000) as it is required for protein synthesis. Animals excrete nitrogen metabolites to the environment through dung and urine (Ball *et al*. 2000). Obtaining nitrogenous compounds such as amino acids, albumin, and casein, is another reason for puddling (Boggs & Gilbert 1979; Beck *et al*. 1999).

Besides lepidopterans, different bee species also engage in puddling behaviour. For example, honey bees, sweat bees (Butler 1940) and stingless bees (Bänziger *et al*. 2009) are known to puddle on sweat and tears.

This paper presents observations of lepidopterans puddling on Asian elephant (*Elephas maximus*) dung, which has previously been recorded only in two species of butterflies; Malayan and Lesser Grass Blue (Hewavitharana *et al*. 2013).

Methodology

Study area

Our study area borders the south-western part of the Wasgamuwa National Park, Sri Lanka.

The area includes different habitat types such as chena (slash-and-burn cultivation), lake beds, agricultural fields, home gardens, scrub lands, secondary forests and dry-mixed evergreen forests.

The climate of the study area is tropical, with a dry season extending from March to September and a rainy season from October to February. From May to August the region experiences high winds. The mean temperature is 32˚C and the mean annual rainfall is 2250 mm, which occurs mostly during the northeast monsoon.

The region is situated in lowland Sri Lanka, and has an elevation gradient of 125–300 m a.s.l. The terrain of the study area is predominantly flat with some low-undulating areas and elevated rock outcrops.

Data collection

Dung–puddling was opportunistically recorded in 2013, 2014, and 2016, while conducting elephant dung transects. When puddling butterflies were encountered, the species, their numbers, and sex were recorded. Butterflies were photographed using a Nikon-Coolpix P510 camera and sexed using wing characteristics.

Habitat types were classified as reservoir bed grasslands, tall grass, scrublands, closed forests, agricultural fields and home gardens based on visual characteristics. The habitat type where dung piles were located was recorded.

Dung was categorized as "fresh" or "old" where dung piles deposited within an approximately 48-hour period was considered as "fresh". Characteristics used to identify fresh dung were; moist outer surface, distinct odour, lighter colour, and the presence of flies.

In order to assess seasonality of puddling in dry and wet seasons, we created a puddling index for each season by dividing the total number of puddling incidents by the total number of dung piles observed in each season, then averaged to a month.

Results

In a total of 148 days of observation, puddling was observed on nine days, on nine of 978 dung piles examined. A total of 26 species of butterflies from five families were observed puddling (Figs. 1, 2 & 3): Lycaenidae (9 species), Pieridae (7 species), Nymphalidae (4 species), Papilionidae (4 species) and Hesperiidae (2 species). Mean number of species recorded per dung pile was 3.78 ± 4.3 (range 1–15).

The most frequently observed species were Common Hedge Blue and Lesser Grass Blue both lycaenids, which were recorded on four occasions. The lycaenids, Indian Cupid and Lime Blue, and the pierid, Common Grass Yellow were recorded on two occasions. All other species were observed only once (Table 1). The number of individuals per dung pile varied from 45 to 1 (mean 8.57 ± 5.9). The most number of individuals of a single species recorded from a dung pile was the Lemon Emigrant (n = 45) followed by the Common Gull (n = 21), both pierids, and the Common Jay (n = 17) a papilionid. The highest number of species recorded on a single dung pile was 12 and represented all five families.

Of 169 individual butterflies observed puddling across all species, 91% were males and 9% females. Recorded females were of Common Albatross, Common Gull, Common Pierrot and Lemon Emigrant.

All the puddling in dung piles occurred in scrubland (56%) and in reservoir grass beds (44%). No puddling incidents were observed in tall grass, closed forest, home gardens and agricultural fields. Puddling incidents in the wet

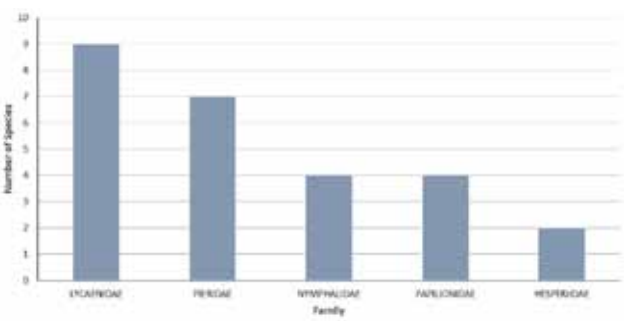

Figure 1. Number of butterfly species recorded in each family.

Figure 2. Butterfly species that were recorded in family Pieridae (a–g) and Lycaenidae (h–p). a = Common Gull; b = Lemon Emigrant; c = Mottled Emigrant; d = Common Albatross, e = One-spot Grass Yellow; f = Common Grass Yellow; g = Small Grass Yellow; h = Indian Cupid; i = Common Pierrot; j = Common Hedge Blue; k = Lesser Grass Blue; l = Common Lineblue; m = Malayan; n = Tailless Lineblue; o = Plains Cupid; p = Lime Blue.

season was 0.3 incidents per month whereas in the dry season it was 0.09 incidents per month. All observations were from fresh dung piles with no puddling events being observed on old dung piles.

Discussion

In the observation of 978 individual dung piles over 148 days, we only observed puddling on nine dung piles on nine days. This suggests that puddling on elephant dung, and its use as a food substrate by butterflies is not common.

All the butterfly species we recorded on elephant dung mainly feed on nectar. Of these, 35% belonged to Lycaenidae, which also has the highest representation among butterflies in Sri Lanka with 34% of species. Lycaenids in general, utilize a variety of food sources (Krenn 2008). Of

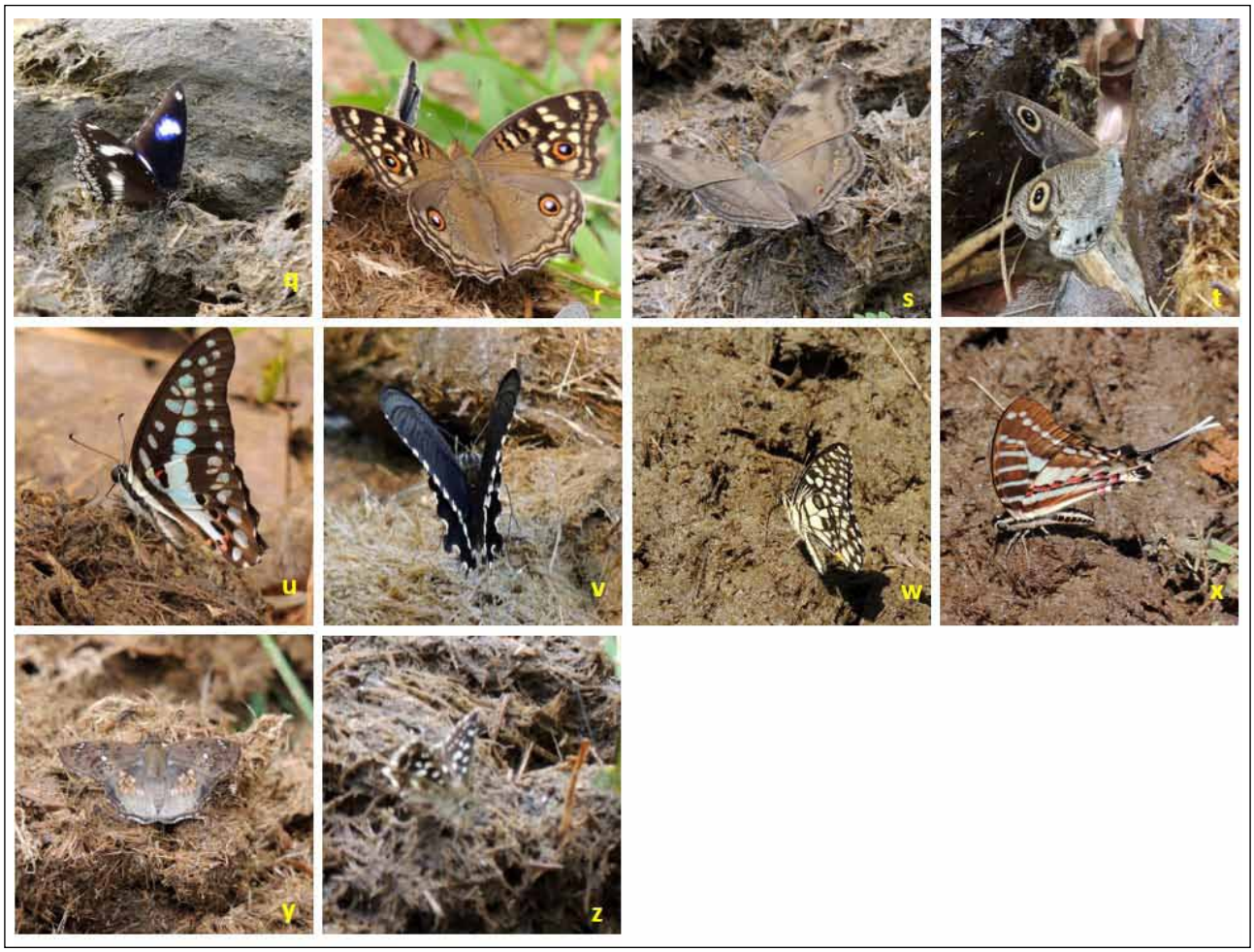

Figure 3. Butterfly species that were recorded in family Nymphalidae (q–t), Papilionidae (u–x) and Hesperiidae (y–z). q = Great Eggfly; r = Lemon Pansy; s = Chocolate Soldier; t = White Four-ring; u = Common Jay; v = Common Mormon; w = Lime Butterfly; x = Spot Swordtail; y = Golden Angle; z = Indian Skipper.

the nine lycaenids observed puddling on elephant dung by us, only the Lesser Grass Blue and the Malayan have been previously reported to do so (Hewavitharana *et al*. 2013). Among the others, the Common Hedge Blue, Common Lineblue and Tailless Lineblue have been reported to feed on scat and bird droppings (van der Poorten & van der Poorten 2016). The Common Pierrort was thought to seldom feed on dung (Rima *et al*. 2016; van der Poorten & van der Poorten 2016). The Indian Cupid, Lime Blue and Plains Cupid have been reported to puddle on mud (van der Poorten & van der Poorten 2016) but not on other substrates.

While pierids are known for mud sipping, they were not previously reported to feed on elephant dung. Pierids congregate in large numbers in wet soil (van der Poorten & van der Poorten 2016). We also observed the Common Albatross, Common Gull, Lemon Emigrant and Mottled Emigrant congregating on elephant dung, displaying greater gregariousness than other butterflies in dung puddling also.

The four species of papilionids that we recorded on elephant dung have been observed to mud sip especially during dry and hot weather (Rima *et al*. 2016; van der Poorten & van der Poorten 2016), but no previous records were found on the use of other substrates as food sources by them.

Amongst the recorded nymphalids, the Great Eggfly and Chocolate Soldier are known to feed on tree sap and fruits (van der Poorten & van der Poorten 2016). Although the Lemon Pansy imbibes liquids from the soil, they have not been recorded to feed on mammalian dung previously. The White Four-ring has been reported to feed on bear faeces (Hewavitharana *et al*. 2013).

Table 1. Butterfly species and their frequency of occurrence (N) in elephant dung in Wasgamuwa.

Family	Common name	Scientific name	N
Papilionidae	Lime Butterfly	*Papilio demoleus*	1
	Common Mormon	*Papiliyo polytes*	1
	Common Jay	*Graphium doson*	1
	Spot Swordtail	*Graphium nomius*	1
Pieridae	Common Gull	*Cepora nerissa*	1
	Common Albatross	*Appias albina*	1
	Lemon Emigrant	*Catospilla pomona*	1
	Mottled Emigrant	*Catospilla pyranthe*	1
	Small Grass Yellow	*Eurema brigitta*	1
	Common Grass Yellow	*Eurema hecabe*	2
	One-spot Grass Yellow	*Eurema ormistoni*	1
Nymphalidae	Lemon Pansy	*Junonia lemonias*	1
	Chocolate Soldier	*Junonia iphita*	1
	Great Eggfly	*Hypolimnas bolina*	1
	White Four-ring	*Ypthima ceylonica*	1
Lycaenidae	Common Hedge Blue	*Acytolepis puspa*	4
	Common Pierrot	*Castalius rosimon*	1
	Lime Blue	*Chilades lajus*	2
	Indian Cupid	*Everes lacturnus*	2
	Malayan	*Megisba malaya*	1
	Tailless Lineblue	*Prosotas dubiosa*	1
	Common Lineblue	*Prosotas nora*	1
	Lesser Grass Blue	*Zizina otis*	4
	Plains Cupid	*Chilades pandava*	1
Hesperiidae	Indian Skipper	*Spialia galba*	1
	Golden Angle	*Caprona ransonnettii*	1

Hesperiids are known to feed on substrates such as tree-sap, bird droppings and dung in addition to nectar. The hesperids we observed puddling on elephant dung, the Indian Skipper and the Golden Angle have previously not been recorded to feed on mammalian dung.

Hewavitharana *et al*. (2013) recorded five species of lepidopterans puddling on bear faeces in Wasgamuwa National Park. These species also occur in our study area. Among them, we observed only the White Four-ring on elephant dung. The other four species recorded by Hewavitharana *et al*. (2013), the Common Evening Brown (*Melanitics leda*), Tamil Yeoman (*Cirrochora thais*), Large Four Lineblue (*Nacaduba pactolus*) and Common Cerulean (*Jamides celeno*) could be potential puddlers on elephant dung, as butterflies tend to be non-species specific in feeding on dung.

A majority of the puddling incidents occurred during the wet season. This implies that butterflies were not feeding on elephant dung to obtain moisture. In the tropics, the reproductive season of butterflies coincides with rainfall (Braby 1995; Kemp 2001; Jones 2011). In seasonal habitats such as Wasgamuwa, butterflies arrest their breeding activities during the dry season as most of the larval food plants either cease their growth, are deciduous or seasonal. Butterflies start their breeding activities with the onset of the monsoon. During the breeding season, nutrient requirements of butterflies are high, especially for males, which may explain the relative increase in puddling. Another possibility is that it was related to seasonal differences in nutrient availability in elephant dung, as elephant diet varies seasonally.

It has been suggested that acquiring sodium is the main trigger for puddling (Braby 1995; Beck

et al. 1999; Boggs & Dau 2004; Krenn 2008). Elephant dung is a good source of sodium, as it is one of the minerals that determine elephant diet (Dougall 1963; Weir 1972). As nectar is low in sodium, male butterflies collect sodium from non-floral substrates such as mud, carrion, rotten fruits, sweat and bird droppings (Molleman *et al*. 2005; Ravenscraft & Boggs 2016). They transfer a significant amount of collected sodium to females through spermatophores, as a nuptial gift to increase mating success (Sculley & Boggs 1996; Beck *et al*. 1999; Molleman *et al*. 2005). Therefore, it is predominantly young males that engage in puddling (Boggs & Jackson 1991). Male biased sex differentials in our study support this assertion.

All the puddling incidents observed by us were in relatively open habitats, such as reservoir-bed grasslands and scrublands. This is probably linked with the habitat preferences of the butterfly species observed puddling, as they inhabit relatively open and sunlit habitats during the breeding season.

We only recorded puddling on fresh dung piles. The outer surface of elephant dung desiccates within about 48 hours after defecation, eliminating the surface moisture in which nutrients and other chemicals are dissolved. This may provide an explanation as to why butterflies were not recorded on dry (old) dung piles. It also suggests that butterflies are unable to penetrate into elephant dung when it is dry and feed on the nutrients inside, and why butterflies are not specialized puddlers on elephant dung.

Butterflies locate their food sources using both olfactory and visual cues. According to Beck *et al*. (1999), pierids and papilionids mainly depend on visual cues to discover food sources whereas nymphalids, hesperiids and lycaenids rely on olfactory cues. It is likely that olfaction may assist butterflies in locating elephant dung more than visual cues, as it provides a wider zone of detection. Fresh elephant dung has a strong smell that fades away within a day or two after defecation, which may also be a reason for our observation of butterflies puddling only on fresh dung (Fig. 4).

In the tropics, studies on foraging behaviour of lepidopterans have mainly focused on food preferences in terms of nectar and fruits and the use of other substrates including mammalian dung has received little attention. Our findings show that a variety of butterfly species use elephant dung for supplementary foraging, indicating the importance of assessing the foraging ecology of lepidopterans on other foraging substrates.

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Figure 4. Common Gulls puddling on a fresh elephant dung pile.

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Research Article *Gajah 46 (2017) 21-27*

Gastrointestinal Strongyle Infections in Captive and Wild Elephants in Sri Lanka

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Abstract. We assessed gastrointestinal strongyle prevalence and abundance in 141 captive Asian elephants under two management regimes and compared them to 50 wild elephants. Gastrointestinal nematode prevalence was found to be 38% in Pinnawela Elephant Orphanage, 90% in privately owned and 100% in wild elephants. Mean number of larvae was 1.9 in Pinnawela, 108 in privately owned and 372 in wild elephants. Elephants being dewormed every 3 months had significantly less parasites than the ones on a 6-monthly regime. Variance in parasite prevalence and load is likely to be primarily related to differences in anthelmintic treatment, and secondarily to husbandry practices.

Introduction

The Asian elephant (*Elephas maximus*) is classified as 'endangered' (IUCN 2017). Asian elephants are unique among endangered mega-fauna in that a significant number are in captivity and managed by a variety of institutions and individuals. Currently about 15,000 Asian elephants are in captivity, comprising one-third of the global population (Fernando 2012). In many range countries captive elephants play a prominent role in tourism, logging, religious and cultural festivals.

Sri Lankans have a close association with captive elephants that extends back millennia (Fernando *et al*. 2011). Historically elephants were used in wars, hauling heavy items, cultural and religious parades and kept as a hallmark of nobility. Currently, temples, private owners, the National Zoological Gardens, the Pinnawela Elephant Orphanage and the Elephant Transit Home keep elephants in Sri Lanka (Fernando *et al*. 2011).

Gastrointestinal helminths are common in all animals (e.g. Fagiolini *et al*. 2010). Nematode worms and particularly strongyles are prevalent among mammals and their control is an important aspect of animal husbandry. While internal parasites of domesticated species are well documented, studies on gastrointestinal helminths in species such as elephants, both in captivity and in the wild, are limited (Woodroffe 1999).

Nutritional and physiological status, stress and captive conditions of animals can influence their resistance to parasites (Geraghty *et al*. 1982). It has been found that the severity of parasite infections is higher in weaker animals than in healthy animals (Lively & Dybdahl 2000; Smith *et al*. 2009). Occurrence of parasites in captive elephants is thought to vary according to husbandry practices, disease prophylaxis and treatment (Fowler 2006; Vanitha *et al*. 2011).

In Sri Lanka, both western and traditional veterinary care is used for captive elephants, targeting active control of gastrointestinal parasites. Here we determine the occurrence and intensity of nematode infections in captive elephants under two different management systems and compare them to that of wild elephants.

Materials and methods

Origin of samples

A total of 191 samples were collected from 47 captive elephants at the Pinnawela Elephant Orphanage (PEO), 94 privately owned elephants, and 50 wild elephants.

Samples from wild elephants were collected in Galgamuwa in Northwest Sri Lanka. This region is characterized by high habitat heterogeneity with interspersed crop fields, irrigation reservoirs, settlements and forest patches. Wild elephants occur over much of the landscape, leading to high human-elephant conflict. We collected 50 samples from dung piles of wild elephants, found around water bodies.

The PEO is a captive elephant breeding centre managed by the state and currently holds 88 Elephants (37 males and 51 females) representing three generations (Fernando et al. 2011). Western veterinary care was provided in-house for elephants at the PEO and anthelmintic treatment administered every 3 months. Elephants at the PEO are managed as a herd during daytime and allowed free range over a few acres, but individually stalled at night. The 47 PEO samples were collected in 2012 and 2013.

At the time of the study 112 elephants were kept by temples and private owners in Sri Lanka (Fernando *et al*. 2011). Most such elephants were managed individually. In May and June 2012 samples were collected from 11 elephants kept in Colombo and 3 in Kegalle. In July 2012 samples were collected from 46 elephants at the perahera (an annual religious festival and parade) in Kandy. In August 2013 we collected a further 18 samples at the Kandy perahera and 16 at the Kataragama perahera in the South. Information on anthelmintic treatment of individual elephants was obtained from the elephant keepers. Their veterinary treatment varied for logistic reasons and irregular access to treatment. For 63 elephants (67.7%) treatment was administered every three months while 26 elephants (28.0%) were on a 6-monthly deworming schedule. Four owners administered treatment only when 'necessary'. Of the privately owned elephants six received traditional and 59 western veterinary care. The remaining 28 received both western and traditional care. Treatment information was not available for one elephant.

Elephants at the PEO and privately held elephants were provided with similar food, consisting mainly of jackfruit tree (*Artocarpus heterophyllus*) leaves, kitul palm (*Caryota urens*) stems and coconut palm (*Cocos nucifera*) fronds. Wild elephants are known to consume a wide range of graze and browse, consisting of over a hundred species (Samansiri & Weerakoon 2007).

Sample collection

An elephant dung pile consists of a number of discrete boli. Samples were collected from freshly deposited dung piles of captive elephants. Samples from wild elephants were obtained from dung piles estimated to be less than 12 hours post-defection. Scrapings from a number of boli of a dung pile were mixed together to obtain a 12 g composite sample, which was placed in a small plastic container and capped.

Lab techniques

The sample was incubated in the dark at room temperature for 7 days, checked periodically and moistened if dry. Samples were processed and analyzed according to Abeysinghe *et al*. (2012) using faecal culture and harvesting through Baermann technique. Strongyle nematode L3 larva were identified and quantified based on morphology and morphometry (Condy 1973; Fowler 2006). Sample processing and analysis was done at the Animal Physiology Laboratory, University of Peradeniya, the Department of Zoology, University of Colombo and at the field station of the Centre for Conservation and Research in Galgamuwa.

Statistical analysis

Data was analyzed using the computer program JMP 11.0.0. Chi-squared tests were used to evaluate significance of differences in nematode prevalence. For comparisons, the number of

parasites was logarithmized to increase normality. If there were zero parasites, the logarithm was taken from 0.5, giving a slightly negative value (-0.693). A one-way ANOVA with Tukey-Kramer HSD post-hoc tests was used to compare the number of parasites between the three populations and to assess the effects of health regime and deworming frequency on parasite numbers. For all other comparisons unpaired t-tests were used.

Results

Prevalence of nematodes

Gastrointestinal strongyle prevalence was 38.3% in the dung of PEO elephants, 90.4% in privately owned elephants and 100% in the wild. Prevalence was significantly different between the three groups (Chi-square, $P < 0.0001$).

Parasite load

The mean number of strongyle larvae detected per 12 g sample was 1.9 ± 3.6 (range 0–18) in PEO elephants, 108.4 ± 253.4 (range 0–2158) in privately owned elephants and. 371.6 ± 388.9 (range 20–1473) in wild elephants. Parasite numbers were significantly different across the 3 populations (One-way ANOVA, $P < 0.0001$). All pair-wise comparisons revealed significantly different parasite loads between wild, privately owned and PEO Elephants (Tukey-Kramer HSD, all $P < 0.0001$, Fig. 1).

In samples from privately owned elephants, there was no significant difference in parasite numbers (t-test, $P = 0.723$) between males ($N = 71$) and females ($N = 23$) or between samples (t-test, $P = 0.309$) from 2012 ($N = 60$) and 2013 ($N = 34$).

Regardless of the type of health care, privately owned elephants had significantly higher parasite numbers than PEO elephants ($P < 0.0001$) (Fig. 2). Private elephants on Western veterinary care had the same number of parasites as the ones on traditional ($P = 0.999$) or mixed care ($P = 0.893$).

Privately owned elephants which were dewormed every 3 months had significantly less parasites than the ones on a 6-monthly regime ($P = 0.0001$), or on a 'if necessary' schedule ($P = 0.0042$) (Fig. 3). Elephants receiving anthelmentic drugs 'if necessary' had a similar parasite load as the ones on a 6-monthly schedule ($P = 0.5833$) or wild elephants ($P = 0.999$).

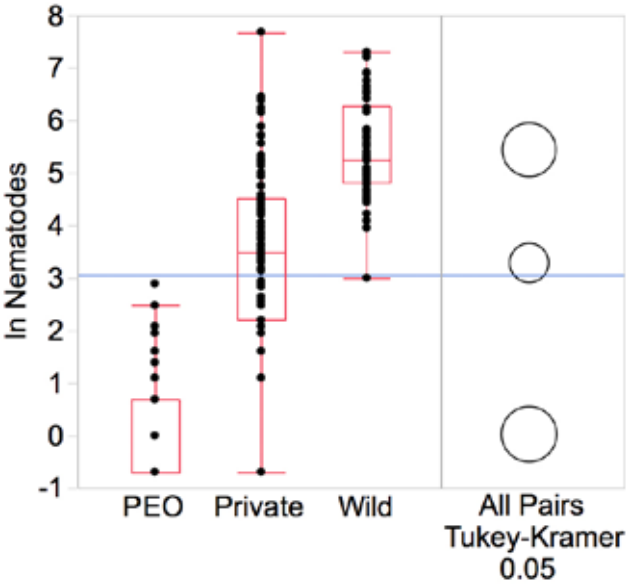

Figure 1. Logarithmic parasite loads of PEO, privately owned and wild elephants. The blue horizontal line represents the grand mean. The comparison circles on the right visualize whether or not the mean values for the three categories are significantly different (no overlap).

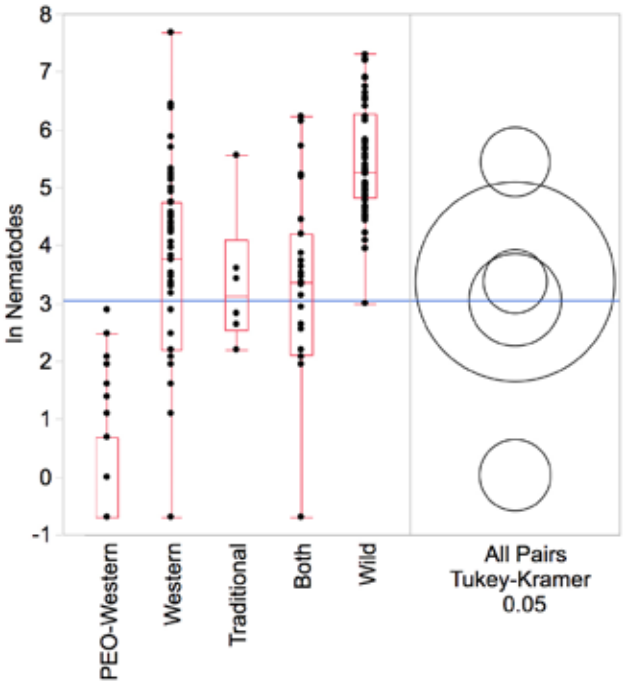

Figure 2. Logarithmic parasite loads of elephants based on their health care regime.

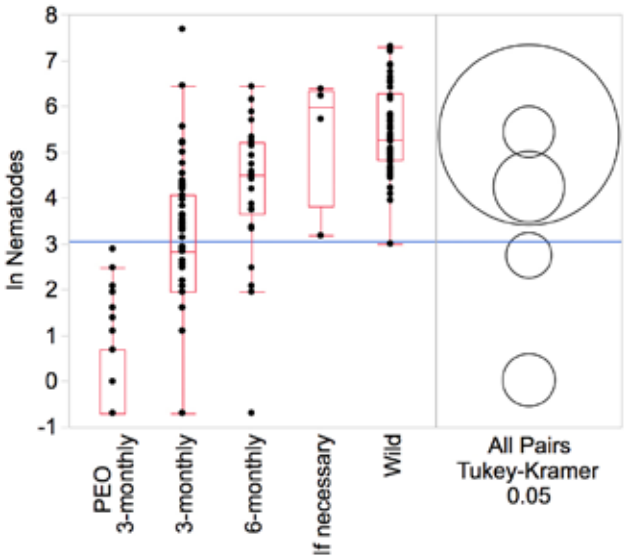

Figure 3. Logarithmic parasite loads of elephants based on the deworming frequency.

Discussion

Prevalence of nematodes

We found all samples from wild elephants to be positive for strongyles but high variation in parasite load among samples. A nematode prevalence of 83% was found in wild elephants in Udawalwe National Park (Heinrich 2016). A study of wild elephants in Nilgiris, South India found parasite presence in 86.8% of samples (Vidya & Sukumar 2002). Strongyles were observed in 40%, 16% and 8% of samples from Mudumalai, Anamalai and Sathyamangalam forests respectively in South India (Nishant *et al*. 2012). A study of wild Borneo elephants found a strongyle prevalence of 82.7% and 50% in fragmented and intact habitat respectively and concluded that habitat fragmentation was associated with increased disease incidence (Hing 2012). Therefore, intestinal parasites in general and strongyles in particular appear to be widespread in wild elephants but the incidence seems to vary widely between sites.

Gastrointestinal parasite infections in wild elephants have been assumed to be determined by intrinsic and extrinsic factors including host demographic aspects such as age, sex and group composition (Vidya & Sukumar 2002). However, Vidya and Sukumar (2002) failed to find any correlation with these factors and parasite load in wild elephants in Southern India. Research on primates has found that within social groups, individuals might vary in their susceptibility to parasitic infection according to their major histocompatability complex genotype, physiological status, general health and immune status (Lilly *et al*. 2002; Schad *et al*. 2005). Given the wide range of possible determinants, intensive, long-term and large-scale studies would be needed to identify the factors responsible for the observed variance in incidence and parasite load in wild elephants.

We found gastrointestinal strongyle prevalence in wild elephants to be significantly higher than in captive elephants (Fig. 1). Similarly, another study in Sri Lanka found a nematode prevalence of 83% in wild elephants in Udawalawe and 53% in captive elephants at the National Zoo and Elephant Transit Home (Heinrich 2016). A study of gastro-intestinal helminths in India found an incidence of 38.1% in wild elephants in Kanha National Park, and incidences of 25%, 41.4% and zero in captive elephants in Kanha, a circus and a zoo respectively (Kashid *et al*. 2002). In Tamil Nadu, India, lower parasite prevalence was observed among private and temple elephants compared to elephants kept by the Forest Department (Vanitha 2007). The difference was attributed to solitary management and traditional medicine of private and temple elephants, and sharing habitats of wild elephants and management as groups of Forest Department elephants (Vanitha 2007). Thus Vanitha (2007) implies cross infection from presumed higher parasite prevalence in wild elephants in the case of Forest Department elephants. None of the captive elephants in Sri Lanka have any opportunities to socialize with wild elephants (Fernando *et al*. 2011), therefore cross infection from the wild cannot explain the variation observed in our study.

The majority of Sri Lankan privately owned elephants were managed under solitary conditions, but they had a higher strongyle nematode prevalence than elephants managed in groups at the PEO. Group living provides more opportunities of parasite transmission and elephants managed in groups can be expected to

have higher prevalence (Vanitha 2007). However, our results suggest that managing elephants in groups or solitarily is not a major determinant of parasite prevalence in Sri Lanka.

The major difference between our three groups was the presence/absence and level of anthelmintic treatment. The most intensive treatment was at the PEO where anthelmintics were given every 3 months. While some of the privately held elephants were said to be on a similar schedule, as a group, the privately held elephants received less and more variable treatment and the wild elephants none. Thus, the main determinant of the variation in prevalence we observed could be attributed to differences in treatment. Our findings are consistent with others that have attributed low gastrointestinal strongyle prevalence among captive elephants to regular deworming (Saseedran *et al*. 2003).

Parasite load

We found significantly higher parasite loads in wild elephants than in captive elephants, and higher levels in privately held elephants than in PEO elephants. Variation in parasite load followed the pattern observed for prevalence and could also be attributed to the differences in treatment.

Decrease in parasite load caused by treatment may depend on frequency of administration and compounds used, which are likely to vary greatly among individually owned elephants. However, we also found higher parasite loads in privately held elephants on the same treatment regime as the PEO elephants. Occurrence of internal nematodes in captivity may also vary according to the type of husbandry practices (Geraghty *et al*. 1982). Differences in quantity of fodder, cleanliness of stalls and healthcare is likely to be greater among privately held elephants than at the PEO, which may also partly explain the observed differences in parasite load. The observed lack of difference in parasite load between the sexes and inter-annually in privately held elephants, probably reflects the similarity in management of males and females and the overarching impact of husbandry practices over environmental factors. We also failed to detect any difference in the effectiveness of western medicine over traditional medicine with regard to parasite load.

Gastrointestinal parasite management in captive elephants

Gastrointestinal parasite control in animals has largely been developed targeting high-intensive livestock production and is based on regular anthelmintic drug treatment. Although productivity is usually not a factor, livestock parasite control practices are often directly applied to captive management of wild species. For example in captive elephants, completely eliminating internal parasites through intensive anthelmintic use is the norm and many studies have stated the effectiveness of albendazole against strongylosis in captive elephants (Chandrashekaran 1992; Suresh *et al*. 2001; Saseedran *et al*. 2003).

Farm animals typically have a short life span, which in most cases is less than 10 years. In contrast the life span of a captive elephant can exceed 70 years (Sukumar *et al*. 1997). Long-term effects of intensive anthelmintic treatment targeting parasite elimination in captive elephants may have negative consequences (Stringer & Linklater 2014). Intensive use of anthelmintics has led to widespread drug resistance in farm animals and this has become a global concern (Gasbarre *et al*. 2009). In contrast, chronic helminth infections may also have beneficial effects such as lowering the prevalence of allergic diseases (Maizels *et al*. 1993; van den Biggelaar *et al*. 2000). Using naturally acquired immunity to control gastrointestinal helminth infections in farm animals is gaining interest (Sutherland *et al*. 1999).

Host-parasite relationships may play an important role in evolution and speciation (Nunn *et al*. 2004; Stringer & Linklater 2014). Our study demonstrates the universal prevalence of gastrointestinal parasites in wild elephants. Parasites and elephants have co-existed and co-evolved for millions of years. Captive elephants have a recent wild origin rarely exceeding 2–3 generations at most (Fernando *et al*. 2011).

Therefore inherent parasite resistance is likely to be still effective in them.

Control of gastrointestinal helminths in captive elephants based on natural immunity would be preferable to possible negative consequences of intensive long-term drug use. Thus, enhancing the immunity of captive elephants through proper nutrition, sanitation and minimizing stress, together with regular faecal testing and treatment of individuals with above 'normal' parasite loads maybe a better management approach.

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Elephant Mortality on Railway Tracks of Northern West Bengal, India

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Introduction

Asian elephant (*Elephas maximus*) deaths due to train accidents are not unusual in some range states of India. During 1987–2007, 150 elephants died due to train hits across India, of which 36% of incidents occurred in 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 Orissa (Rangarajan *et al*. 2010). There has been an increase of Elephant Train Collisions (ETC) since 2007 in West Bengal.

The elephants of North West Bengal (NWB) represent the western-most extension of the northeast Indian subpopulation of elephants. The total extent of NWB is 7050 km^2, of which 3051 km^2 is forested. Elephant habitat is confined to about 2200 km^2. There are 529–550 elephants in this region comprising approximately 1.8% of elephants in India (Anon. 2014). Elephants in NWB occur in the districts of Darjeeling, Jalpaiguri, Alipurduar and Cooch Behar. NWB is considered a hotspot of human-elephant conflict, attributable to unplanned settlements, tea gardens, farmlands, defence establishments, encroachment of elephant habitat and expansion of linear infrastructure such as roads and railways. Almost 50% of the elephant habitat in NWB comprises of non-conservation areas.

This study assessed ETCs on the Siliguri-Alipurduar railway track in NWB.

Methods

The study was conducted across the zone of elephant distribution in NWB (Fig. 1) and was based on primary and secondary data obtained directly from the field, sites of incidents,

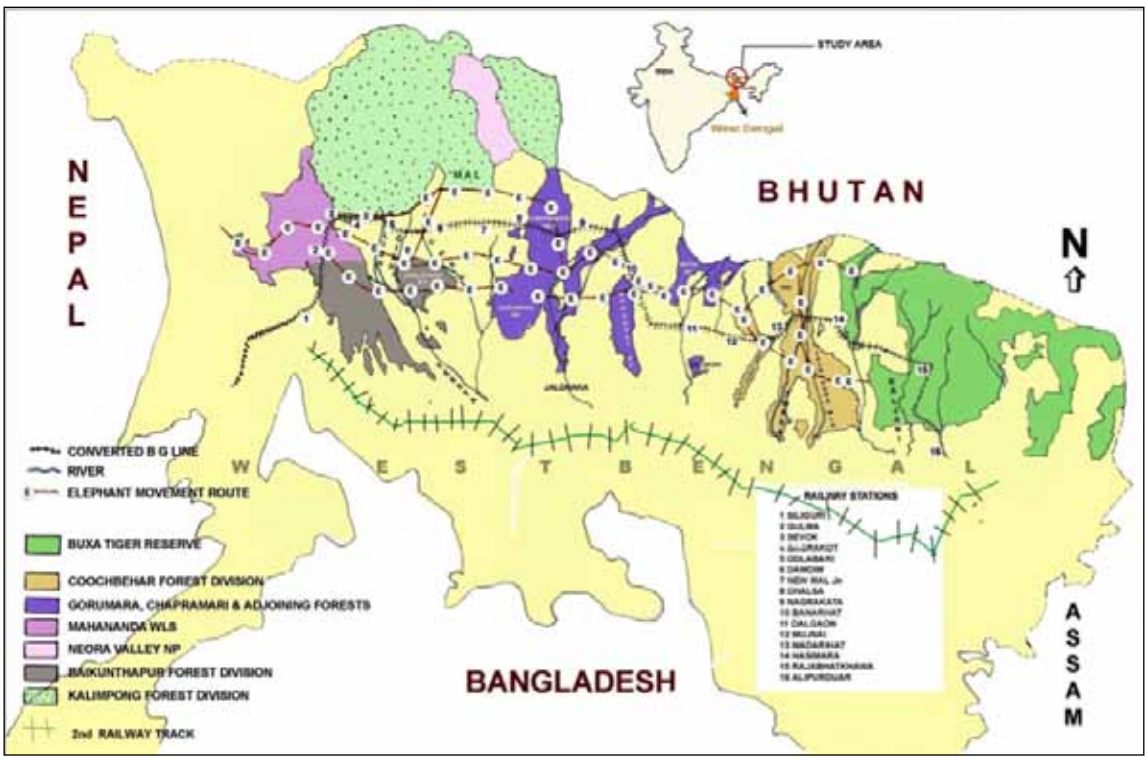

Figure 1. Study area in northern West Bengal.

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information collected from the local community and official records of the Forest and Railway departments. Age-sex classes of the elephants were determined following Varma *et al*. (2012).

Results and discussion

Alignment of railway track in NWB

Of the 161 km of railway track between Siliguri and Alipurduar, 78 km run through protected areas (Fig. 2). This track was laid by the British rulers in early 20th century to transport timber from Himalayan foothill forests. Originally this was a meter-gauge track used by a limited number of smaller trains running at speeds of around 50–60 km/h. In 2003, the track was converted to broad-gauge with trains running at 110–130 km/h. There was a daily movement of 4–5 trains on the previous meter-gauge track, whereas 14–18 trains ply between Siliguri and Alipurduar on the present day broad-gauge track. Between 1974 and 2015, 82 elephants were killed in 56 incidents along this track (Fig. 3).

Figure 3. Mangled body of an adult female on Jaldhaka Rail Bridge.

Spatio-temporal distribution of ETC

The locations of ETCs recorded over the last four decades on the Siliguri-Alipurduar track are given in Figure 4. In 4 accidents 22 elephants died during 2010–2013, where each ETC resulted in the death of 4–7 elephants. Frequency of ETC incidents was one or less than one per year before

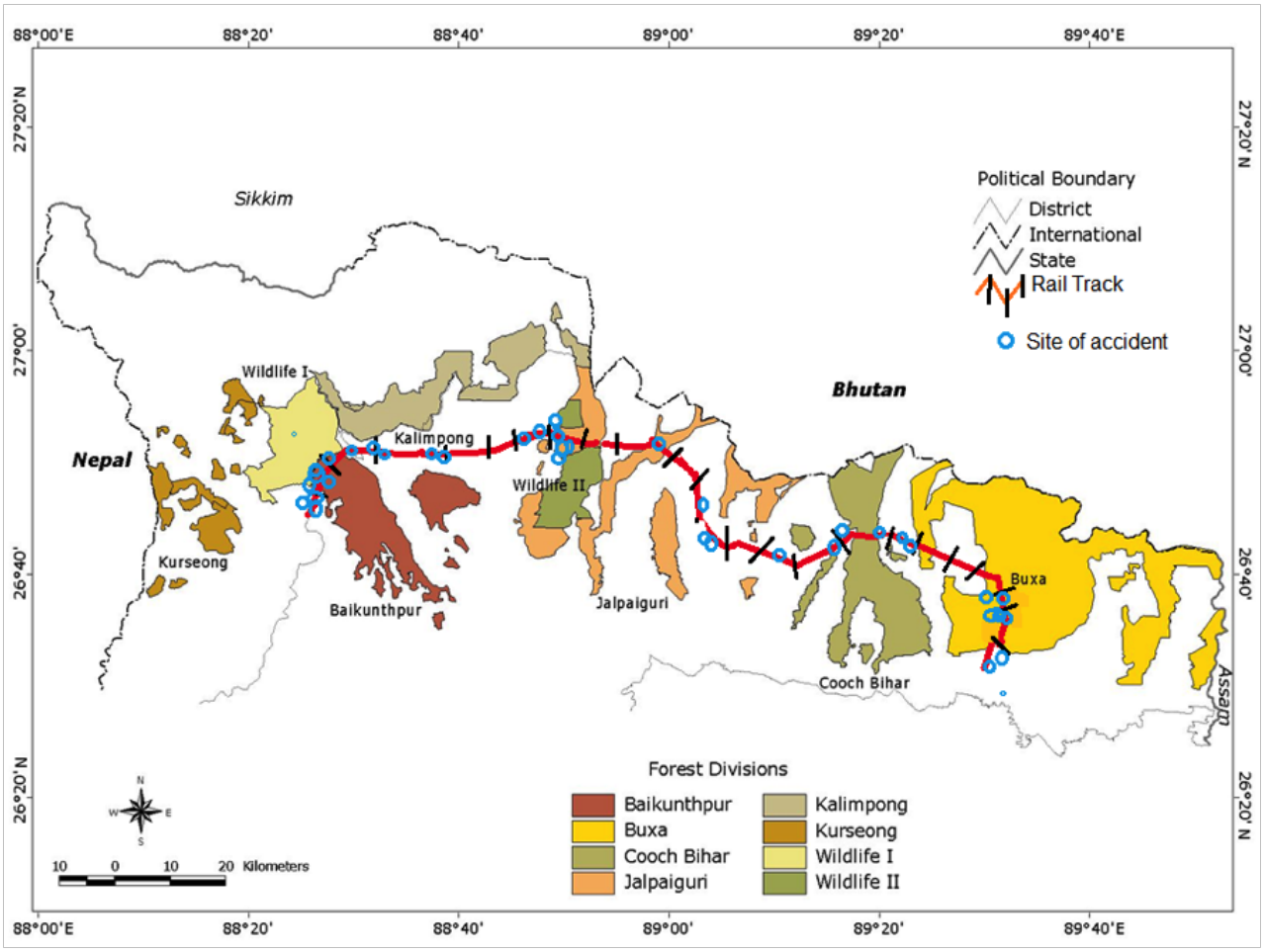

Figure 2. Accident sites along the railway track.

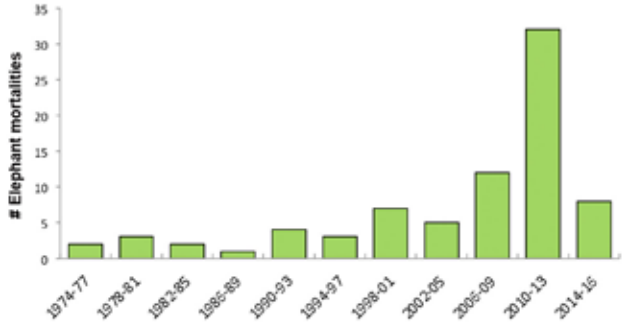

Figure 4. Frequency distribution of elephant mortalities in 4-year intervals from 1974–2016.

2004, which became 2.9–3 per year after 2004. There were 5 accidents at different places during 2013 and another 4 during 2015.

Intensity of ETC was highest with a frequency of 1 incident/km in the Gulma-Sevok stretch in Mahananda Wildlife Sanctuary. The next highest was in the Chalsa-Nagrakata stretch with a frequency of 0.84 incidents/km, which is within 2–10 km from the protected areas of Gorumara and Chapramari (Fig. 1). The majority (79%) of ETC incidents occurred either inside or within 2–10 km from the protected areas.

The temporal distribution of the ETC incidents showed a distinct pattern. The highest number of ETCs (72%) happened between 7:00 pm and 3:00 am, 20% in early morning (3:00 am to 6:00 am) and the remaining 8% during late morning hours (6:00 am to 8:00 am).

The majority of ETCs (69.8%) occurred during paddy and maize seasons. ETCs were higher during the paddy harvesting season from October to December than in the maize season from May

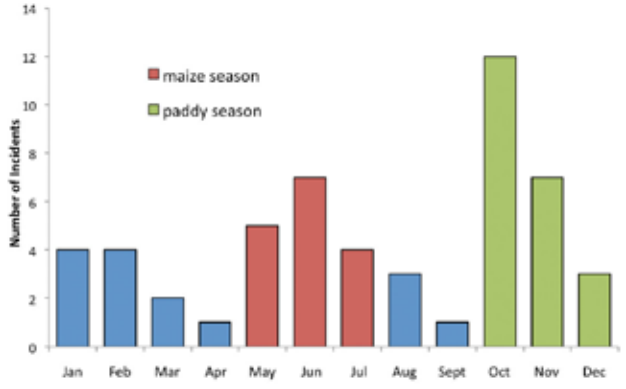

Figure 5. Seasonal pattern of ETCs.

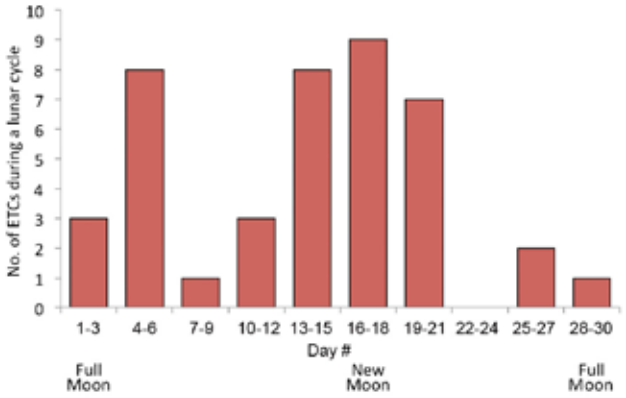

Figure 6. Pattern of ETC in lunar cycle.

to July (Fig. 5). The daily and seasonal differences in ETCs were probably due to differences in elephant movements related to time of day and seasonal agricultural practices.

Relationship of ETC to lunar cycles was not conclusive with a high proportion of incidents occurring from a few days before to a few days after the day of the new moon, but also with a peak about 4–6 days after a full moon (Fig. 6).

Among the total recorded mortalities in ETC, adult males and females constituted the highest number (Fig. 7).

The increase in ETCs in recent times appears to be related to the change from a meter-gauge track to a broad-gauge track, with the associated increase in the speeds and number of trains. Given that the current Siliguri-Alipurduar track runs across a significant extent of elephant range, it is likely that ETCs will continue to occur at a high level.

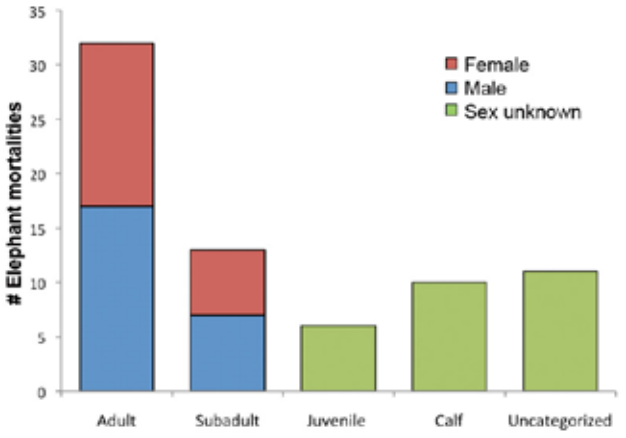

Figure 7. Pattern of elephant mortality with respect to age-sex class.

Given that most ETCs occurred during 7:00 pm to 6:00 am, revision of train schedules to decrease travel at this time and or using slower speeds, especially through vulnerable areas could be a short-term measure to reduce ETCs. The ongoing measures for reducing ETC incidents such as patrolling on the tracks, coordination between line departments, sensitization of the train drivers etc. should be continued to minimize ETCs in the short term. However, they are not a long-term solution.

Construction of over- and under-passes for elephants to cross the tracks safely may be a long-term solution. However, given the high financial outlay and the length of track where incidents occur, such an intervention is not practical.

Another broad-gauge line of 183 km between New Jalpaiguri and Alipurduar, is located to the south of the Siliguri-Alipurduar track (Fig. 1). There has been no record of elephant deaths due to train accidents on this track, as it does not cross any elephant range. The distance between the former and latter tracks varies from 5–30 km at different points. The station of New Jalpaiguri is only 7 km away from the Siliguri station. Therefore, use of the second track instead of the first is practical and would avoid elephant fatalities. A long-term solution to ETCs would be to use the New Jalpaiguri-Alipurduar track as an alternative to the Siliguri-Alipurduar track and to expand the Jalpaiguri-Alipurduar track to a double line to accommodate the increased traffic. The Siliguri-Alipurduar track could be utilized for ecotourism or as a heritage ride as it passes through pristine forests and would provide a great opportunity to view the scenic landscapes and wildlife. Such use would carry a much smaller number of trains running during day time, that could traverse the problem areas at low speeds, hence prevent ETCs.

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Figure 8. Elephants in northern West Bengal (photo by Mr. Koushik).

Postponement of Musth in Asian Elephants Using a GnRH Vaccine

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Introduction

In Sri Lanka and in other Asian countries, mature male captive Asian elephants (*Elephas maximus*) are an integral part of celebrations related to cultural, religious and state occasions. However, the annually occurring musth period of adult males (Fig. 1) may hinder sourcing of elephants for these events (Lincoln & Rathnasooriya 1996; Jainudeen *et al*. 1972).

Musth in mature males is a testosterone dependent (Rasmussen *et al*. 2008), highly predictable event, which lasts between 3–6 months. When in musth, privately owned captive males are kept tethered in stables (Ananth 2000; Rajapaksha *et al*. 2004). During this period male elephants can be difficult to handle and often are aggressive to the point that they may injure handlers and in some instances, even kill them (Pool 1989; Rasmussen & Perrin 1999).

Endocrinologically, the mean normal serum testosterone concentrations in captive Asian male elephants vary from 1–10 ng/ml while in pre-musth and musth, the levels are 10–20 ng/ml and 20–50 ng/ml, respectively (Yon *et al*. 2008). During musth, bull elephants show marked increase in testosterone secretion and studies have shown high sensitivity of the testes to GnRH during the non-musth period (Somgird *et al*. 2016).

Controlling and monitoring the aggressive behaviour of captive male elephants during musth is of paramount importance not only from a public safety perspective but also from an animal welfare standpoint. De Nys *et al*. (2010) were able to reduce musth-related aggression by surgical castration. However, as elephants have intra-abdominal testes, this procedure is difficult, costly and irreversible. The use of anti-androgens, oestrogens (Hettiarachchi *et al*. 2005), GnRH agonists, and GnRH antagonists also has limited value due to unpredictable results and practical difficulties in administration.

De Nys *et al*. (2010) and Talwar *et al*. (1995) suggested the use of GnRH vaccine to down-regulate the hypothalamic-pituitary-gonadal axis, as noted in several other species of animals (Miller *et al*. 2000), which could be a useful, reversible (Miller *et al*. 2000) and a relatively inexpensive procedure to suppress musth in elephants. No detrimental effects of this vaccine on elephants have been reported.

Figure 3. Wild musth bull in Minneriya National Park. Note the secretion from its temporal gland and the wet hind legs from urine dribbling. Photo by Jennifer Pastorini.

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The objective of this study was to investigate the effects of GnRH vaccine in the postponement of musth in captive male elephants.

Methods

Four privately owned males and two males from Pinnawela Elephant Orphanage were selected for the study. For musth suppression, three doses of GnRH vaccine (800 μg per dose; BOPRIVA®bovine immune castration vaccine, Zoetis GMS Australia) was injected IM at monthly intervals so that the last injection was approximately one month prior to the anticipated date of musth.

At the time of each vaccination, blood samples were collected from the ear vein, the serum separated and stored at -20ºC until analysis. Testosterone levels were assessed using an Enzyme-Linked Immuno Sorbent Assay.

Elephant owners and handlers were educated on musth, its undesirable effects and potential threat to public safety and the effect of musth postponement by GnRH vaccine was explained (Fig. 2). The elephant keepers were asked to keep a note on the behaviour i.e. obedience, of the elephants in their care.

Results

Of the four privately owned elephants, all three doses were given to one elephant, two doses to each of two elephants and a single dose to one elephant (Table 1). The full course could not be

Figure 2. Explaining the procedure to the mahout before vaccination.

Table 1. Animals included in the study, dates of vaccinations, serum testosterone levels (STL), anticipated and onset dates of musth. NV = not vaccinated; NR = not recorded.

Ownership	Elephant	End of last musth	Expected next musth	Onset of musth	Vaccination date and STL [ng/ml]					
					1st dose		2nd dose		3rd dose	
					Date	STL	Date	STL	Date	STL
Private	Saliya	15.3.2014	5.7.2014	27.9.2014	15.4.2014	2.96	19.5.2014	2.37	19.6.2014	0.68
	Udaya	5.11.2013	15.7.2014	7.7.2014	29.4.2014	9.19	29.5.2014	0.82	NV	NR
	Tharaka	20.10.2013	19.4.2014	11.3.2014	4.2.2014	NR	4.3.2014	NR	NV	NR
	Ranji	15.2.2014	5.10.2014	20.8.2014	15.7.2014	24.52	NV	NR	NV	NR
Pinnawela	Jayathu	Continuous for two years	Unpredictable	5.12.2014	22.9.2013	1.52	24.10.2013	3.87	22.11.2013	4.97
	Suranimala	Irregular, twice a year	Unpredictable	25.1.2015	25.1.2014	15.70	4.3.2014	9.22	25.3.2014	2.03

given to all as the owners and keepers did not comply with the injections and advice. Blood samples could not be collected from Tharaka, one of the privately owned males because he was aggressive and a new keeper had been employed.

The elephant receiving all three doses demonstrated a three-month delay in the onset of musth (Table 1), together with a marked reduction in aggressiveness. The two elephants that received two doses showed signs of musth around the expected time, however, there was a reduction in aggression. The animal that received a single dose came into musth two months prior to the expected date with higher aggression and had a prolonged period of musth.

Of the two Pinnawala elephants, one had been in continuous musth for almost two years when the first dose was administered and he came out of musth immediately after the first injection and had lowered aggression. However, musth reappeared approximately 13 months after the third dose (Table 1). The other had a history of irregular musth twice a year and responded by delayed commencement of musth by approximately 10 months after the third dose (Table 1), with lowered aggression.

Testosterone levels were reduced in two of the four privately owned elephants in which all tests were done and one of the Pinnawala elephants while the other Pinnawala elephant showed an increase in testosterone levels (Table 1).

Discussion

This is the first time that the vaccine was used on privately owned captive elephants in Sri Lanka. One elephant with a typical history of musth, given three doses of GnRH vaccine, responded with decrease in serum testosterone levels, postponement of musth, and decrease in aggressiveness.

A high serum testosterone level at the time of the first vaccination may be associated with eliciting a good response to the course of injection, as seen by the delay in musth and reduced aggression, by elephants Saliya and Suranimala. In three of four animals tested, the serum testosterone level declined after the vaccinations. Privately owned male elephants have an assigned keeper for several years, while in the Pinnawela Orphanage, this is not the case. Although musth is essentially testosterone dependent, the elephant-keeper relationship could possibly influence the behaviour during musth (Hettiarachchi *et al*. 2005), which may have had an effect on levels of aggression observed in this study.

In Thailand five bulls vaccinated with 600 μg GnRH two months before expected musth and boosted three times with 600 μg at four week intervals, showed decreased serum testosterone levels with musth postponement in three and skipping of musth for that year in the other two (Somgird *et al*. 2016). In Sri Lanka, three of six bulls given 600 μg GnRH, in three injections one month apart, showed reduced serum testosterone levels while others did not show anticipated response (Rajapaksa *et al*. 2010).

Unpredictable behaviour in male elephants can be seen even naturally when serum testosterone decreases after the peak in musth (Lincoln & Ratnasooriya 1996). Therefore elephant keepers must be made aware that, though GnRH is likely to postpone musth, the length of post-musth period could vary. Some elephant owners in Sri Lanka believe that disruption of musth in healthy males leads to intractable handling difficulties (Rajaram 2006). In this study, an attempt was made to address this belief by education to the contrary. However, this may have been the reason for non-compliance by two of the privately held

Figure 3. Vaccination of a captive bull.

elephant owners in completing the three doses of vaccine. Incentives such as service priorities and discounts in professional costs may help increase compliance.

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Clinical Management of a Chronic Abscess in a Juvenile Asian Elephant

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Introduction

Abscesses occur in all parts of the body in elephants and could become chronic, if not treated in time (Ollivet-Courtois *et al*. 2003). Latent period from initial wound to development of abscess may vary from a week to months (Schmidt 1986).

Here we describe the clinical management of a chronic abscess in an Asian elephant (*Elephas maximus*).

History

A juvenile captive female elephant of 5.5 feet shoulder height presented with a lump, at the Sanjay Gandhi Biological Park, Patna. On clinical examination an 8 x 7 cm lump was found on the medial side of the right forelimb, with signs of chronic inflammation and an opening of about 2 cm on the dependent part through which pus oozed out. The diagnosis of a chronic abscess was made based on the clinical signs (Fig. 1).

Clinical management

The pyogenic exudate was collected by sterile swab and culture and antibiotic sensitivity tests were conducted for selection of a suitable antibiotic (Table 1).

Treatment was initiated by surgical opening of the lump at the dependent part, under local anaesthesia with Lignocaine 2% (30 ml) injected around the lump. Drainage of pus was facilitated by flushing of the abscess with potassium permanganate (0.01%) solution made by diluting a 400 mg tablet in 4 l of water, and using a 100 ml syringe and exerting manual pressure on the lump.

The wound was irrigated regularly for three consecutive days with 0.01% potassium permanganate solution, to dissolve the pyogenic membrane. The wound was then painted with povidone iodine and left open for seven days.

Benzene hexacholride spray was used to avoid myiasis (maggot infestation). Amoxicillin and Clavulanic Acid 7.2 g was given parenterally daily for seven days to avoid secondary bacterial

Figure 1. Chronic abscess.

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Table 1. Culture and antibiotic sensitivity test result. Organism isolated was *Staphylococus* spp. and *Pseudomonas* spp.

Antibiotic	Sensitivity
Levofloxacin	++
Amikacin	-
Ciprofloxacin	-
Gentamicin	+++
Ceftriaxone	+++
Cefotaxime	-
Chloramphenicol	-
Cloxacillin	-
Amoxicillin & Clavulanic acid	++++
Enrofloxacin	++++
Moxiflox	-
Cefetrixone & Salbactum	-
Cobactan	++++

infection and Serratiopeptidase 3 boli was given orally once a day for 3 days . The animal recovered uneventfully after 2 weeks (Fig. 2).

Discussion

Wound healing can be prolonged in elephants due to their thick dermis and is dependent on several factors such as wound management, type of wound, environment, site of wound, and nutritional status of the animal (Sukklad *et al*. 2006). Due to the thick epidermis in elephants opening of wounds is very necessary for proper drainage.

Administration of antibiotics identified through culture and antibiotic sensitivity tests and proper surgical and medical management as in this case study, enables successful management of chronic abcesses in elephants.

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Figure 2. Healed wound.

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The Jakarta Declaration for Asian Elephant Conservation

Introduction

The 2nd Asian Elephant Range States Meeting was successfully held in Jakarata, Indonesia from 18th to 20th April 2017. Members from 12 range countries participated (Nepal could not attend due to election code of conduct). The meeting was organised by the Ministry of Environment and Forestry, Republic of Indonesia in collaboration with Regain Foundation and IUCN Asian Elephant Specialist Group. The purpose of this meeting was to discuss the challenges confronting elephant conservation in Asia, possible solutions and to enhance the cooperation among Asian countries to conserve elephants in Asia. The meeting concluded with the "Jakarta Declaration for the Asian Elephant Conservation" agreed upon by all the 13 countries.

The Declaration

We, the representatives of the relevant agencies from Asian elephant ranges states including the Kingdom of Bhutan, People's Republic of Bangladesh, Kingdom of Cambodia, People's Republic of China, Republic of India, Republic of Indonesia, Lao People's Democratic Republic, Federal Democratic Republic of Nepal, Democratic Socialist Republic of Sri Lanka, Republic of the Union of Myanmar, Malaysia, Kingdom of Thailand, and the Socialist Republic of Vietnam, declare our common goal to conserve the Asian elephant in all Asian elephant range states, and:

Recognize that the Asian elephant, a seriously endangered species and one of Asia's most charismatic animals, faces a challenging future with the loss of its habitat, fragmented populations, high levels of human-elephant conflict, poaching, as well as other factors that have resulted in serious population declines in most of the range states;

Note that compared to the more frequently publicized African elephant there are ten times fewer Asian elephants, and like the African elephant, some Asian elephant range states face the loss of their elephant populations;

Acknowledge that the Asian elephant is a keystone species and an umbrella species whose conservation helps ensure the conservation of myriads of other species. Asian elephants are also culturally significant across Asia. A failure to protect Asian elephants and their habitat will therefore not only result in the loss of elephants but also the loss of biological and cultural diversity and the tangible and intangible benefits provided by elephants and the ecosystems they inhabit;

Note that while elephant conservation is primarily a national responsibility, there is an urgent need to synergize national actions with international cooperation amongst the range states for the long-term conservation of Asian elephants. The reversal of the crisis facing Asian elephants is additionally dependent upon political, financial, and technical support from the international community;

Understand the role of international agreements on the conservation of biological diversity and protection of rare and endangered species, including the Asian elephant, such as the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the Convention on Biological Diversity (CBD), and the Convention on the Conservation of Migratory Species of Wild Animals (CMS);

Acknowledge the presence and support of other governments, international organizations, non-governmental organizations, and other supporters of Asian elephant conservation.

Thus we declare:

- We have a common vision to promote Asian elephant conservation;
- Affirm our intention to cooperate based on

the principles of sustainable development and through research and development, education and training, fund-raising, as well as other activities that are relevant to Asian elephant conservation and development within the range states;
- Commit to develop where necessary, and implement our National Asian Elephant Action Plans that include, but are not limited to, the priorities listed in the annex to this declaration.

And call upon the international community to join us in reversing the decline in Asian elephant numbers and positioning the Asian elephant securely on the road to recovery.

Annex: Priorities

- Maintain large Asian elephant conservation landscapes where no unregulated, economic or commercial infrastructure development or other adverse activities are permitted, and create connectivity between such landscapes where all permitted developmental activities are elephant- and biodiversity-appropriate;
- Work collaboratively on transboundary issues to allow uninhibited movement of wild Asian elephants in and between range states through appropriate corridors and transboundary protected areas;
- Minimize the negative impacts of humans on Asian elephants and their habitats, address the root causes of human-elephant conflict and develop long term solutions to minimize such conflict; engage with local communities to gain their participation in biodiversity conservation and land-use planning; and provide sustainable and alternative livelihoods through financial support, technical guidance, and other measures;
- Ensure effective enforcement of existing national laws and regulations across the species' range to prevent illegal killing of Asian elephants and the illegal trade in live Asian elephants, ivory, and other elephant body parts.
- Strengthen international collaboration, coordination, and communication where relevant, involving specialized expertise from international organizations, including but not limited to, CITES, INTERPOL, and UNODC;
- Cooperatively develop captive Asian elephant registration programs, including where appropriate microchipping and/or DNA-based systems, and ensure cross-border movements of captive Asian elephants are in compliance with all national and international laws and regulations;
- Ensure the welfare of captive elephants is maintained at all times;
- Develop where necessary National Asian Elephant Action Plans and a Range-wide Asian Elephant Conservation Plan and ensure their timely implementation.

Workshop on Addressing Human-Elephant Conflict in Myanmar

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Introduction

Myanmar has been experiencing increasing levels of human-elephant conflict (HEC) in recent years. HEC leads to significant crop and property damage, as well as injury and loss of life for people and elephants, and is a significant threat to the long-term conservation of elephants. To better address HEC in Myanmar, a coalition of groups, including Myanmar's Ministry of Natural Resources and Environmental Conservation (MONREC), the Smithsonian Conservation Biology Institute (SCBI), Wildlife Conservation Society (WCS) and WWF co-hosted a two-day workshop in Nay Pyi Taw in June, 2016. The workshop was an opportunity to review the draft chapter on HEC, which will serve as the national HEC strategy under the national Myanmar Elephant Conservation Action Plan (MECAP), and to develop a draft 3-year action plan to launch activities under the strategy. Meeting discussions identified drivers of HEC and measures to address them in the MECAP.

The workshop included 47 participants, with representation from the Myanma Timber Enterprise (MTE), Fauna and Flora International (FFI) and local organization Friends of Wildlife, in addition to members of the organizations hosting the workshop. Presentations included background information on HEC; the MECAP process and HEC strategy; and stakeholder engagement.

Background on HEC

During the first session providing background information on HEC, Dr. Christy Williams, WWF-Myanmar Country Director and former leader of WWF's Asian Rhino and Elephant Action Strategy (AREAS), presented on the wider HEC context in Asia, and provided different scenarios for the occurrence of HEC in various landscapes across Asian elephant range countries, as well as the advantages and disadvantages of existing HEC mitigation measures.

Maung Win (Nature and Wildlife Conservation Division - NWCD) gave an introduction to HEC in Myanmar by providing some background on the issue and highlighting recent increases in HEC – based on existing records, the year 2014 had the most human and elephant casualties in recent years, with most people killed in the Bago Region and most wild elephants killed in the Ayeyarwady Region.

During his presentation, Wayuphong Jitvijak (WWF) argued that HEC was not difficult to deal with if governments and communities had the right attitude, knowledge, and capacity, and if the government, NGOs, and community worked together, citing the case study of the POWER (Partnership On Wildlife and Ecosystem Resilience) Initiative in Thailand's Kui Buri National Park. Due to a number of successful interventions, including habitat management, there have been no elephant deaths in Kui Buri as a result of HEC or poaching since 2010.

Dr. Zaw Min Oo (MTE) discussed Myanmar's significant captive elephant population and mentioned that MTE is reducing, and will eventually stop, logging country-wide, which means that the elephants previously used for logging operations will be out of work. Any release plan for these working elephants must take into consideration the potential for increased HEC and transmission of zoonotic diseases.

MECAP

The session on the MECAP process and HEC strategy kicked off with a presentation by Dr. Simon Hedges (WCS), who provided an overview of the MECAP process, as well as a summary of progress, stressed that addressing HEC was a major component of the MECAP, which also includes three other key components – wild elephant conservation, illegal trade, and captive elephants. The MECAP is a 10-year plan, with the HEC action plan being the first chapter of the MECAP to be discussed in detail at the workshop. The workshop also contributed to the development of a shorter-term implementation plan. The MECAP is set to be completed and ready for implementation in 2018.

Following this, Dr. Peter Leimgruber (SCBI) provided an overview of HEC in Myanmar, outlining the current status, causes, and management of the issue. Most HEC is linked to development and expansion in agriculture, transportation and infrastructure, and dam construction. Following the onset of these developments, HEC increases as the result of the combined effects of habitat loss (e.g. loss in forest area), increases in human population, and increases in early successional vegetation areas. In Myanmar, the development of hydropower dams may have additionally contributed to the rise in HEC in some areas such as the Bago Yoma. As a consequence, addressing HEC should be a multi-sectoral and multi-stakeholder process involving a range of government departments (e.g. Forestry, Agriculture, Transportation, Energy), as well as local communities.

When addressing HEC in Myanmar, it's important to realize that elephant conservation is only possible if there are effective long-term strategies for managing HEC that are minimizing negative effects on people and elephants. This requires a) developing effective management structures; b) supporting HEC-affected communities; c) monitoring, research, and adaptive management; and d) addressing development impacts and land-use planning.

HEC action plan

The final session on stakeholder engagement provided context for the discussion on drawing up a HEC action plan, with key actors in HEC management giving presentations on their recent work and planned actions for the near future.

Dr. Zaw Min Oo (MTE) presented on the Emergency Elephant Response Units (EERU) managed by the MTE to reduce and prevent HEC. EERU teams educate local communities, drive wild elephants away from community areas, translocate wild elephants from the Delta and Bago West regions to North Zarmari Wildlife Sanctuary (with limited success), collect elephant data and information, and collaborate with FD and NGOs for collaring and research, among others.

Saw Htoo Thar Po (WCS) then spoke about WCS's past work on elephant conservation and HEC work, including helping create Hukaung Tiger Reserve, which is very good elephant habitat where they have done elephant survey work and provided law enforcement training; establishing an enforcement program in Alaungdaw Kathapa National Park—five Elephant Protection Units (EPUs) were recruited for patrolling, although this elephant program is currently suspended, establishing elephant conservation program in Rakhine Yoma Elephant Reserve (RYER) and recruiting two EPUs for patrolling in RYER. He also updated the group on WCS's future plans for HEC actions in the country, including conducting a country-wide elephant occupancy survey in collaboration with other NGOs.

Next, Kyi Soe Lwin (Friends of Wildlife Myanmar) provided information about the organization's recent work, including organizing a workshop on HEC and enforcement and field surveys on HEC in West Pathein, Tharbaung, and Gwa townships. Their future plans include establishing Elephant Conservation Units in selected villages in Ayeyarwady and Rakhine with 4 or 5 young villagers, and training villagers in community forestry for habitat restoration.

Nay Myo Shwe (FFI) then presented on their work in Lenya, where HEC cases are present because palm oil plantations are expanding into natural forests and increasing HEC. FFI's work to-date includes camera trapping inside plantation concessions, corridors, and in natural forests, and questionnaire surveys with the local community to investigate possible HEC hotspots.

Paing Soe (WWF) presented on WWF's aim, at the time, to launch field programs on elephant conservation, which have since been in effect, in partnership with SCBI. This included plans to GPS-collar elephants in the Bago Region in collaboration with SCBI and potentially in Tanintharyi in collaboration with FFI, set up a new EERU in Tanintharyi in collaboration with SCBI, and work with the private sector to promote sustainable business practices for large-scale agriculture projects.

The final presentation of the session was by Aung Myo Chit (SCBI) who presented on their work on testing and developing long-term HEC management strategies through research, monitoring, outreach and community-based conservation. SCBI has successfully collared and tracked 8 wild elephants together with MTE and FD, conducted pre-management community surveys, funded and trained village-based HEC response teams, trained MTE mahouts and villagers in collecting dung from conflict elephants for DNA analysis, and worked with communities to develop low-cost, small-scale electric fencing. SCBI has also collaborated with Compass Films to develop public service TV spots on HEC and an outreach campaign. Among their future plans is to conduct dung DNA surveys to identify elephants involved in HEC and conducting outreach campaigns, in addition to the collaborative elephant collaring and tracking with WWF.

Key outcomes for HEC strategy

- Addressing HEC
  - There is need for a national level plan to address HEC under the MECAP.
  - The village administrator, FD, and MTE should take leading role at the ground level with capacity building of ground level staff.
  - An early warning alarm system should be established for known HEC-prone areas and at relevant times of the year.

- Monitoring and adaptive management
  - Monitoring data must be collected in a reactive, not proactive manner.
  - Data on death and injury is more reliable than data on crop damages as crop damages can be over-reported.
  - EERU regular patrols can provide data on both HEC and poaching.

- Supporting local communities to address HEC
  - Local communities depending on forests are the focus of the support.
  - Proposed measures include: changing agriculture practices to cultivate crops that are unpalatable to elephants, electric fences and alarm systems, and planting elephant food plants in the forest far from villages.
  - Key government actors: FD, MTE, Police Force, and General Administration Department must be involved in providing support to communities.
  - Elected village representatives will coordinate with government agencies.

- HEC and Development Impacts / Land Use Planning
  - Infrastructure-related causes for HEC include dams and irrigation infrastructure, roads, power grids, urbanization – develop a payment system to mitigate the environmental impacts of infrastructure.
  - Collect information on elephant presence and work with developers and communities to reduce encroachment and habitat impacts.

The aim of the 3-year action plan was to launch some of the activities listed as priorities under the key outcomes.

The Myanmar Elephant Conservation Action Plan (MECAP) is currently awaiting endorsement from the Myanmar government, and implementation will begin in 2018.

Expanding the Conservation Network of Asian Mahouts

Sathyanarayana Mamatha[1]*, Nazaruddin[2] and Heidi S. Riddle[3]

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Mahouts are critical to elephant conservation programs across Asia. India, in particular, has for many years used trained elephants and their mahouts for direct conservation efforts. Although in many state Forest Departments the mahouts are from traditional families of mahouts, according to recent reports the Karnataka Forest Department (KFD), in southern India, is actively recruiting new mahouts because of the rising trend in human-elephant conflict (HEC) in various parts of Karnataka state. This state is home to the largest population of wild Asian elephants, presently thought to number approximately 6000 elephants. Currently there are about 122 trained elephants in all KFD camps, and the KFD has 71 posts of mahouts and 90 posts of kavadis (assistant mahouts).

It is generally felt that mahouts require ongoing awareness and updating on various management methods and current technology. Hence a series of awareness programs were arranged for the mahouts and kavadis of the Balle, Dubare, Rampura, and Sakrebyle elephant camps in Karnataka starting in January 2015 and continuing to date. A total of over 100 mahouts have participated in the programs so far. The goal of these sessions is to achieve recognition of mahout professionalism; to increase the capacity and competency of mahouts in elephant conservation work and habitat protection efforts; to create an information and communication system between mahouts locally and regionally; and to increase the welfare of mahouts and elephants.

In the state of Karnataka, the majority of Forest Department mahouts are tribal whose families have been working with elephants for generations, with fathers passing on their knowledge and skills to their sons. These mahouts are rarely exposed to new information about captive elephant management, and previous opportunities for casual information sharing have been well received.

Issues addressed and discussed during the sessions include the problems faced by the mahouts in their elephant conservation and habitat protection efforts, finding solutions to improve the care and management of India's wild and captive elephants, improving the welfare of the mahouts and their elephants, and creating an informal network with colleagues locally and in the region.

The main goals of these Mahout Awareness Sessions are as follows:

1. Sharing knowledge and experiences with Karnataka Forest Department mahouts by:
   - Presentations by representative camp mahouts about utilizing mahouts and elephants for conservation duties, followed by discussions about the different local experiences in camp elephant management.
   - Presentations by representative camp mahouts about the work each camp is doing to address issues such as HEC.
   - Discussions about local experiences and knowledge of elephant care, husbandry, and training.
   - Discussions about building capacity within the mahout community for improved skills in forest protection and wildlife conservation, and improved job performance and welfare of these individuals.

2. On-going mahout education via the following topics:
   - Introduction to general elephant biology.
   - Asian and African elephants - physiological differences, conservation management similarities (i.e. HEC).
   - Captive elephant management in other forest camps in Asia and in non-range countries.
   - Training elephants for veterinary care and treatment.

3. Pre and post training survey:
   - To better understand how the program contributes to enhancing the capacity of mahouts in their daily elephant care and conservation work, participants are asked to complete a survey before and again after the session that gives an indication of what has been learned and what type of information is needed by mahouts.
   - Survey results are important to understand the effectiveness of the programs and results will indicate where changes are needed.

Indonesia is a country with a more recent captive elephant and mahout experience. For a number of years NGOs have been supporting Indonesian government conservation agencies to implement long term projects in Sumatra using trained camp elephants and their mahouts for direct conservation interventions. Previously neglected camp elephants and their mahouts now actively patrol protected areas reporting on illegal activities, providing assistance and support during wild elephant translocations and/or radio-collaring, and supporting local communities to mitigate HEC.

The success of these patrol units has led to additional units being established by the government conservation and national park agencies around Sumatra. Following on the accomplishment of the Sumatra work, primarily based on enhancing the skills and motivation of mahouts so they are not just elephant handlers but accomplished field conservation staff, during the past few years collaborations have expanded to other Asian countries (i.e. Myanmar) to develop similar units using trained elephants, their mahouts, and field staff.

The following opportunities to exchange field staff and improve conservation outcomes have occurred: Sumatra field staff taught a course on field navigation using GPS units in Myanmar in December 2014; field staff from Myanmar participated in the 7th Indonesian Mahout Communication Forum Workshop in February 2015 and visited several Sumatra camps to learn more about the use of trained elephants for patrols, for HEC migration strategies, and for tourism. In November 2015, field staff from Myanmar spent time in Sumatra with the Elephant Response Units in Way Kambas National Park, participating in and learning about the use of routine elephant patrols to support local farming communities and mitigate conflict with wild elephants.

As a result of these exchanges, the Indonesian Mahout Communication Forum (FOKMAS) extended an invitation to KFD mahouts to participate in the 2017 Indonesian Mahout Workshop which was held from May 16-18, 2017 in Taman Satwa Lembah Hijau, in Lampung province, Sumatra.

The Karnataka Forest Department is very interested in opportunities to provide continued training for KFD mahouts and showcase the KFD work in forest protection, so two KFD mahouts were deputed to participate in the Indonesian Mahout Workshop. The two KFD mahouts, Mr. Vasantha from the Mattigodu Elephant Camp and Mr. Nayaz Pasha from the Dubare Elephant Camp, attended the workshop and spent a few

Figure 1. Sumatra mahouts demonstrating elephant foot care.

days with one of the elephant patrol units in Way Kambas National Park.

The Indian mahouts are both from traditional mahout families. They first spent time at the Tegal Yoso Elephant Response Unit base camp located on the boundary of Way Kambas National Park. The KFD mahouts participated in activities such as a routine patrol and were shown the basics of GPS navigation by the Sumatra mahouts (Fig. 1).

The KFD mahouts then attended the Indonesian Mahout Workshop in Lampung (Fig. 2). The workshop hosted about 70 participating mahouts from facilities all across Indonesia (government camps, zoos, safari parks). Topics covered during the workshop included the role of trained elephants in HEC mitigation, training elephants for medical procedures, and using more humane training methods. The KFD mahouts had a very dynamic session; the Sumatra mahouts asked many questions about their activities, mainly how the KFD deals with HEC in their region. Practical workshop activities included topics such as the use of ultrasound in reproductive assessments of the elephants at the Taman Satwa Lembah Hijau Park. The KFD mahouts also demonstrated several traditional Indian elephant husbandry practices including the use of oil (Neem and Castor) on elephants' forehead and feet, and the reasons for its use.

Regional partnerships between mahouts and other field conservation staff within Asia have provided tremendous motivation and increased the skills and professionalism of mahouts. There is now greater awareness and knowledge about conservation issues among the mahout staff, and a better understanding of the use of trained elephants and skilled mahout teams to successfully participate in meaningful conservation activities. These Asian mahout partnerships should continue to be encouraged and supported as an effective approach to help protect forests and wildlife in Asia.

We acknowledge and thank the Karnataka Forest Department for their support of the mahouts' visit to Indonesia; in particular we are very grateful to Mr. Manoj Kumar, Chief Conservator of Forests, Kodagu Circle, and Mr. Manikandan, Director of Nagarahole Tiger Reserve, for their help and support. We appreciate and thank Mr. Vinodkumar Naik, Wildlife Journalist, for his assistance. We thank Asian Elephant Support for their financial contribution to the study tour and to ongoing mahout programs in Asia.

Figure 2. Mahout workshop group photo.

Report on the Fifth Elephant Conservation Group Workshop

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Background

The Elephant Conservation Group (ECG) is a network of 11 teams involved in Asian elephant conservation in range countries. It was founded in 2011 and since then the group has been working on common projects across field sites and holding meetings every one or two years. From 25. – 28. October 2016, ECG held its fifth meeting at the Vartika Adventure Retreatic Resort in Kuiburi (Kuiburi Province, Thailand). The meeting was attended by 23 participants from nine countries. ECG members that participated were from Cambodia (FFI), India (NCF and WWF), Indonesia (WWF), Malaysia (MEME), Myanmar (WWF), Nepal (Bird Life), Sri Lanka (CCR) and Thailand (WWF and ZSL). We also had guests from Thailand (National Park staff), Myanmar (FFI) and USA (WWF).

Ongoing work

In the first session each ECG member team gave a summary of their work over the last year. This way everybody was brought up to date on what is happening with the other members' elephant conservation projects.

In the second session our first two common ECG projects, where data collection has already been completed, were discussed. It was decided to wrap up both projects and to complete drafting of publications. One of the common projects undertaken was a distribution survey, which was done in all ECG project areas based on a 25 km^2 grid. It was decided that each ECG member team should first publish the results for their area and after that to do a combined analysis and publication.

The second day was spent working on the current ECG projects. In one session the status of the projects, which were started a year ago, was discussed. One of the ECG team efforts is to collect information on elephant and human deaths caused by human-elephant conflict. Since it takes a while to get reasonable numbers, it was decided to collect data for another year. The other ongoing project is to collect photographs of wild elephants from which their body condition can be evaluated. Again, since elephant visibility is poor in some project areas, it was decided to collect photographs for another year, before analysis.

Role of ECG

We discussed how ECG should develop in the next couple of years. The members appreciated the following aspects of ECG: accessible, small size, real knowledge sharing, capacity building,

Field visit to Kuiburi National Park.

time for discussions, data sharing, exchange visits for training, friendship, trust, everybody is equal, opportunity to stay engaged, comfortable to ask questions and dedication.

It was decided that specific topics based on current needs should be discussed in depth at future meetings. To facilitate such discussions we will identify a specific issue for each meeting and invite experts in that field for the meeting. It was also suggested that ECG should develop policy papers and give statements on key issues. Addressing specific conservation challenges that ECG team members are facing, was also identified as a priority. A framework for fundraising for common projects was also proposed.

Human-elephant conflict

Since all ECG members are involved with human-elephant conflict mitigation, a brain storming session was held on the topic. Members were found to be dealing with five broad aspects of human-elephant conflict: management (fencing, early warning systems, insurance), economics (cost of damage, benefits from tourism), ecology (elephant movements, translocation, food availability, behaviour, densities, drivers of human-elephant conflict), communities (engaging stakeholders, local awareness, tolerance, politics, bureaucracy) and habitat management (sustainability, corridors, park management).

Field visit to Kaeng Krachan National Park.

Special session on Thailand and Myanmar

As the meeting was held in Kuiburi, which is near the Myanmar border, guests from Myanmar were invited and a session was held to discuss existing and possible new collaborations between the two countries.

The Thai participants discussed updating of the Action Plan for Thailand and summarized elephant conservation initiatives by other groups across Thailand. They identified the following needs for better elephant conservation in Thailand: scientific support for elephant management, create/find government champions, standards for park classification and resource allocations, better coordination, capacity building (language, scientific background), learning exchanges and sort out differences in SMART implementation.

The participants form Myanmar listed the following elephant conservation problems for Myanmar: illegal hunting, low capacity for law enforcement, lack of capacity for research, captive elephants not being registered, need for a survey of elephant trade, inconsistent law enforcement and different bodies managing different areas.

Possible future trans-boundary collaborations between Thailand and Myanmar were discussed. Stakeholders in both countries agreed on the need to have coordinated and improved law enforcement at official border crossings. More collaboration in monitoring border areas and collaboration on animals being tracked for research-which cross the border, were stated as important. Difficulties in getting the two governments engaged at such a level were discussed and it was suggested that both governments could learn from India, Nepal and Bhutan, who are working collaboratively on elephant conservation and human-elephant conflict mitigation.

Recent Publications on Asian Elephants

Compiled by Jennifer Pastorini

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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 (2017) publications on Asian elephants.

K.P. Acharya, P.K. Paudel, S.R. Jnawali, P.R. Neupane & M. Köhl

Can forest fragmentation and configuration work as indicators of human–wildlife conflict? Evidences from human death and injury by wildlife attacks in Nepal

Ecological Indicators 80 (2017) 74-83

Abstract. Fragmented forests and heterogeneous landscapes are likely to have less natural vegetation and smaller core areas, a low degree of landscape connectivity, high prevalence of anthropogenic edges, and high landscape heterogeneity, which may alter—at varying degrees—behavior of wildlife species such as attacks on humans. We evaluated whether or not forest fragmentation (e.g. shape, size and distribution of forest patches measured as landscape shape index, effective mesh size, and landscape heterogeneity), habitats (proportion of bush and grassland, distance to water sources), and human disturbances (human population density) have a significant relationship with frequencies of human deaths and injuries by Bengal tiger (*Panthera tigris tigris*), common leopard (*Panthera pardus*), one-horned rhinoceros (*Rhinoceros unicornis*) and Asiatic elephant (*Elephas maximus*). Data on human injury and death were obtained from a national survey over five years (2010–2014). The relationship between wildlife attacks and landscape attributes were investigated using a zero-inflated Poisson regression model. Attacks by tigers were significantly and positively associated with forest fragmentation (effective mesh size which is high in a landscape consisting of disconnected small patches). Attacks by common leopards were strongly positively related with landscape heterogeneity, and negatively related to the proportion of bush and grassland. Attacks by one-horned rhinoceros were positively significantly related to the distance to water sources, and proportion of bush and grassland in the landscape. Attacks by elephants were strongly and positively associated with the forest fragmentation (landscape shape index, which increases as patches in the landscapes becomes disaggregated). These results suggest that forest fragmentation is inevitably a critical driver of human–wildlife conflicts, although the extent of effects varies depending on species specific habitat requirements.

M. Ackermann, J.M. Hatt, N. Schetle & H. Steinmetz

Identification of shedders of elephant endotheliotropic herpesviruses among Asian elephants (*Elephas maximus*) in Switzerland

PLoS One 12 (2017) e0176891

Abstract. Elephants, particularly Asian (*Elephas maximus*), are threatened by lethal elephant hemorrhagic disease (EHD) due to elephant endotheliotropic herpesviruses (EEHV). At least five of seven known EEHV types have been associated to EHD, with types 1, 4, and 5 predominantly affecting Asian elephants. In Switzerland, at least three Asian elephants have been lost due to EHD but nothing is known about the present EEHV1 circulation. Moreover, the prevalence of other EEHV types has never been assessed. Intermittent shedding of EEHV can be monitored through collecting trunk secretions and analyzing them by PCR methods that discriminate the different EEHV types. To identify EEHV shedders, seven of eight Asian elephants in a Swiss zoo were trained to provide

trunk wash samples. These were collected at intervals over a period of four months and tested by PCR for presence of EEHV1 through 6. Moreover, the quality of each sample was assessed by testing for the elephant TNF-alpha gene. Overall, 57% of the samples were valid with five of seven participating elephants identified as EEHV shedders. Two of those shed virus only once, whereas the other three, all closely related among each other, shed virus on multiple occasions. One of the frequent shedders had been in very close contact to all of the three EHD victims. Therefore, we speculate that this particular animal may represent the virus source in all three cases. However, when subtyping was conducted, the presently circulating virus was identified as EEHV1B, while the virus subtype causing EHD had been 1A in all three cases. In addition to four animals excreting EEHV1, a recently introduced animal was observed to shed EEHV3/4. We suggest that the policy of trunk washing to identify and characterize EEHV-shedders is to be endorsed in zoos with ongoing or planned elephant breeding programs. © 2017 The Authors.

N. Avni-Magen, S. Zaken, E. Kaufman & G. Kelmer

Use of infrared thermography in early diagnosis of pathologies in Asian elephants (*Elephas maximus*)

Israel J. of Veterinary Medicine 72 (2017) 22-27

Abstract. Thermography is an imaging technique using a specialized heat sensitive infrared camera, mapping body surface temperature changes, which may indicate inflammatory, vascular or neurological disorders. Thermal images were collected over three months from four Asian elephants at the Tisch Family Zoological Gardens in Jerusalem in which 935 body regions were identified with possible inflammatory pathologies. Suspected thermal areas were divided into three groups according to the appearance of inflammatory processes in a clinical examination: negative, positive and a pre-inflammatory group, which showed a thermal change while imaging, with clinical signs appearing only later on. An analysis of the documented regions it was found that in areas with a clinical signs delta temperatures were significantly higher compared to areas with no clinical signs. It was also found that pre-clinical areas showed a significantly higher temperature compared with that of the clinical and non-clinical areas. Receiver operating characteristic (ROC) test results showed an area under curve (AUC) of 0.91 with sensitivity values of 89.2% and a specificity of 83.4%. In addition, positive predictive value and negative predictive value received were: NPPV = 99.4%, PPV = 19.3%. It was concluded that thermography can be an effective diagnostic tool for early diagnosis of inflammatory processes and useful for regular and continuous monitoring of zoo elephants in general. Early detection of inflammatory processes using this technique makes it possible to prevent unnecessary stress that often accompanies veterinary examinations and to accelerate recovery.

N.N. Barman, B. Choudhury, V. Kumar, M. Koul, S.M. Gogoi, E. Khatoon, A. Chakroborty, P. Basumatary, B. Barua, T. Rahman, S.K. Das & S. Kumar

Incidence of elephant endotheliotropic herpesvirus in Asian elephants in India

Veterinary Microbiology 208 (2017) 159-163

Abstract. Elephant endotheliotropic herpesviruses (EEHVs) are the cause of acute hemorrhagic disease in endangered Asian and African elephants. In the present study, we report the incidence of EEHV infection and associated mortality in the captive elephant of Assam, India. Our result showed the gross morphology and histopathological changes of EEHV infection in the elephant. Moreover, the phylogenetic analysis of the polymerase, helicase, and GPCR genes from the infected tissue samples suggested the presence of EEHV1A virus. © 2017 Reprinted with permission from Elsevier.

T. Bhagwat, A. Hess, N. Horning, T. Khaing, Z.M. Thein, K.M. Aung, K.H. Aung, P. Phyo, Y.L. Tun, A.H. Oo, A. Neil, W.M. Thu, M. Songer, K.L. Connette, A. Bernd, Q. Huang, G. Connette & P. Leimgruber

Losing a jewel—Rapid declines in Myanmar's intact forests from 2002-2014

PLoS ONE 12 (2017) e0176364

Abstract. New and rapid political and economic

changes in Myanmar are increasing the pressures on the country's forests. Yet, little is known about the past and current condition of these forests and how fast they are declining. We mapped forest cover in Myanmar through a consortium of international organizations and environmental non-governmental groups, using freely available public domain data and open source software tools. We used Landsat satellite imagery to assess the condition and spatial distribution of Myanmar's intact and degraded forests with special focus on changes in intact forest between 2002 and 2014. We found that forests cover 42,365,729 ha or 63% of Myanmar, making it one of the most forested countries in the region. However, severe logging, expanding plantations, and degradation pose increasing threats. Only 38% of the country's forests can be considered intact with canopy cover >80%. Between 2002 and 2014, intact forests declined at a rate of 0.94% annually, totaling more than 2 million ha forest loss. Losses can be extremely high locally and we identified 9 townships as forest conversion hotspots. We also delineated 13 large (>100,000 ha) and contiguous intact forest landscapes, which are dispersed across Myanmar. The Northern Forest Complex supports four of these landscapes, totaling over 6.1 mil- lion ha of intact forest, followed by the Southern Forest Complex with three landscapes, comprising 1.5 million ha. These remaining contiguous forest landscape should have high priority for protection. Our project demonstrates how open source data and software can be used to develop and share critical information on forests when such data are not readily available elsewhere. We provide all data, code, and outputs freely via the internet.

B. Bhusri, P. Suksai, C. Mongkolphan, E. Tiyanun, P. Ratanakorn, K. Chaichoun & L. Sariya

Detection of elephant endotheliotropic herpesvirus 4 in captive asian elephants (*Elephas maximus*) in Thailand

Thai J. of Veterinary Medicine 47 (2017) 97-102

Abstract. Elephant endotheliotropic herpesviruses (EEHVs) can cause fatal hemorrhagic disease in elephants, especially young captive Asian elephants (*Elephas maximus*). Currently, seven EEHV types have been reported. In this study, EEHVs were examined in whole-blood samples derived from 56 captive Asian elephants from eight provinces in Thailand by nested PCR using primers specific to the viral DNA polymerase gene in an attempt to monitor EEHV elephant cases. After EEHV testing, one sample (1.78%) was positive and found to be closely related to EEHV4 with 99% amino acid identity. This sample was from a three-year-old female Asian elephant with no clinical signs. These data suggest that asymptomatic EEHV4 infection can occur in Asian elephants.

C. Boehlke, S. Pötschke, V. Behringer, C. Hannig & O. Zierau

Does diet influence salivary enzyme activities in elephant species?

Journal of Comparative Physiology B 187 (2017) 213-226

Abstract. Asian elephants (*Elephas maximus*) and African elephants (*Loxodonta africana*) are herbivore generalists; however, Asian elephants might ingest a higher proportion of grasses than Africans. Although some studies have investigated nutrition-specific morphological adaptations of the two species, broader studies on salivary enzymes in both elephant species are lacking. This study focuses on the comparison of salivary enzymes activity profiles in the two elephant species; these enzymes are relevant for protective and digestive functions in humans. We aimed to determine whether salivary amylase (sAA), lysozyme (sLYS), and peroxidase (sPOD) activities have changed in a species-specific pattern during evolutionary separation of the elephant genera. Saliva samples of 14 Asian and 8 African elephants were collected in three German zoos. Results show that sAA and sLYS are salivary components of both elephant species in an active conformation. In contrast, little to no sPOD activity was determined in any elephant sample. Furthermore, sAA activity was significantly higher in Asian compared with African elephants. sLYS and sPOD showed no species-specific differences. The time of food provision until sample collection affected only sAA activity. In summary, the results suggest several possible factors modulating the activity of the mammal-typical enzymes, such as sAA, sLYS, and sPOD, e.g., nutrition and sampling

procedure, which have to be considered when analyzing differences in saliva composition of animal species. © 2016 With permission of Springer.

K. Buddhachat, J.L. Brown, C. Thitaram, S. Klinhom & K. Nganvongpanit

Distinguishing real from fake ivory products by elemental analyses: A Bayesian hybrid classification method

Forensic Science Internat. 272 (2017) 142-149

Abstract. As laws tighten to limit commercial ivory trading and protect threatened species like whales and elephants, increased sales of fake ivory products have become widespread. This study describes a method, handheld X-ray fluorescence (XRF) as a noninvasive technique for elemental analysis, to differentiate quickly between ivory (Asian and African elephant, mammoth) from non-ivory (bones, teeth, antler, horn, wood, synthetic resin, rock) materials. An equation consisting of 20 elements and light elements from a stepwise discriminant analysis was used to classify samples, followed by Bayesian binary regression to determine the probability of a sample being 'ivory', with complementary log log analysis to identify the best fit model for this purpose. This Bayesian hybrid classification model was 93% accurate with 92% precision in discriminating ivory from non-ivory materials. The method was then validated by scanning an additional ivory and non-ivory samples, correctly identifying bone as not ivory with >95% accuracy, except elephant bone, which was 72%. It was less accurate for wood and rock (25-85%); however, a preliminary screening to determine if samples are not Ca-dominant could eliminate inorganic materials. In conclusion, elemental analyses by XRF can be used to identify several forms of fake ivory samples, which could have forensic application. © 2017 Reprinted with permission from Elsevier.

S.M. Burke, L. Vogelnest, P. Thompson, E.R. Tovey & P. Williamson

Detection of aerosolized bacteria in expired air samples from Asian elephants (*Elephas maximus*)

Journal of Zoo and Wildlife Medicine 48 (2017) 431-439

Abstract. Elephant-mediated transmission of tuberculosis is assumed to be similar to human models, which state close and prolonged contact with an infected individual is required for transmission. Although considered a risk factor for infection, several case studies have reported that close contact with an elephant is not always necessary for transmission, and the role of aerosolized bacteria remains unclear. To investigate aerosol-mediated transmission of pathogenic bacteria from elephants, a method for the detection of aerosols using an adapted sampling system was developed. A commensal bacterium was isolated from the upper respiratory tract of elephants (*Elephas maximus*) and was used as a proxy organism to detect aerosolized droplets in the sampling system. It was found that elephants are capable of producing aerosolized bacterial particles of a size small enough to remain airborne for prolonged periods and penetrate the lower regions of the human respiratory tract. © 2017 American Association of Zoo Veterinarians.

C. Çakırlar & S. Ikram

'When elephants battle, the grass suffers.' Power, ivory and the Syrian elephant

Levant 48 (2016) 167-183

Abstract. The craftsmanship of the ivory objects in Late Bronze Age and Iron Age Eastern Mediterranean leave no doubt as to their intention to impress. Elephant teeth are an important raw material for the manufacture of these objects. Zooarchaeological research shows that cranial, dental, and postcranial remains of Asian elephants (*Elephas maximus*) are nearly as ubiquitous as worked ivory across Southwest Asia. This paper attempts to reconstruct the origins, habitat, range, life style and the end of the Syrian elephant. It discusses recent bone and tooth finds of this animal from Kinet Höyük and Tell Atchana in the Hatay in Turkey against the background of previous research on the 'Syrian elephant' and ivory production in the Levant. It confirms the proposal that Asian elephants were not endemic to the region and that their arrival was anthropogenic. The Syrian elephant was the product of the power-hungry Bronze Age elite in the region. Having become an 'evolutionarily significant unit' for centuries, these elephants died out in the 8th or 7th century BC. Present evidence,

including off-site evidence, suggests that while their local extinction was also anthropogenic, elephants themselves were not merely passive victims in the process; they have made an already difficult and degraded environment even more unsustainable for themselves and the human communities in the region. The immense demand for ivory and competition among first commercial, then territorial powers of the Bronze Age Levant, who symbolically associated themselves with elephants, caused the birth of the 'Syrian elephant'. In their demise, not only the elites, but also non-elite herders and agriculturalists were probably responsible. © 2016 Council for British Research in the Levant.

B.M. Chandranaik, B.P. Shivashankar, K.S. Umashankar, P. Nandini, P. Giridhar, S.M. Byregowda & B.M. Shrinivasa

***Mycobacterium tuberculosis* infection in free-roaming wild Asian elephant**

Emerging Infectious Diseases 23 (2017) 555-557

Abstract. Postmortem examination of a wild Asian elephant at Rajiv Gandhi National Park, India, revealed nodular lesions, granulomas with central caseation, and acid-fast bacilli in the lungs. PCR and nucleotide sequencing confirmed the presence of *Mycobacterium tuberculosis*. This study indicates that wild elephants can harbor *M. tuberculosis* that can become fatal.

C. Cox

The elephant in the sales room: Ivory and the British antiques trade

International Journal of Cultural Property 23 (2016) 321-334

Abstract. In March 2015, it was reported that His Royal Highness, the Duke of Cambridge would "like to see all the ivory owned by Buckingham Palace destroyed." In May 2015, the Conservative Party's manifesto stated that if elected the party would "press for a total ban on ivory sales," and policy decisions made as part of President Obama's National Strategy for Combating Wildlife Trafficking saw "all commercial imports of African elephant ivory, including antiques" being prohibited.1 In a changing international environment, the United Kingdom's antique trade faces a threat to the legitimate sale of pre- 1947 worked ivory without the extent of any illegal trade being clear. With only 15 convictions since 1992 for offences relating to the trade in ivory in the English courts, this article examines the two most recent cases, which came to court in 2014. © 2016 International Cultural Property Society.

R. Dale &d J.M. Plotnik

Elephants know when their bodies are obstacles to success in a novel transfer task

Scientific Reports 7 (2017) e46309

Abstract. The capacity to recognise oneself as separate from other individuals and objects is difficult to investigate in non-human animals. The hallmark empirical assessment, the mirror self-recognition test, focuses on an animal's ability to recognise itself in a mirror and success has thus far been demonstrated in only a small number of species with a keen interest in their own visual reflection. Adapting a recent study done with children, we designed a new body-awareness paradigm for testing an animal's understanding of its place in its environment. In this task, Asian elephants (*Elephas maximus*) were required to step onto a mat and pick up a stick attached to it by rope, and then pass the stick forward to an experimenter. In order to do the latter, the elephants had to see their body as an obstacle to success and first remove their weight from the mat before attempting to transfer the stick. The elephants got off the mat in the test significantly more often than in controls, where getting off the mat was unnecessary. This task helps level the playing field for non-visual species tested on cognition tasks and may help better define the continuum on which body- and self-awareness lie. © 2017 The Authors.

T. Eisenberg, J. Rau, U. Westerhüs, T. Knauf-Witzens, A. Fawzy, K. Schlez, M. Zschöck, E. Prenger-Berninghoff, C. Heydel, R. Sting, S.P. Glaeser, D. Pulami, M. van der Linden & C. Ewers

***Streptococcus agalactiae* in elephants – A comparative study with isolates from human and zoo animal and livestock origin**

Veterinary Microbiology 204 (2017) 141-150

Abstract. *Streptococcus agalactiae* represents a significant pathogen for humans and animals. However, there are only a few elderly reports on *S. agalactiae* infections in wild and zoo elephants

even though this pathogen has been isolated comparatively frequently in these endangered animal species. Consequently, between 2004 and 2015, we collected *S. agalactiae* isolates from African and Asian elephants (n = 23) living in four different zoos in Germany. These isolates were characterised and compared with isolates from other animal species (n = 20 isolates) and humans (n = 3). We found that the isolates from elephants can be readily identified by classical biochemistry and MALDI-TOF mass spectrometry. Further characterisations for epidemiological issues were achieved using Fourier transform-infrared spectroscopy, capsule typing and molecular fingerprinting (PFGE, RAPD PCR). We could demonstrate that our elephant isolate collection contained at least six different lineages that were representative for their source of origin. Despite generally broad antimicrobial susceptibility of *S. agalactiae*, many showed tetracycline resistance in vitro. *S. agalactiae* plays an important role in bacterial infections not only in cattle and humans, but also in elephants. Comparative studies were able to differentiate *S. agalactiae* isolates from elephants into different infectious clusters based on their epidemiological background.

A. Gangadharan, S. Vaidyanathan & C.C. St. Clair

Planning connectivity at multiple scales for large mammals in a human-dominated biodiversity hotspot

J. for Nature Conservation 36 (2017) 38-47

Abstract. Connectivity for large mammals across human-altered landscapes results from movement by individuals that can be described via nested spatial scales as linkages (or zones or areas) with compatible land use types, constrictions that repeatedly funnel movement (as corridors) or impede it (as barriers), and the specific paths (or routes) across completely anthropogenic features (such as highways). Mitigation to facilitate animal movement through such landscapes requires similar attention to spatial scale, particularly when they involve complex topography, diverse types of human land use, and transportation infrastructure. We modeled connectivity for Asian elephant (*Elephas maximus*) and gaur (*Bos gaurus*) in the Shencottah Gap, a multiple-use region separating two tiger reserves in the Western Ghats, India. Using 840 km of surveys for animal signs within a region of 621 km^2, we modeled landscape linkages via resource selection functions integrated across two spatial resolutions, and then potential dispersal corridors within these linkages using circuit theoretical models. Within these corridors, we further identified potential small-scale movement paths across a busy transportation route via least-cost paths and evaluated their viability. Both elephants and gaur avoided human-dominated habitat, resulting in broken connectivity across the Shencottah Gap. Predicted corridor locations were sensitive to analysis resolution, and corridors derived from scale-integrated habitat models correlated best with habitat quality. Less than 1% of elephant and gaur detections occurred in habitat that was poorer in quality than the lowest-quality component of the movement path across the transportation route, suggesting that connectivity will require habitat improvement. Only 28% of dispersal corridor area and 5% of movement path length overlapped with the upper 50% quantile of the landscape linkage; thus, jointly modeling these three components enabled a more nuanced evaluation of connectivity than any of them in isolation.

V.R. Goswami & D. Vasudev

Triage of conservation needs: The juxtaposition of conflict mitigation and connectivity considerations in heterogeneous, human-dominated landscapes

Frontiers in Ecology and Evol. 4 (2017) e144

Abstract. Conservation of wide-ranging endangered species is increasingly focused on large heterogeneous landscapes. At such scales, particularly when conservation landscapes are human dominated, it is imperative that prioritization techniques be used to allocate limited resources wisely. Moreover, spatial aspects of conservation planning warrant key consideration within these landscapes, such that certain sites that are key to either mitigating threats to species or to maintaining ecological processes, are prioritized. However, there are often multiple conservation needs, and multiple associated

constraints, for species conservation in such landscapes. While there are tools to prioritize sites based on single or few conservation requirements and constraints, there is less knowledge on how these conservation needs, or corresponding management interventions, relate to each other in a scenario where conservation focus on one issue potentially detracts from another. We take the specific example of two conservation needs that are central to landscape-scale conservation of the endangered Asian elephant *Elephas maximus*, namely the maintenance of connectivity, and the mitigation of human–elephant conflict. We show that conservation decision making, in addition to considering which species and sites to focus on, should also prioritize conservation needs. We review documentation of conflict mitigation and examine if the maintenance of connectivity was simultaneously addressed, and if so, whether optimal conservation solutions differed when connectivity considerations were included. We conclude with a discussion on the triage of conservation needs, and future prospects and challenges in ensuring that landscape-scale conservation strategies account for multiple interacting conservation needs for endangered species in heterogeneous human-dominated landscapes.

A.K.J. Gowda, N.K. Dharanesha, P. Giridhar & S.M.B. Gowda

***Cobboldia elephantis* (Cobbold, 1866) larval infestation in an Indian elephant (*Elephas maximus*)**

Journal of Parasitic Diseases 41 (2017) 364-366

Abstract. In the present study, post-mortem was conducted on a female elephant aged about 37 years died at Rajeev Gandhi National Park, Hunsur, Mathigoodu Elephant Camp, Karnataka state. The animal suffered with diarrhoea, anorexia, dehydration and was unable to walk for about one week before death and was treated with antibiotics and fluid therapy for three days. The post-mortem examination revealed that, the gastric mucosa was severely congested, hyperaemic and numerous stomach bots attached to the mucosa. The bots were recovered from the gastric mucosa and processed for species identification. The posterior spiracles of the bots showed three longitudinal parallel slits in each spiracle, the abdominal segments had a row of belt like triangular shaped spines and the anterior end had two powerful oral hooks with cephalo-pharyngeal skeleton. Based on the above said morphological characters, the bots were identified as *Cobboldia elephantis*. This seems to be the first report of *C. elephantis* in free range wild elephant from Karnataka state. © 2017 With permission of Springer.

T.N.E. Gray, A. Billingsley, B. Crudge, J.L. Frechette, R. Grosu, V. Herranz-Muñoz, J. Holden, O. Keo, K. Kong, D. MacDonald, T. Neang, R. Ou, C. Phan & S. Sim

Status and conservation significance of ground-dwelling mammals in the Cardamom Rainforest Landscape, southwestern Cambodia

Cambodian Journal of Natural History 2017 (2017) 38-48

Abstract. The Cardamom Rainforest Landscape (CRL) is a 17,000 km^2 protected landscape in southwestern Cambodia spanning an elevation range from sea-level to above 1,700 m. Despite the conservation value of the landscape there is little recent published information on the status and conservation significance of the ground-dwelling mammal populations. We report on seven camera trap studies conducted in five protected areas across the landscape between 2012 and 2016 with 255 trap-stations and >30,000 trap-nights. At least 30 species of medium to large ground-dwelling mammals were detected including one species included on the IUCN Red List as Critically Endangered, two as Endangered, eight as Vulnerable, and three as Near Threatened. Sun bears *Helarctos malayanus*, mainland clouded leopards *Neofelis nebulosa*, and dholes *Cuon alpinus* were detected from six or more of the seven studies. Populations of these three species in the landscape, though below ecological carrying capacity, are regionally significant. However we did not detect any *Panthera* cats, confirming that tigers *P. tigris* and leopards *P. pardus* are likely to have been extirpated. With the exception of these two species, and deciduous dipterocarp forest specialist ungulates, all globally threatened ground-dwelling and freshwater mammals likely to occur in the CRL have been detected in recent camera trapping

surveys. The Cardamoms are thus of global conservation significance. However, poaching, particularly snaring, combined with the presence of domestic dogs across the landscape is likely to be impacting current and future conservation value strongly. The persistence of significant mammalian biodiversity requires a paradigm shift in both governmental and civil society responses to the drivers of poaching. © 2017 Centre for Biodiversity Conservation.

B.J. Greco, C.L. Meehan, J,L. Heinsius & J.A. Mench

Why pace? The influence of social, housing, management, life history, and demographic characteristics on locomotor stereotypy in zoo elephants

Applied Animal Behaviour Science 194 (2017) 104-111

Abstract. Stereotypic behaviors (SB) are common in zoo-housed elephants, and these behaviors can be performed at high rates. Elephants perform different SB forms (e.g., weaving, pacing), but no published studies have evaluated the factors contributing to the development or performance of these different forms. Instead, as with most SB studies across species, elephant studies have relied on analyses that aggregate all SB forms, which limits the development and testing of form-specific hypotheses or abatement practices. Our objectives were to characterize the SB forms of North American zoo elephants and use multivariable epidemiological models to test form-specific hypotheses. We videotaped 77 elephants (African: N = 5 males, 31 females; Asian N = 8 males, 33 females) at 39 zoos who performed SBs and used a novel classification scheme and 5-min instantaneous samples to characterize their SB forms. Locomotor and whole-body SBs were the most common, but most elephants who performed locomotor SBs also performed whole-body SBs. Thus, we characterized each elephant according to whether it included locomotion in its SB repertoire [Locomotor Presence (LP)] or only whole-body movements. We used binomial regression models fitted with generalized estimating equations to test hypotheses about which of 26 social, housing, management, life history, and demographic variables were most associated with LP. The odds of LP increased by 26% for every 10% increase in time housed separately (odds ratio = 1.026, p = 0.04), 96.2% for every additional social group with which an elephant had contact (odds ratio = 1.962, p = 0.01), and 46% for every 10% increase in time housed indoors (odds ratio = 1.046, p = 0.01). Age was non-significantly confounded with all three variables. We hypothesize that the social variables in our models increase LP risk because they are associated with uncontrollable social group changes, anticipation of potentially rewarding social experiences, or the frustration of social behaviors. The housing variable included in our model likely increases LP risk because indoor spaces are less complex, resulting in the channeling of walking or social avoidance behaviors into more simplistic movements. Overall, our results suggest that elephant managers may best be able to prevent locomotor SB by enhancing their elephants' social environment and the spatial complexity of their enclosures. Future research should focus on determining whether addressing the risk factors for LP results in less frequent performance and identifying other temporally proximate eliciting factors.

E.M. Gross, N. Drouet-Hoguet, N. Subedi & J. Gross

The potential of medicinal and aromatic plants (MAPs) to reduce crop damages by Asian elephants (*Elephas maximus*)

Crop Protection 100 (2017) 29-37

Abstract. In all 13 Asian range countries of the wild Asian elephant (*Elephas maximus* L.), farmers suffer from crop damages caused by this endangered and highly protected species. As elephants are lured by highly nutritional crop types into agricultural lands, measures to deter or repel them from the high attraction will always be costly and labour intensive. The cultivation of crops, which are less attractive to elephants, yet economically viable for local farmers could lead to a new direction of land-use and income generation in human-elephant conflict areas. In this study, seven medicinal and aromatic plants (MAPs) containing higher amounts of specific plant secondary compounds were explored for their attractiveness to wild

Asian elephants against a control of rice (*Oryza sativa* L.) and maize (*Zea mays* L.). The results show that chamomile (*Matricaria chamomilla* L.), coriander (*Coriandrum sativum* L.), mint (*Mentha arvensis* L.), basil (*Ocimum basilicum* L.), turmeric (*Curcuma longa* L.), lemon grass (*Cymbopogon flexuosus* (Nees ex Steud.) W. Watson) and citronella (*Cymbopogon winterianus* Jowitt.) were less attractive and were not consumed by elephants compared to rice. Damages to the MAPs occurred only through trampling, with mint being most prone to being trampled. Other wildlife species, however, were observed to feed on lemon-grass. Long-term learning effects and the eventual palatability of crops with less efficient antifeedants need to be further explored. This study, however, gives first evidence that MAPs bear a high potential for a secure income generation in and close to Asian elephant habitats. Furthermore, the strategic plantation of crops unattractive and attractive to elephants could lead to new land-use strategies and improve functionality of elephant corridors.

D. Gunaryadi, Sugiyo & S. Hedges

Community-based human-elephant conflict mitigation: The value of an evidence-based approach in promoting the uptake of effective methods

PLoS ONE 12 (2017) e0173742

Abstract. Human-elephant conflict (HEC) is a serious threat to elephants and can cause major economic losses. It is widely accepted that reduction of HEC will often require community-based methods for repelling elephants but there are few tests of such methods. We tested community-based crop-guarding methods with and without novel chili-based elephant deterrents and describe changes in farmers' willingness to adopt these methods following our demonstration of their relative effectiveness. In three separate field-trials that took place over almost two years (October 2005 – May 2007) in two villages adjacent to Way Kambas National Park (WKNP) in Indonesia, we found that community-based crop-guarding was effective at keeping Asian elephants (*Elephas maximus*) out of crop fields in 91.2% (52 out of 57), 87.6% (156 out of 178), and 80.0% (16 out of 20) of attempted raids. Once the method had been shown to be effective at demonstration sites, farmers in 16 villages around WKNP voluntarily adopted it during the July 2008 to March 2009 period and were able to repel elephants in 73.9% (150 out of 203) of attempted raids, with seven villages repelling 100% of attempted raids. These 16 villages had all experienced high levels of HEC in the preceding years; e.g. they accounted for >97% of the 742 HEC incidents recorded for the entire park in 2006. Our work shows, therefore, that a simple evidence-based approach can facilitate significant reductions in HEC at the protected area scale.

M. Gupta, A. Joshi & T.N.C. Vidya

Effects of social organization, trap arrangement and density, sampling scale, and population density on bias in population size estimation using some common mark-recapture estimators

PLoS One 12 (2017) e0173609

Abstract. Mark-recapture estimators are commonly used for population size estimation, and typically yield unbiased estimates for most solitary species with low to moderate home range sizes. However, these methods assume independence of captures among individuals, an assumption that is clearly violated in social species that show fission-fusion dynamics, such as the Asian elephant. In the specific case of Asian elephants, doubts have been raised about the accuracy of population size estimates. More importantly, the potential problem for the use of mark-recapture methods posed by social organization in general has not been systematically addressed. We developed an individual-based simulation framework to systematically examine the potential effects of type of social organization, as well as other factors such as trap density and arrangement, spatial scale of sampling, and population density, on bias in population sizes estimated by POPAN, Robust Design, and Robust Design with detection heterogeneity. In the present study, we ran simulations with biological, demographic and ecological parameters relevant to Asian elephant populations, but the simulation framework is easily extended to address questions relevant to other social species. We collected capture history

data from the simulations, and used those data to test for bias in population size estimation. Social organization significantly affected bias in most analyses, but the effect sizes were variable, depending on other factors. Social organization tended to introduce large bias when trap arrangement was uniform and sampling effort was low. POPAN clearly outperformed the two Robust Design models we tested, yielding close to zero bias if traps were arranged at random in the study area, and when population density and trap density were not too low. Social organization did not have a major effect on bias for these parameter combinations at which POPAN gave more or less unbiased population size estimates. Therefore, the effect of social organization on bias in population estimation could be removed by using POPAN with specific parameter combinations, to obtain population size estimates in a social species.

F.K. Harich & A.C. Treydte

Mammalian wildlife diversity in rubber and oil palm plantations

CAB Reviews 11 (2016) e20

Abstract. In the face of globally diminishing natural habitats in biodiversity-rich regions, agricultural landscapes around protected areas have increasingly gained importance as extended habitat for wildlife species. Rubber (*Hevea brasiliensis*) and oil palm (*Elais guineensis*) plantations are two of the dominant land-use systems in Southeast Asia that have seen a tremendous expansion over the last decades. Despite far-reaching ecological consequences of these intensively cropped monocultures on natural ecosystems, relatively little is known about their utilization by wildlife populations. With this review we want to give an overview of mammalian diversity in rubber and oil palm plantations with reference to human–wildlife conflicts occurring as a result of overlapping resource use. We searched the literature for studies on wild mammalian diversity in rubber and oil palm plantations and found 17 publications. We considered 29 additional publications that provided information on single species in such plantations. We discuss the potential of 'wildlife-friendly' farming for mammalian assemblages in plantations and its importance in the case of rubber and oil palm production. Our review showed that most wild mammal species found in these plantations were likely to be visitors that use cultivated landscapes as fringe habitat but some adapted well to plantations and few even became resident. We conclude that although plantations in the tropics and subtropics cannot substitute for forests and the preservation of natural habitats is indispensable, the reality of ongoing forest degradation and transformation into plantations will make wildlife-friendly farming a key strategy in maintaining mammalian diversity, particularly in land-use matrices surrounding natural habitats.

T. Ishige, M. Miya, M. Ushio, T. Sado, M. Ushioda, K. Maebashi, R. Yonechi, P. Lagan & H. Matsubayashi

Tropical-forest mammals as detected by environmental DNA at natural saltlicks in Borneo

Biological Conservation 210A (2017) 281-285

Abstract. Although tropical forests are among the most species-rich ecosystems on earth, 42% of mammal species in tropical forests are endangered because of overhunting and/or unsustainable exploitation. Camera-trap surveys have shown that natural saltlicks can be used to determine mammalian fauna, especially medium to large endangered species in tropical forests; establishment of camera traps, however, is time and effort intensive. Furthermore, the photographic range and detectable size of species are often restricted. Environmental DNA (eDNA) metabarcoding is a powerful approach that might provide a better way to study terrestrial animals in tropical forests. In this study, we examined whether eDNA from natural saltlicks comprehensively represented species composition in a Bornean tropical forest. We collected 100–150-ml water samples from natural saltlicks in Sabah, Malaysian Borneo. We constructed amplicon libraries for MiSeq sequencing using eDNA extracted from the water samples. Six endangered species were detected using this method, including Bornean orangutan (*Pongo pygmaeus*), Bornean banteng (*Bos javanicus lowi*), Asian elephant (*Elephas maximus*), Sunda pangolin (*Manis javanica*), sambar deer (*Rusa unicolor*) and bearded pig

(*Sus barbatus*). However, most small and minor species were not detected, with low sequence identity (80–96%). Therefore, we propose that more species of tropical forest mammals should have their sequences deposited in DNA databases. This study is the first to report the endangered mammals of a tropical forest detected using eDNA from natural saltlicks.

T. Janyamethakul, S. Sripiboon, C. Somgird, P. Pongsopawijit, V. Panyapornwithaya, S. Klinhom, J. Loythong & C. Thitaram

Hematologic and biochemical reference intervals for captive Asian elephants (*Elephas maximus*) in Thailand

Kafkas Univ Vet Fak Derg 23 (2017) 665-668

Abstract. Species specific blood value reference intervals are needed for the proper diagnosis, and treatment of disease, appropriate for specific populations, because age, sex, management, exercise and geographical location can all affect hematological values. The aim of this study was to establish a set of hematology and blood chemistry reference intervals for captive Asian elephants. Blood samples were collected from 149 healthy Asian elephants in 15 tourist camps in Northern Thailand. Hematological and biochemical parameters were determined. The results showed similarity of haematological and blood chemistry range to others previously published. There were no sex differences for most hematological parameters except some parameters were different i.e. MCV, MCHC, BUN, AST, and ALP. The hematology and blood chemistry reference intervals of our study can be used as the reference for hematological analysis in Thailand, and several Asian elephant range countries and zoos.

S. Jayakumar, S. Sathiskumar, N. Baskaran, R. Arumugam & V. Vanitha

Ethno-veterinary practices in southern India for captive Asian elephant ailments

J. of Ethnopharmacology 200 (2017) 182-204

Abstract. India has a long tradition of practicing Ayurvedic medicine not only for human ailments, but also for the management of livestock in the form of ethno-veterinary practices. Asian elephant is a significant part of Indian culture, and ethno-veterinary practices have extended to manage and cure various ailments of Asian elephant in captivity. Much of this knowledge has been lost in the light of modern practices. This study is aimed at documenting the existing knowledge on ethno-veterinary medicines practiced by elephant keepers (mahouts) in Tamil Nadu and Puducherry. The study was carried out between June 2015 and February 2016 employing a questionnaire survey among 50 selected informants (mahouts) with traditional knowledge on plants in veterinary medicine. Information was elicited from the informants on various diseases prevailing among captive elephants and the traditional treatment employed by them. In total, the study documented 53 plant species belonging to 29 families being used as medicine for 23 types of ailments prevailing among captive elephants. *Ferula assafoetida*, *Zingiber officinale*, *Piper longum*, *P. nigrum*, *Cuminum cyminum*, *Trachyspermum roxburghianum* and *Carum bulbocastanum* were the most commonly used plants either independently or in combination. Among them, *F. assa-foetida* (12.4%) and *Z. officinale* (10.4%) had the highest usage. Of the 23 diseases reported, constipation was the most common ailment (14.6%) followed by bloating (8.7%) and flatulence (8.7%). Documentation of this indigenous knowledge is valuable for the communities concerned, both at present and in future and for scientific consideration for wider use of traditional knowledge in treating captive elephants. The study has identified 53 medicinal plants to treat various ailments among captive elephants in southern India. The most frequently used plants in the captive elephant health care practice are *F. assafoetida*, *Z. officinale*, *P. longum* and *P. nigrum*. Among the 29 families, Apiaceae and Piperaceae are widely used. The leaves are the most useful part of the plants, while paste is the widely used form of preparation. The present findings show that mahouts have wide knowledge about elephant diseases and their treatment using herbal medicine. A more detailed investigation should be designed on priority to document the dying art of ethno-veterinary practices for the long-term conservation of the Asian elephant.

D.K. Jha, N.T. Kshetry, B.R. Pokharel, S.K. Lal & R. Panday

Identification and differentiation of the Asian elephant ivory by using Schreger lines

Journal of Institute of Science and Technology 22 (2017) 99-103

Abstract. Elephant ivory is one of the highly priced, illegally traded wildlife trophies and its identification has always been a challenging task. A total of 21 Asian elephant tusks stored at the office of the Chitwan National Park, Kasara, Nepal were morphometrically studied with an aim to typify elephant ivory by using Schreger lines. The ivory samples were cleaned, their Schreger lines were photographed and their angles were measured by using a protractor. A total of 120 Schreger angles data from both outer and inner areas were obtained resulting both concave and convex appearance. The observed maximum and minimum Schreger angles values were 125° and 50° respectively. The mean Schreger angle was found to be 95.60° (±14.23). The Schreger lines were present in all studied samples. Thus, it is concluded that the presence of Schreger line is the identifying feature of an elephant tusk. © 2017 Institute of Science and Technology.

Ritesh Joshi

Wanderers of Rajaji: Are elephants learning new lessons in the changing environment?

Current Science 112 (2017) 1808-1811

Abstract. none.

S. Kongsawasdi, S. Mahasawangkul, P. Pongsopawijit, K. Boonprasert, B. Chuatrakoon, N. Thonglorm, R. Kanta-in, T. Tajarernmuang & K. Nganvongpanit

Biomechanical parameters of Asian elephant (*Elephas maximus*) walking gait

Kafkas Univ Vet Fak Derg 23 (357-362)

Abstract. Quadruped animals have a unique mechanism of movement that minimizes energy use and allows muscles to work effectively. Elephants are the biggest quadruped animals on earth and how they stabilize their body and use energy are of interest. This study aimed to analyze the characteristics of kinematic gait in Asian elephants trained to work with a mahout for tourism activities in Thailand. Twenty-one healthy adult Asian elephants were recorded by 2 digital cameras while walking at normal speed (average 1.1 m s-1.) along a 15-meter, solid-soil path. The temporospatial parameters evaluated for each limb consisted of stride length (cm), stride time (sec), swing time (sec), stance time (sec) and stance time percentage, using 2D motion analysis software. The result revealed that the average stride length was varied between 192-199 cm with no significant difference between fore and hindlimbs on either side but the stride length on the right side was significantly longer than that on the left in both forelimbs (right 197.5 cm; left 192.6 cm, $P<0.05$) and hindlimbs (right 198.9 cm; left 193.2 cm, $P<0.01$). The mean gait cycle time (stride time) was varied between 2.26 and 2.34 seconds for each limb and mean stance time was varied between 1.67-1.80 seconds, with both parameters were longer on the forelimbs than hindlimbs significantly ($P<0.01$). Hence, swing time for the forelimb was shorter than that for the hindlimb ($P<0.001$). The calculated stance time percentage for each limb was 72.64-76.09%. Data from this study confirmed that elephants walk with a lateral sequence and footfall pattern, and distribute the center of mass proportionally between all four limbs. Gait analysis is a valuable tool for identifying and understanding the pathogenesis of gait abnormality.

Chalita Kongrit

Genetic tools for the conservation of wild Asian elephants

International Journal of Biology 9 (2017) e2

Abstract. The distribution of the Asian elephant (*Elephas maximus*) has been limited to the remaining discontinuous forests, mainly in the South and Southeast Asia. A global number of wild Asian elephants have been declining due to habitat loss, forest fragmentation, and anthropogenic disturbance. Acquiring information of wild populations is important for effective conservation and management plan. This article reviews the applications of noninvasive genetic method as a tool for studying wild Asian elephants. Noninvasive genetic method has been introduced to the field of wildlife conservation for more than two decades. The method provides reliable information of a population and facilitates investigation of genetic effects on small and fragmented populations. Various DNA markers for the Asian elephant, those include mitochondrial DNA, microsatellite

DNA, and sex determination markers, have been developed and used to study wild elephant populations across the distribution range. Most of the studies revealed the issues of low genetic diversity in the small populations and interruption of gene flow among the fragmented populations. Tracking of ivory poaching has not yet been done in the Asian elephant. It could be carried out if a reference genetic database of the natural populations is available. Noninvasive genetic method has been proved to be a promising tool for conservation of the wild Asian elephants. Transboundary collaboration would give hope for a successful long-term conservation of this charismatic species in their natural habitats.

C. Kongrit & C. Siripunkaw

Determination of age and construction of population age structure of wild Asian elephants based on dung bolus circumference

Thai Journal of Veterinary Medicine 47 (2017) 145-153

Abstract. Estimating the age of wildlife is an important technique for the construction of a population age structure that could be useful for the prediction of population change. The age of wild elephants can be reliably estimated from the size of dung bolus circumference, which correlates with elephant growth. This research aimed to determine a cut-off bolus circumference for the mature age class of wild Asian elephants at Salakphra Wildlife Sanctuary as inferred from the social behavior of male elephants. Males living within their natal groups were considered immature males, whereas solitary males were considered mature males. The largest bolus circumference of the immature males was used as a cut-off criterion for age class determination. Noninvasive molecular sexing was applied to determine the sex of elephant samples. From a total of 225 dung samples, 96% were successfully sex determined; 90 and 126 samples were identified as male and female, respectively. Among the male samples, 49 samples were from males living within their natal groups and 41 samples were from solitary males. The cut-off bolus circumference was determined to be 42.5 cm. The dung samples with bolus circumferences larger than the cut-off size were classified as belonging to mature elephants. The same criterion was applied to females as well. A population age structure of Salakphra elephants was created based on the bolus circumferences regardless of individual identification. The construction of population age structure based on dung sampling could be useful for a rapid population survey.

H. Kuhrt, A. Bringmann, W. Härtig, G. Wibbelt, L. Peichl & A. Reichenbach

The retina of Asian and African elephants: Comparison of newborn and adult

Brain, Behavior and Evolution 89 (2017) 84-103

Abstract. Elephants are precocial mammals that are relatively mature as newborns and mobile shortly after birth. To determine whether the retina of newborn elephants is capable of supporting the mobility of elephant calves, we compared the retinal structures of 2 newborn elephants (1 African and 1 Asian) and 2 adult animals of both species by immunohistochemical and morphometric methods. For the first time, we present here a comprehensive qualitative and quantitative characterization of the cellular composition of the newborn and the adult retinas of 2 elephant species. We found that the retina of elephants is relatively mature at birth. All retinal layers were well discernible, and various retinal cell types were detected in the newborns, including Müller glial cells (expressing glutamine synthetase and cellular retinal binding protein; CRALBP), cone photoreceptors (expressing S-opsin or M/L-opsin), protein kinase Cα-expressing bipolar cells, tyrosine hydroxylase-, choline acetyltransferase (ChAT)-, calbindin-, and calretinin-expressing amacrine cells, and calbindin-expressing horizontal cells. The retina of newborn elephants contains discrete horizontal cells, which coexpress ChAT, calbindin, and calretinin. While the overall structure of the retina is very similar between newborn and adult elephants, various parameters change after birth. The postnatal thickening of the retinal ganglion cell axons and the increase in ganglion cell soma size are explained by the increase in body size after birth, and the decreases in the densities of neuronal and glial cells are explained by the postnatal expansion of the retinal surface area. The expression of glutamine synthetase and CRALBP in the Müller cells of newborn elephants

suggests that the cells are already capable of supporting the activities of photoreceptors and neurons. As a peculiarity, the elephant retina contains both normally located and displaced giant ganglion cells, with single cells reaching a diameter of more than 50 μm in adults and therefore being almost in the range of giant retinal ganglion cells found in aquatic mammals. Some of these ganglion cells are displaced into the inner nuclear layer, a unique feature of terrestrial mammals. For the first time, we describe here the occurrence of many bistratified rod bipolar cells in the elephant retina. These bistratified bipolar cells may improve nocturnal contrast perception in elephants given their arrhythmic lifestyle. © 2017 S. Karger AG, Basel.

A. Kumar, H.S. Bargali, A. David & A. Edgaonkar
Patterns of crop raiding by wild ungulates and elephants in Ramnagar Forest Division, Uttarakhand
Human-Wildlife Interactions 11 (2017) 41-49
Abstract. Crop raiding is a major form of human–wildlife conflict that not only affects livelihoods of farmers living close to forest areas but also jeopardizes the objective of wildlife conservation. In this study, we report patterns associated with crop raiding based on periodic field inspections of 95 crop fields spread across 16 villages in India. Average raided area of the field was highest in seedling stage (21%). Fields closer to the forest edge incurred higher damage in the seedling (22%) and mature stages (7%) than fields farther from the forest edge, although this was not statistically significant. Guarding was found to be ineffective in decreasing crop raiding, with no statistical difference in the mean area of damage between guarded and unguarded fields. Cheetal (*Axis axis*), sambar (*Rusa unicolor*), nilgai (*Boselaphus tragocamelus*), and wild pig (*Sus scrofa*) were the main raiders in fields close to the forest edge whereas nilgai and wild pig were chief raiders in fields farther from the forest edge. Results of this study suggest that in the study area, wild pig and nilgai are more problematic species than elephants (*Elephas maximus*), which are reported to cause the most damage in other landscapes.

S. Liu, Y. Dong, F. Cheng, Y. Zhang, X. Hou, S. Dong & A. Coxixo
Effects of road network on Asian elephant habitat and connectivity between the nature reserves in Xishuangbanna, Southwest China
J. for Nature Conservation 38 (2017) 11-20
Abstract. Evaluating road effects on the ecological status and landscape connectivity is critical for animal corridor design. Taking the fragmented nature reserves in Xishuangbanna as a case, road impacts on Asian elephant habitats were determined based on a suitability analysis. Potential corridors between different sub-reserves were located using "least-cost" method as a systematic way incorporating remote sensing (RS) and geographic information system (GIS). Our results revealed that road networks, especially high-level roads (expressway, national road and city-county city road), had the largest effects on the suitability according to the sensitivity analysis. Suitability (> 40) area will increase about 40% if there were no high-level roads. In total, seven potential linkages were located and found to be capable of connecting the habitats of the four sub-reserves. We suggested the Menglun reserve could serve as a stepping-stone for elephant migration. Four further conservation priorities were also identified between the Menglun reserve and the Mengla reserve where the road impacts were intensive. Our study provided information for the development of an efficient reserve network for elephant conservation between existing nature reserves in China and neighboring provinces in Lao PDR. © 2017 Reprinted with permission from Elsevier.

M. Lynch, K. McGrath, K. Raj, P. McLaren, K. Payne, R. McCoy & U. Giger
Hereditary factor VII deficiency in the Asian elephant (*Elephas maximus*) caused by a F7 missense mutation
Journal of Wildlife Diseases 53 (2017) 248-257
Abstract. Hereditary disorders and genetic predispositions to disease are rarely reported in captive and free-ranging wildlife, and none have been definitively identified and characterized in elephants. A wild-caught, 41-yr-old male Asian elephant (*Elephas maximus*) without an apparent increased bleeding tendency was consistently

found to have prolonged prothrombin times (PTs, mean=55±35 s) compared to 17 other elephants (PT=10±2 s). This elephant's partial thromboplastin times (PTT) fell within the normal range of the other elephants (12–30 s). A prolonged PT in the presence of a normal PTT suggests disruption of the extrinsic pathway via deficiency of coagulation Factor VII (FVII). This elephant's plasma FVII activity was very low (2%) compared to that of 15 other elephants (57–80%), but other coagulation factors' activities did not differ from the control elephants. Sequencing of genomic DNA from ethylenediaminetetraacetic acid blood revealed a single homozygous point mutation (c.202A>G) in the F7 gene of the FVII deficient elephant that was not present in unrelated elephants. This mutation causes an amino acid substitution (p.Arg68Gly) that is predicted to be deleterious. Two living offspring of the affected elephant were heterozygous for the mutation and had normal plasma FVII activities and coagulation profiles. Tissue from a third offspring, a deceased calf, was utilized to show that it was also a heterozygote. A DNA test has been developed to enable the screening of additional elephants for this mutation. Consistent with FVII deficiency investigations in other species, the condition did not cause a serious bleeding tendency in this individual elephant.

R.N. Makecha & R. Ghosal

Elephant conservation: Reviewing the need and potential impact of cognition-based education

International Journal of Comparative Psychology 30 (2017) 1-6

Abstract. Conservation education programs centered on animal cognition seem to be effective in bringing humans closer to non-human species and thereby, influencing their conservation attitudes. Systematic evaluation of the impact of cognition-based education programs on the attitudes of participants has revealed positive feedback and an appreciation towards the species of interest. However, such evaluations are rare for species like elephants, which suffer severe conservation challenges such as high degrees of conflict with the local community. In this paper, we review the need for cognition-based education programs in elephant conservation as well as the need to evaluate these programs to assess their impact on conservation attitudes. In particular, we emphasize the need for such programs in the native ranges of elephants, which are more prone to human-elephant conflict, and argue that exposure to such programs may potentially increase the collaboration of the local community towards conservation efforts.

S. Mendis, N.K. Jayasekera, R.C. Rajapakse & J.L. Brown

Endocrine correlates of puberty in female Asian elephants (*Elephas maximus*) at the Pinnawala Elephant Orphanage, Sri Lanka

BMC Zoology 2 (2017) 1

Abstract. Previous studies have established ovarian cycle characteristics of adult Asian elephants using progestagen analyses, but little work has been done on young elephants to determine age at puberty. Demographic studies of wild Asian elephants suggest females give birth at about 12–18 years of age (conceiving at 10–16 years of age based on a 2-year gestation). However, there are a few examples of zoo elephants giving birth at only 5–6 years of age, so they would have started cycling much earlier. This study was carried out at the Pinnawela Elephant Orphanage (PEO) in Sri Lanka, where a herd of >80 captive elephants breeds successfully, resulting in a unique opportunity to monitor hormones and document initiation of ovarian cyclicity in young females, thus contributing to the normative reproductive database for this species. We measured serum progestagens in samples collected every 10 days for 18–24 months from 11 females (3.5–15 years of age), and found six (5.5–12 years of age) already were cycling at study onset. Four females started cycling during the study at 4.5, 5.5, 7.5 and 15 years of age. There were no quantitative or qualitative differences between the first pubertal luteal phase and those of subsequent cycles. Of the 46 ovarian cycles observed, 78% were associated with clear behavioral signs of estrus (heightened bull attentiveness, and willingness of females to be mounted) during the late non-luteal period when progestagens were low. The average body weight at puberty was ~48% of that

of adult female elephants at PEO. Asian elephants under human care, including under semi-captive conditions, may reach puberty earlier than those in the wild, perhaps due to better nutrition and reaching a body weight capable of supporting reproductive activity at a younger age. Thus, facilities with bulls need to carefully manage elephants to avoid accidental pregnancies in young females that may be too small to safely carry a pregnancy to term. © 2017 The Authors.

M. Meyer, E. Palkopoulou, S. Baleka, M. Stiller, K.E.H. Penkman, K.W. Alt, Y. Ishida, D. Mania, S. Mallick, T. Meijer, H. Meller, S. Nagel, B. Nickel, S. Ostritz, N. Rohland, K.Schauer, T. Schüler, A.L. Roca, D. Reich, B. Shapiro & M. Hofreiter

Palaeogenomes of Eurasian straight-tusked elephants challenge the current view of elephant evolution

eLife 6 (2017) e25413

Abstract. The straight-tusked elephants *Palaeoloxodon* spp. were widespread across Eurasia during the Pleistocene. Phylogenetic reconstructions using morphological traits have grouped them with Asian elephants (*Elephas maximus*), and many paleontologists place *Palaeoloxodon* within *Elephas*. Here, we report the recovery of full mitochondrial genomes from four and partial nuclear genomes from two *P. antiquus* fossils. These fossils were collected at two sites in Germany, Neumark-Nord and Weimar-Ehringsdorf, and likely date to interglacial periods ~120 and ~244 thousand years ago, respectively. Unexpectedly, nuclear and mitochondrial DNA analyses suggest that *P. antiquus* was a close relative of extant African forest elephants (*Loxodonta cyclotis*). Species previously referred to *Palaeoloxodon* are thus most parsimoniously explained as having diverged from the lineage of *Loxodonta*, indicating that *Loxodonta* has not been constrained to Africa. Our results demonstrate that the current picture of elephant evolution is in need of substantial revision. © 2017 The Authors.

D. Neupane, S. Kunwar, A.K. Bohara, T.S. Risch & R.L. Johnson

Willingness to pay for mitigating human-elephant conflict by residents of Nepal

J. for Nature Conservation 36 (2017) 65-76

Abstract. Human-elephant conflict (HEC) is a significant problem in Nepal, with approximately two-thirds of households being impacted by elephants (*Elephas maximus*), particularly during the winter. In addition to elephant casualties, more than 10% of the households surveyed have had human casualties (injury or death) during the past 5 years. This study evaluates the economic viability of elephant conservation in Nepal within the context of current and proposed HEC mitigation scenarios. Face-to-face interviews were carried out using a structured questionnaire to elicit the residents' willingness to pay (WTP) for elephant conservation and HEC mitigation programs using seemingly unrelated regression (SUR). Residents' WTP was found to be positively related to income and education, and negatively related to damage-related programs. Local stakeholders were willing to pay about 42% more to programs that were economically transparent and improved upon existing management. Residents' WTP were also greater if they have had previous HEC-related injuries or deaths. © 2017 The Authors. Reprinted with permission from Elsevier.

G. Pant, M. Dhakal, N.M.B. Pradhan, F. Leverington & M. Hockings

Nature and extent of human–elephant *Elephas maximus* conflict in central Nepal

Oryx 50 (2016) 724-731

Abstract. Human–elephant conflict is one of the main threats to the long-term survival of the Asian elephant *Elephas maximus*. We studied the nature and extent of human–elephant interactions in the buffer zones of Chitwan National Park and Parsa Wildlife Reserve in Nepal, through household questionnaire surveys, key informant interviews, site observations, and analysis of the reported cases of damage during January 2008–December 2012. During this 5-year period 290 incidents of damage by elephants were reported, with a high concentration of incidents in a few locations. Property damage (53%) was the most common type of damage reported. Crop damage was reported less often but household surveys revealed it to be the most frequent form of conflict. There were also human casualties, including 21 deaths and four serious injuries.

More than 90% of the human casualties occurred during 2010–2012. More than two thirds of the respondents (70%) perceived that human–elephant conflict had increased substantially during the previous 5 years. Despite the increase in incidents of human–elephant conflict in the area, 37% of respondents had positive attitudes towards elephant conservation. Our findings suggest that public awareness and compensation for losses could reduce conflict and contribute to ensuring coexistence of people and elephants in this human-dominated landscape. © 2015 Fauna & Flora International.

S. Paudel, J.L. Brown, S. Thapaliya, I.P. Dhakal, S.K. Mikota, K.P. Gairhe, M. Shimozuru & T. Tsubota

Comparison of cortisol and thyroid hormones between tuberculosis-suspect and healthy elephants of Nepal

Journal of Veterinary Medical Science 78 (2016) 1713-1716

Abstract. We compared cortisol and thyroid hormone (T3 and T4) concentrations between tuberculosis (TB)-suspected (n=10) and healthy (n=10) elephants of Nepal. Whole blood was collected from captive elephants throughout Nepal, and TB testing was performed using the ElephantTB STAT-PAK® and DPP VetTB® serological assays that detect antibodies against *Mycobacterium tuberculosis* and *M. bovis* in elephant serum. Cortisol, T3 and T4 were quantified by competitive enzyme immunoassays, and the results showed no significant differences in hormone concentrations between TB-suspect and healthy elephants. These preliminary data suggest neither adrenal nor thyroid function is altered by TB disease status. However, more elephants, including those positively diagnosed for TB by trunk wash cultures, need to be evaluated over time to confirm results. © 2016 Japanese Society of Veterinary Science.

K.U.E. Perera, S. Wickramasinghe, B.V.P. Perera, K.B.A.T. Bandara & R.P.V.J. Rajapakse

Redescription and molecular characterization of *Anoplocephala manubriata*, Railliet et al., 1914 (Cestoda: Anoplocephalidae) from a Sri Lankan wild elephant (*Elephas maximus*)

Parasitology International 66 (2017) 279-286

Abstract. The present work provides a detailed morphological and molecular description of *Anoplocephala manubriata* in elephants. Adult worms were recovered during an autopsy of a wild elephant in Elephant Transit Home, Udawalawe, Sri Lanka. Necropsy findings revealed a severe cestode infection in the small intestine. These tapeworms were tightly attached to the intestinal mucosae, resulted in hyperemic thickened intestinal mucosae, variable size irregular well-demarcated multifocal ulcerative regions sometimes covered with necrotic membranes and variable size, diffuse, well-demarcated raised nodular masses were evident in the small intestine. The article provides an account of the biology of *A. manubriata* and a comparative analysis of the morphology and morphometrics of Anoplocephala species that occur in different hosts. Phylogenetic analysis of the second internal transcribed spacer region (ITS-2), a portion of the 28S region and cytochrome oxidase subunit 1 (COX1) genes revealed that *A. manubriata* is closely associated with Anoplocephala species in horse in comparison to other Anoplocephalines. This study will enhance the current knowledge in taxonomy of elephant tapeworms and contribute to future phylogenetic studies. © 2017 Reprinted with permission from Elsevier.

S.S. Pokharel, P.B. Seshagiri & R. Sukumar

Assessment of season-dependent body condition scores in relation to faecal glucocorticoid metabolites in free-ranging Asian elephants

Conservation Physiology 5 (2017) cox039

Abstract. We studied seasonal and annual changes in visual body condition scores (BCSs), and assessed how these scores were related to levels of faecal glucocorticoid metabolites (fGCMs) in free-ranging Asian elephants (*Elephas maximus*) in the seasonally dry tropical forests of the Mysore and Nilgiri Elephant Reserves in southern India. We assessed the animals' BCS visually on a scale of 1 to 5; where 1 represents a very thin and 5 represents a very fat elephant. To understand the influence of seasonality on BCS, we sampled the population during dry (n = 398) and wet seasons (n = 255) of 2013 and 2015 while, for annual changes in BCS, we sampled nine free-ranging adult females from different family groups that had been repeatedly sighted over seven years.

To evaluate the influence of body condition on fGCM, 307 faecal samples were collected from 261 different elephants and were analysed. As a parameter of adrenocortical activity, and thus stress, fGCM was measured (μg/g) in the ethanol-extracted samples using a group-specific 11-oxoaetiocholanolone EIA (antibody raised against 11-oxoaetiocholanolone-17-CMO:BSA and biotinylated-11-oxoaetiocholanolone as a label). Effect of age and season on BCS in relation to fGCM was also studied. A seasonal shift in BCS was observed as expected, i.e. individuals with low BCS were more frequent during the dry season when compared with the wet season. Concentrations of fGCM were highest in individuals with lowest BCS (BCS 1) and then significantly declined till BCS 3. fGCM levels were almost comparable for BCS 3, 4 and 5. This pattern was more conspicuous in female than in male elephants. Season-dependent BCS, hence, reflect the stress status as measured by fGCM, especially in female Asian elephants. This could be used as an important non-invasive approach to monitor the physiological health of free-ranging elephant populations.

J.-P. Puyravaud, S.A. Cushman, P. Davidar & D. Madappa

Predicting landscape connectivity for the Asian elephant in its largest remaining subpopulation

Animal Conservation 20 (2017) 225-234

Abstract. Landscape connectivity between protected areas is crucial for the conservation of megafauna. But often, corridor identification relies on expert knowledge that is subjective and not spatially synoptic. Landscape analysis allows generalization of expert knowledge when satellite tracking or genetic data are not available. The Nilgiri Biosphere Reserve in southern India supports the largest wild populations of the endangered Asian elephant *Elephas maximus*. Current understanding of connectivity in this region is based on corridors identified by experts, which are not empirically validated and incongruent with each other. To more rigorously assess population connectivity for the Asian elephant, we evaluated a combination of three resistance layers and three dispersal abilities. The resistance models were based on the combined contributions of land cover, topographical slope, elevation, roads and buildings. A spatially explicit connectivity modeling tool predicted optimal movement corridors as a function of factorial least-cost routes across the resistance maps. A resistant kernel approach produced maps of the expected frequency of elephant movement through each cell to define core areas. We conducted a sensitivity analysis to determine the influence of resistance and dispersal. We selected the resistance surface and dispersal ability that produced the highest correlation with observed elephant densities. We evaluated the optimality of expert corridors by using a path randomization method. Eleven out of 24 expert corridors had connectivity values significantly higher than expected by chance, while only two corridors were spatially congruent between expert teams. Areas with the highest connectivity corresponded well with priority areas identified by conservationists and elephant density predicted by the resistant kernel connectivity model correlated significantly with surveys (Spearman's $\varrho = 0.85$, $n = 500$, $P \ll 0.001$). The results provide the first rigorous, spatially synoptic and empirically validated evaluation of the connectivity of the elephant population across the reserve.

M. Rebein, C. N. Davis, H. Abad, T. Stone, J. del Sol, N. Skinner & M.D. Moran

Seed dispersal of *Diospyros virginiana* in the past and the present: Evidence for a generalist evolutionary strategy

Ecology and Evolution 7 (2017) 4035-4043

Abstract. Several North American trees are hypothesized to have lost their co-evolved seed disperser during the late-Pleistocene extinction and are therefore considered anachronistic. We tested this hypothesis for the American persimmon (*Diospyros virginiana*) by studying the effects of gut passage of proposed seed dispersers on seedling survival and growth, natural fruiting characteristics, and modern animal consumption patterns. We tested gut passage effects on persimmon seeds using three native living species, the raccoon (*Procyon lotor*), Virginia opossum (*Didelphis virginiana*), and coyote (*Canis latrans*), and two Pleistocene

analogs; the Asian elephant (*Elephas maximus*) and alpaca (*Vicugna pacos*). Persimmon seeds excreted by raccoons, coyotes, and elephants survived gut transit. Gut passage did not affect sprouting success, but did tend to decrease time to sprout and increase seedling quality. Under field conditions, persimmon fruits were palatable on the parent tree and on the ground for an equal duration, but most fruits were consumed on the ground. Seven vertebrate species fed upon persimmon fruits, with the white-tailed deer (*Odocoileus virginianus*)—a species not capable of dispersing persimmon seeds—comprising over 90% of detections. Conversely, potential living seed dispersers were rarely detected. Our results suggest the American persimmon evolved to attract a variety of seed dispersers and thus is not anachronistic. However, human-induced changes in mammal communities could be affecting successful seed dispersal. We argue that changes in the relative abundance of mammals during the Anthropocene may be modifying seed dispersal patterns, leading to potential changes in forest community composition.

S. Regnault, J.J.I. Dixon, C. Warren-Smith, J.R. Hutchinson & R. Weller

Skeletal pathology and variable anatomy in elephant feet assessed using computed tomography

PeerJ 5 (2017) e2877

Abstract. Foot problems are a major cause of morbidity and mortality in elephants, but are underreported due to difficulties in diagnosis, particularly of conditions affecting the bones and internal structures. Here we evaluate post-mortem computer tomographic (CT) scans of 52 feet from 21 elephants (seven African *Loxodonta africana* and 14 Asian *Elephas maximus*), describing both pathology and variant anatomy (including the appearance of phalangeal and sesamoid bones) that could be mistaken for disease. We found all the elephants in our study to have pathology of some type in at least one foot. The most common pathological changes observed were bone remodelling, enthesopathy, osseous cyst-like lesions, and osteoarthritis, with soft tissue mineralisation, osteitis, infectious osteoarthriti, subluxation, fracture and enostoses observed less frequently. Most feet had multiple categories of pathological change (81% with two or more diagnoses, versus 10% with a single diagnosis, and 9% without significant pathology). Much of the pathological change was focused over the middle/lateral digits, which bear most weight and experience high peak pressures during walking. We found remodelling and osteoarthritis to be correlated with increasing age, more enthesopathy in Asian elephants, and more cyst-like lesions in females. We also observed multipartite, missing and misshapen phalanges as common and apparently incidental findings. The proximal (paired) sesamoids can appear fused or absent, and the predigits (radial/tibial sesamoids) can be variably ossified, though are significantly more ossified in Asian elephants. Our study reinforces the need for regular examination and radiography of elephant feet to monitor for pathology and as a tool for improving welfare.

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

Patterns of human-wildlife conflict and people's perception towards compensation program in Nilambur, Southern Western Ghats, India

Conservation Science 4 (2016) 1-6

Abstract. The aim of this research was to examine patterns of human-wildlife conflict and assess community perception towards compensation program implemented to ameliorate human-wildlife co-existence. Data were collected from the official archives of applications made by victims or their families at Divisional Forest Office, Nilambur North and South Forest Division, for the period 2010–2013. The data included (a) types of conflict, (b) wildlife species involved in the conflict, (c) dates of application made by applicants, (d) dates of final decision made by concerned authority and (d) relief amount sanctioned. People's perceptions towards compensation program were gathered using a questionnaire survey (n=179). Crop damage was the most common type of conflict, followed by property damage, injury and death by wildlife attack. Crop damage was contributed mainly by elephant (*Elephas maximus*) (59%) and wild boar (*Sus scrofa*) (32%). On average, people took 13 days to claim compensation, which received

decisions in 90 days. The majority of respondents (67%) were not satisfied with the compensation schemes. The main causes of such dissatisfaction were (a) allocation of insufficient money for the compensation (46.6%), (b) prolonged and difficult administrative procedures to make claims (20%), (c) people's convictions that compensation scheme does not eradicate the conflict (20%) and (d) disbelief on the officials involved in compensation program (6.6%). Our results suggest that compensation program has not gained acceptance among local community as an effective strategy to mitigate human-wildlife conflict. Although it may reduce hostile attitude towards wildlife, alternative approaches are needed that avoid conflicts.

A.H. M.R. Sarker, A. Hossen, M. Suza & E. Røskaft

Protected area versus people conflict and a co-management programme: A case study from the Dhudpukuria-Dhopachari Wildlife Sanctuary, Bangladesh

Environment and Natural Resources Research 7 (2017) 1927-0488

Abstract. Conflicts over the conservation of natural resources at the community level occur in different forms and at various levels of severity. These conflicts can be defined as situations in which the allocation, management or use of natural resources results in attacks on human rights or denial of access to natural resources to an extent that considerably diminishes human welfare. However, the conflict between the authorities of the Dhudpukuria-Dhopachari Wildlife Sanctuary (DDWS) and local people over wildlife conservation is one of the most serious conservation issues in Chittagong region of Bangladesh. The DDWS is managed under a co-management programme, but there are many questions that have already been asked about the success of co-management in the study area. A total of 195 standardized, structured and semi-structured questionnaires were administered randomly to villagers. The majority of respondents reported that they did not receive any potential benefit from the DDWS, and almost one-third of respondents reported that they had problems with the DDWS. Almost all respondents reported that they were unable to control the damage caused by wildlife. More than 80% of respondents reported that the co-management approach was not effective in mitigating conflict between people and protected areas. More than 45% of the participants in co-management program reported greater effectiveness of the co- management approach than non-participants. Moreover, the respondents who received more benefits from the Protected Areas (PA) reported more effectiveness of the co-management approach than those who received less or no benefits from the protected area. Integration of local knowledge and preferences into the co-management process will ensure the sustainability of the co-management programme by minimizing the conflict between people and protected areas.

C. Schiffmann, M. Clauss, S. Hoby & J.-M. Hatt

Visual body condition scoring in zoo animals – composite, algorithm and overview approaches in captive Asian and African elephants

J. of Zoo and Aquarium Research 5 (2017) 1-10

Abstract. Various body condition scoring (BCS) methods have been developed as management tools in zoo animal husbandry. In contrast to BCS for farm animals, where visual and palpable features are used, these protocols are mainly restricted to visual cues. Considering their inherent subjectivity, such methods face scepticism as their reliability is questioned. In terms of their respective methodology, composite BCS (where individual body regions are scored and a sum or mean is calculated), algorithm BCS (where a score is achieved by following a flow chart) and overview BCS protocols (where a score is given based on overall appearance) can be distinguished. In order to compare their practicability and consistency, we conducted a test with veterinary students (n=18) scoring an equal number (n=15) of African (*Loxodonta africana*) and Asian elephant (*Elephas maximus*) photographs using three different protocols. The composite approach showed least inter-observer consistency, while the overview protocol led to the highest differentiation of individual elephant condition. When regularly assessed, visual body condition scoring may serve as an important tool for the health surveillance and complete the medical history of individual zoo animals. Nonetheless, a validation process for

each protocol developed should be carried out before its application. Further research might concentrate on long-term, individual-based body condition monitoring, using archives of standardised photographs. © 2017 The Authors.

M. Seguel & N. Gottdenker

The diversity and impact of hookworm infections in wildlife

International Journal for Parasitology: Parasites and Wildlife 6 (2017) 177-194

Abstract. Hookworms are blood-feeding nematodes that parasitize the alimentary system of mammals. Despite their high pathogenic potential, little is known about their diversity and impact in wildlife populations. We conducted a systematic review of the literature on hookworm infections of wildlife and analyzed 218 studies qualitative and quantitatively. At least 68 hookworm species have been described in 9 orders, 24 families, and 111 species of wild mammals. Black bears, red foxes, and bobcats harbored the highest diversity of hookworm species and *Ancylostoma pluridentatum*, *A. tubaeforme*, *Uncinaria stenocephala* and *Necator americanus* were the hookworm species with the highest host diversity index. Hookworm infections cause anemia, retarded growth, tissue damage, inflammation and significant mortality in several wildlife species. Anemia has been documented more commonly in canids, felids and otariids, and retarded growth only in otariids. Population- level mortality has been documented through controlled studies only in canines and eared seals although sporadic mortality has been noticed in felines, bears and elephants. The main driver of hookworm pathogenic effects was the hookworm biomass in a population, measured as prevalence, mean burden and hookworm size (length). Many studies recorded significant differences in prevalence and mean intensity among regions related to contrasts in local humidity, temperature, and host population density. These findings, plus the ability of hookworms to perpetuate in different host species, create a dynamic scenario where changes in climate and the domestic animal-human-wildlife interface will potentially affect the dynamics and consequences of hookworm infections in wildlife. © 2017 The Authors.

G. Simpson, R. Zimmerman, E. Shashkina, L. Chen, M. Richard, C.M. Bradford, G.A. Dragoo, R.L. Saiers, C.A. Peloquin, C.L. Daley, P. Planet, A. Narachenia, B. Mathema & B.N. Kreiswirth

***Mycobacterium tuberculosis* infection among Asian elephants in captivity**

Emerging Infectious Diseases 23 (2017) 513-516

Abstract. Although awareness of tuberculosis among captive elephants is increasing, antituberculosis therapy for these animals is not standardized. We describe *Mycobacterium tuberculosis* transmission between captive elephants based on whole genome analysis and report a successful combination treatment. Infection control protocols and careful monitoring of treatment of captive elephants with tuberculosis are warranted.

C. Somgird, J.L. Brown & C. Thitaram

Reproductive control in elephant: A tool for population and aggression management

Thai J. of Veterinary Medicine 47 (2017) 1-6

Abstract. Although Asian elephant is listed among the endangered species, the number of populations is over the carrying capacity in some areas, resulting in human-elephant conflict, as well as African elephants. High aggression associated with musth and female reproductive pathology are observed in captive elephants. Thus, population and aggression management through reproductive control is an alternative method for mitigating these problems. This article reviews methods of reproductive control in both Asian and African elephants with an overview of male and female reproductive physiology. Hormonal control and immunocontraception, i.e. porcine zona pellucida and gonadotropin releasing hormone (GnRH), are described for the control of reproduction, musth and reproductive pathology.

R.B. Suba, J. van der Ploeg, M. van't Zelfde, Y.W. Lau, T.F. Wissingh, W. Kustiawan, G.R. de Snoo & H.H. de Iongh

Rapid expansion of oil palm is leading to human-elephant conflicts in North Kalimantan Province of Indonesia

Tropical Conservation Science 10 (2017) 1-12

Abstract. Crop raiding by Bornean elephants (*Elephas maximus borneensis*) is increasing

rapidly in North Kalimantan, mainly due to a rapid conversion of swiddens and secondary forest into oil palm plantations. In the Tulin Onsoi subdistrict, the area used by oil palm plantations has grown from 3302.71 ha in 2001 to 21,124.93 ha in 2014. Particularly from 2006 to 2010, the area covered by oil palm plantations increased rapidly (418%). Preventing further encroachment of oil palm plantations in elephant habitat and regulating land use change are keys to stop further population declines and make way for the reestablishment of a viable elephant population in Kalimantan. Crop raiding is a strong determinant of the local people's perceptions of elephants and risks eroding cultural values that enabled people to coexist with elephants. People's perception and attitude toward elephants are generally negative. Nevertheless, negative attitudes have not led to cases of retaliation in the Tulin Onsoi subdistrict. Public education at the community level could strengthen cultural values and foster coexistence between humans and elephants. © 2017 The Authors.

A. Suzuki, S. Thong, S. Tan & A. Iwata

Camera trapping of large mammals in Chhep Wildlife Sanctuary, northern Cambodia

Cambodian Journal of Natural History 2017 (2017) 63-75

Abstract. Chhep Wildlife Sanctuary in northern Cambodia comprises a large tract of deciduous dipterocarp forest (DDF). A camera trap survey was conducted in the wildlife sanctuary during two successive dry seasons, 2012–2013 and 2013–2014. A total of 7,483 camera-trap-nights yielded 3,787 records of 30 large mammal species. Our results confirm the continued occurrence of DDF-associated large mammals such as Eld's deer *Rucervus eldii*, banteng *Bos javanicus*, and jungle cat *Felis chaus*. Importantly, large-spotted civet *Viverra megaspila*, a globally Endangered species, was the fourthmost commonly photographed species in the wildlife sanctuary. This highlights the global significance of Chhep Wildlife Sanctuary for conservation of mammal assemblages in a lowland DDF-dominated landscape, given that DDF and lowland forests are under-represented by protected areas in mainland Southeast Asia. © 2017 Centre for Biodiversity Conservation.

K. Takahashi & K. Yasui

Taxonomic invalidity of Busk's elephant (*Elephas maximus buski* Matsumoto, 1927) demonstrated by AMS C dating

Paleontological Research 21 (2017) 195-202

Abstract. The ages of the holotype and a referred molar of *Elephas maximus buski* described by Matsumoto in 1927, and a molar supposedly of the same subspecies described by Makiyama in 1938 from Higashi Betsuin temple in Nagoya, were investigated by AMS (Accelerator Mass Spectrometry) dating. The holotype (IGPS 7266) may date from any of four periods between 1676 and 1941 cal AD, with 1732–1777 cal AD being the most probable (40.7% likelihood). The referred specimen (IGPS 5845) most likely dates from 1784–1796 cal AD (39.4% probability), and the specimen from Higashi Betsuin from 1454–1494 cal AD (52.9% probability). The present specimens, including the holotype are, therefore, not fossils. Historical records show that Asian elephants did not inhabit Japan at these times. These molars must have been imported into Japan in some fashion during historical times and do not represent a subspecies distinct from extant Asian elephants, *E. maximus*. Although the nominal subspecies *E. maximus buski* is clearly invalid, it is not clear which of the three extant subspecies of Asian elephant is its senior synonym in this research. © 2017 Palaeontological Society of Japan.

Z. Takatsu, M. Tsuda, A. Yamada, H. Matsumoto, A. Takai, Y. Takeda & M. Takase

Elephant's breast milk contains large amounts of glucosamine

Journal of Veterinary Medical Science 79 (2017) 524-533

Abstract. Hand-reared elephant calves that are nursed with milk substitutes sometimes suffer bone fractures, probably due to problems associated with nutrition, exercise, sunshine levels and/or genetic factors. As we were expecting the birth of an Asian elephant (*Elephas maximus*), we analyzed elephant's breast milk to improve the milk substitutes for elephant calves. Although there were few nutritional differences between conventional substitutes and elephant's breast milk, we found a large unknown peak in the breast milk during high-performance liquid

chromatography-based amino acid analysis and determined that it was glucosamine (GlcN) using liquid chromatography/mass spectrometry. We detected the following GlcN concentrations [mean ± SD] (mg/100 g) in milk hydrolysates produced by treating samples with 6 M HCl for 24 hr at 110°C: four elephant's breast milk samples: 516 ± 42, three cow's milk mixtures: 4.0 ± 2.2, three mare's milk samples: 12 ± 1.2 and two human milk samples: 38. The GlcN content of the elephant's milk was 128, 43 and 14 times greater than those of the cow's, mare's and human milk, respectively. Then, we examined the degradation of GlcN during 0–24 hr hydrolyzation with HCl. We estimated that elephant's milk contains >880 mg/100 g GlcN, which is similar to the levels of major amino acids in elephant's milk. We concluded that a novel GlcN-containing milk substitute should be developed for elephant calves. The efficacy of GlcN supplements is disputed, and free GlcN is rare in bodily fluids; thus, the optimal molecular form of GlcN requires a further study.

N.R. Talukdar & P. Choudhury

Conserving wildlife wealth of Patharia Hills Reserve Forest, Assam, India: A critical analysis

Global Ecology and Conservation 10 (2017) 126-138

Abstract. Wildlife plays an important role in maintaining the balance of various natural processes of the earth. It contributes to food security, economical growth, pollination, seed dispersal for forest regeneration. The present study was carried out at Patharia Hills Reserve Forest (RF) of southern Assam (India) with the aim to study the wildlife distribution, species trend over time and various threats to them. Semi-structure interview and secondary literature were used during the study; 83 species of mammals were found to inhabit RF. Unfortunately, the wildlife of the RF are facing numerous threats, largely due to clearing of forest, encroachment, collection of timber and non-timber forest products, habitat loss and fragmentation. People are of the opinion that the RF is their common property, which they can exploit as their wish. The study revealed the wildlife distribution and the various threats, which is the basic challenge for the conservation. Multi-action approaches for the benefit of villagers as well as wildlife are suggested. Elevating the status of the RF may be a vital solution to protect the RF in a better way.

P. Tankaew, T. Singh-La, C. Titaram, V. Punyapornwittaya, P. Vongchan, T. Sawada & N. Sthitmate

Evaluation of an in-house indirect ELISA for detection of antibody against haemorrhagic septicemia in Asian elephants

J. of Microbiological Methods 134 (2017) 30-34

Abstract. *Pasteurella multocida* causes haemorrhagic septicemia in livestock and wild animals, including elephants. The disease has been reported in Asian elephants in India and Sri Lanka, but to date there have been no reported cases in Thailand. ELISA or indirect hemagglutination assays (IHA) have been demonstrated to be able to detect the antibody against the disease in cattle, but no data are available for elephants. The present study reports a novel in-house indirect ELISA for antibody detection of haemorrhagic septicemia in Asian elephants, and evaluates the sensitivity and specificity of the method using a Bayesian approach. The characteristics of ELISA and IHA were analyzed using a one population Bayesian model assuming conditional dependence between these two diagnostic tests. The IHA was performed as recommended by the World Organization for Animal Health (OIE) manual for haemorrhagic septicemia. An in-house indirect ELISA was developed with a heat extract antigen of *P. multocida* strain M-1404 (serovar B:2) as a coating antigen and rabbit anti-immunoglobulin G conjugated with horseradish peroxidase (eIgG-HRP). The checkerboard titration method was done using elephant sera immunized with *P. multocida* bacterin and negative sera from colostrum-deprived elephant calves. The concentrations of heat extract antigen (160 μg/ml), sample serum (1:100), and eIgG-HRP (1:1000) were optimal for the assay. The calculated cut-off value was 0.103. Of the elephant sera, 50.59% (43/85) were considered seropositive by ELISA. The sensitivity of the ELISA test was higher than that of the IHA test [median = 86.5%, 95% posterior probability

interval (PPI) = 52.5–98.9%] while the specificity was lower (median = 54.1%, PPI = 43.6–64.7%). The median sensitivity and specificity of IHA were 80.5% (PPI = 43.8–98.0%) and 78.4% (PPI = 69.0–87.0%), respectively. These findings suggest that our in-house indirect ELISA can be used as a tool to detect the antibody against haemorrhagic septicemia in Asian elephants. © 2017 Reprinted with permission from Elsevier.

D.K. Tarbert, E. Behling-Kelly, H. Priest & S. Childs-Sanford

Evaluation of the i-STAT portable clinical analyzer for measurement of ionized calcium and selected blood chemistry values in Asian elephants (*Elephas maximus*)

Journal of Zoo and Wildlife Medicine 48 (2017) 319-327

Abstract. The i-STAT® portable clinical analyzer (PCA) provides patient-side results for hematologic, biochemical, and blood gas values when immediate results are desired. This analyzer is commonly used in nondomestic animals; however, validation of this method in comparison with traditional benchtop methods should be performed for each species. In this study, the i-STAT PCA was compared with the Radiometer ABL 800 Flex benchtop analyzer using 24 heparinized whole blood samples obtained from healthy *E. maximus*. In addition, the effect of sample storage was evaluated on the i-STAT PCA. Analytes evaluated were hydrogen ion concentration (pH), glucose, potassium (K^+), sodium (Na^+), bicarbonate (HCO_3^-), total carbon dioxide (TCO_2), partial pressure of carbon dioxide (PCO_2), and ionized calcium (iCa_2^+). Statistical analysis using correlation coefficients, Passing-Bablok regression analysis, and Bland-Altman plots found good agreement between results from samples run immediately after phlebotomy and 4 hr postsampling on the i-STAT PCA with the exception of K^+, which is known to change with sample storage. Comparison of the results from the two analyzers at 4 hr postsampling found very strong or strong correlation in all values except K^+, with statistically significant bias in all values except glucose and PCO_2. Despite bias, mean differences assessed via Bland-Altman plots were clinically acceptable for all analytes excluding K^+. Within the reference range for iCa_2^+, the iCa_2^+ values obtained by the i-STAT PCA and Radiometer ABL 800 Flex were close in value, however in light of the constant and proportionate biases detected, overestimation at higher values and underestimation at lower values of iCa_2^+ by the i-STAT PCA would be of potential concern. This study supports the use of the i-STAT PCA for the evaluation of these analytes, with the exception of K+, in the Asian elephant. © 2017 American Association of Zoo Veterinarians.

G.V. Venkataramana, Sreenivasa & H.G. Lingaraju

An assessment of crop damage and economic loss caused by elephants in Harohalli and Kodihalli ranges of Bannerghatta National Park, Karnataka, India

Current Science 113 (2017) 161-167

Abstract. The human–elephant conflict, which results in extensive crop damage as well as casualties (both humans and elephants) has significantly increased over the past decade. We studied the patterns of crop raiding and associated economic loss by elephants across two forest ranges of Bannerghatta National Park (BNP), Karnataka, India, namely Kodihalli and Harohalli ranges, from January 2014 to December 2014. We found that 127 villages reported crop raids by elephants during the study period. The incidence of crop raiding in villages ranged from 1 to 59 (mean = 7.17) and was highest in Kodihalli division. Maximum crop raiding incidences were recorded during the rainy season in both the ranges. Elephants with varying proportions raided all cultivated crop species in the study area. Finger millet (*Eleusine coracana*) (65 acres), banana (*Musa paradisia*) (1535 plants) and coconut (*Cocus nucifera*) (140 trees) were the most raided crop species. Crop maturity and crop raiding incidence showed positive correlation for finger millet in the Kodihalli range. In contrast, bananas were damaged throughout the year in the Harohalli range. Other crops such as red gram, paddy, sugarcane and beans were raided less in the sampling areas. In conclusion, this study reveals rising incidence of human– elephant conflicts and significant economic loss as a result of crop damage in the adjoining regions of BNP.

S. Yasui & G. Idani

Social significance of trunk use in captive Asian elephants

Ethology Ecology & Evolution 29 (2017) 330-335

Abstract. Tactile behaviour plays an important role in maintaining social relationships in several mammalian species. Touching with the tip of the trunk is a common social behaviour among Asian elephants (*Elephas maximus*). This is considered an affiliative behaviour; however, few studies have investigated it in detail. Therefore, this study aimed to determine whether this is an affiliative behaviour and whether it has other functions. We directly observed a group of captive female Asian elephants in Thailand. We found that the elephants usually touched each other with their trunks shaped in a U (U-type) or S (S-type) shape. The S-type shape was observed mainly when the elephants touched the lips of other elephants; however, this behaviour was occasionally observed in agonistic or play contexts, where it appeared to be a threat or dominant behaviour, particularly amongst adults. In contrast, the U-type shape was more frequently observed when the elephants were disturbed, where it appeared as a gesture for reassurance. We found that the U-type touch on the genitals may be used for interacting with neonates. Therefore, we suggest that despite the S-type touch having a tactile component, it may be a rare behaviour in Asian elephants that is similar to visual threat displays in other mammals. However, the U-type touch is similar to social grooming behaviour in primates or flipper rubbing in dolphins, and can be used as an indicator of affiliative relationships. Asian elephants change the shape of their trunk while touching others depending on their motivation and the situation, thereby demonstrating that the nuances of trunk use can assist in understanding the social relationships between individuals.

A. Zachariah, J. Pandiyan, G.K. Madhavilatha, S. Mundayoor, B. Chandramohan, P.K. Sajesh, S. Santhosh & S.K. Mikota

***Mycobacterium tuberculosis* in wild Asian elephants, Southern India**

Emerging Infectious Diseases 23 (2017) 504-506

Abstract. We tested 3 wild Asian elephants (*Elephas maximus*) in southern India and confirmed infection with *Mycobacterium tuberculosis*, an obligate human pathogen, by PCR and genetic sequencing. Our results indicate that tuberculosis may be spilling over from humans (reverse zoonosis) and emerging in wild elephants.

G.H. Zhao, X.F. Hu, T.L. Liu, R.S. Hu, Z.Q. Yu, W.B. Yang, Y.L. Wu, S.K. Yu & J.K. Song

Molecular characterization of *Blastocystis* sp. in captive wild animals in Qinling Mountains

Parasitology Research 116 (2017) 2327-2333

Abstract. *Blastocystis* is one common protist inhabiting in gastrointestinal tracts of animals and humans. Examining the subtypes has important implications for assessing the zoonotic potential of *Blastocystis* and intestinal health of hosts. In the present study, a total of 497 fecal samples collected from 37 wild animal species in Qinling Mountains were investigated for the presence and subtypes of *Blastocystis*. Of them, 200 (40.2%) were positive for *Blastocystis* and 13 subtypes were found, including eight known subtypes (STs1–3, 5, 10, 12–14) and five possible novel subtypes (temporarily named as STs18–22), with ST10 as the predominate subtype and the subtype ST5 was detected in an ostrich for the first time. These findings indicated the wide distribution and specific subtype characteristics of *Blastocystis* in wild animals of Qinling Mountains.

Tusker in Yala National Park (Sri Lanka).

News Briefs

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1. Two rare elephants killed for ivory in central Sabah (Malaysia)

Channel News Asia – 2.1.2017

Wildlife rescue workers in Sabah entered the new year in shock, as two wild bull elephants were killed by poachers near Segama River, Kawag Forest Reserve within a few weeks. The first bull was found on Dec 27, 2016 in the middle of an estate bordering Kawag Forest Reserve while the second bull, a gorgeous sabre-tusked bull named Sabre, was found on New Year's Eve.

According to satellite data, Sabre was killed on Nov 21, 2016."On the day China banned ivory trade, we get two of our precious elephants murdered for their ivory. Our elephants are already threatened by habitat loss, development such as the planned road/bridge in Sukau-Kinabatangan. And if we add poaching for ivory, I don't give many years for the species to become extinct."

Meanwhile, wildlife veterinarian from the Wildlife Rescue Unit, Dr. Pakeeyaraj Nagalingam, who took part in the rescue and translocation of Sabre, said there are no words to express his sadness. He told Bernama that it looks like there is no safe place for elephants in Sabah anymore. "The relevant authorities who are responsible for enforcement of illegal wildlife poaching and other illegal activities must work harder and smarter if we want to conserve our wildlife in Sabah," he stressed.

2. Wild elephants kill 5 villagers in Myanmar's northeast

Anadolu Agency – 9.1.2017

Five villagers have been killed by rampaging elephants in a village in Myanmar's mountainous Shan State, authorities said Monday. A herd of three elephants rampaged in Sint Kin village in Mong Mate Township of northeastern Shan before dawn Sunday, killing five villagers – including a nine-year-old boy – and destroying several houses, according to a local Forestry Department officer.

"Three women and a boy were killed by the elephants in the village," Swe Thein told Anadolu Agency by phone Monday. "A man was later found dead near a well outside the village," he said, adding that the man was also killed by rampaging elephants. Such deaths are not uncommon in rural areas in Myanmar, where deforestation has resulted in a rising number of conflicts between human residents and elephants. According to media reports, there were more than 70 such destructive encounters from 2010-2016, leaving at least 15 people dead.

Forest coverage in Myanmar – which lost almost 20% of its forests between 1990 and 2010 – fell from 58% of the country in 1990 to 47% in 2010, before dropping to 45% – or under 32 million hectares – in 2015, according to Forestry Ministry figures. The government estimates that there are currently around 3000 wild elephants left in Myanmar's jungles, down from 6000 in 1960-1970, and 4639 recorded in a 1991 census.

3. In a first, jumbo delivers twins in Sathyamangalam Tiger Reserve (India)

Times of India – 10.1.2017

The elephant and its two calves have been spotted in the automatic camera, fixed in the forest area as part of the wild life census survey." The footage shows a female elephant with her two calves. It

is the first time in the STR for an elephant to give birth to twins," said a forest official. The officials said that they were monitoring the calves and the mother elephant's movements closely. "The calves look healthy and we are closely monitoring their movements," the officials said. Talking to TOI, S Sharavanan, Trustee, Wildlife Nature Conservation Trust (WNCT), said that only a healthy elephant could have delivered twins. An elephant is ready to have calves any time after 15 years. During its lifetime, it will deliver at least 13 times. A few years ago there were two twin deliveries, one in Mettupalayam and another in Anaimalai Tiger Reserve.

4. Kumki loses tusk after being attacked by wild tusker (India)

The Hindu – 19.1.2017

Sujay, 45, a male kumki elephant attached to Chadivayal elephant camp lost its tusk after an attack by a wild elephant on Wednesday. Forest Department officials said that Sujay could have been attacked by a wild elephant in musth (an aggressive behaviour born out of urge for biological ventilation).

The lone tusker trespassed into the compound of Chadivayal camp, breaking the fencing. Though eight forest staff were present at the camp, Sujay, who was chained, was badly attacked by the lone tusker. The right tusk of the kumki, which came off from the root, was found on the ground. The lost tusk had a projected length of three feet.

"After hearing loud trumpeting sounds, our staff chased the wild elephant using crackers and torches. The wild elephant, a gigantic one aged around 40 and 11 feet tall, must be in musth as it broke the electric fencing. Following the incident, Forest Department officials rushed to spot and administered medicines to Sujay.

According to forest officials, the elephant is taking food and water after treatment. Following the incident, six more forest staff have been deputed at camp which also has another kumki named Pari (36). The forest officials are also observing the movement of the tusker that attacked Sujay.

5. Myanmar to launch elephant conservation project

Myanmar Times – 19.1.2017

Amid a dramatic rise in elephant poaching, the government is stepping up efforts to protect the tusked mammals with a new conservation project expected to be unveiled later this week. Minister of Natural Resources and Environmental Conservation U Ohn Win said the Myanmar Elephant Conservation Project will legislate against killing elephants, and will also include establishing a registry of both wild and domesticated elephants.

He added that the project has been drafted with urgency in order to crack down on the increase in elephant killing, and the trade in elephant parts. U Ohn Win said the project plans should contain the relevant laws, which can be used against those involved in the illegal killing of elephants.

In order to undertake long-term conservation, the project will make a list enumerating both wild and domesticated elephants. All elephant owners will be informed and require to register the animals with the ministry, according to U Ohn Win. The Ministry of Forestry estimates there are about 2000-3000 wild elephants in the country, including in sanctuaries and natural habitats.

The elephant conservation project will also seek to advance research on elephant, human-wildlife conflict caused by territory encroachment and how citizens can contribute to habitat preservation efforts. According to government records from 2010 to 2016, Myanmar lost a total of 133 elephants – 72 to natural causes and 61 to poachers.

6. Phuket elephants DNA tested to curtail trafficking (Thailand)

The Phuket News – 19.1.2017

Officials from the National Park, Wildlife and Plant Conservation Department (DNP) yesterday took DNA samples from 67 elephants, including those that perform at the popular Phuket

FantaSea tourist attraction in Kamala, as part of a drive to crackdown on elephants trafficked onto the island. There are currently 222 elephants registered at 23 camps in Phuket.

"Today we checked four elephant camps with 32 elephants all used by Phuket FantaSea as well as 20 elephants at Pang Chang Hai elephant camp, 13 elephants at Kalim camp, and two elephants at Tritrang elephant camp," Mr Supot said.

The DNA tests are part of a five-day campaign that began yesterday (Jan 18) to confirm the identity of all registered elephants on the island, including those used at tourist attractions and jungle-trekking tours, he explained.

The DNP teams, assisted Department of Livestock and Department of Provincial Administration officials, are checking identification certificates and microchip implants. "Officials from the Veterinary Research and Development Centre Southern Region are checking the health of the elephants and the conditions of their shelters," Mr Supot said.

7. 11 hour operation to detach trunk from tusk (Sri Lanka)

Sunday Times – 21.1.2017

A tusker whose trunk had gotten stuck inside one of its tusks, rendering it unable to intake food for two days, was rescued by veterinary surgeons of the Department of Wildlife Conservation (DWC). The elephant, a 25-year-old tusker by the name of 'Nandimitra,' is known to frequent the area of the Sithulpawwa Rajamaha Viharaya.

After receiving information that the tusker's trunk had been stuck inside one of its tusks, wildlife officers launched a two-day search operation to locate the animal. They were finally able to locate 'Nandimitra' last evening. The trunk was finally detached from the tusk after an operation lasting 11 hours. DWC officials say Nandimitra had attacked and damaged about 107 vehicles along the Sithulpawwa road, mainly due to pilgrims trying to feed the tusker.

8. Bangla fencing to keep M'laya jumbos away (Bangladesh)

Shillong Times – 31.1.2017

Bangladesh is fencing the hillocks near Garo Hills to stop infiltration of a different type. The forest department of the neighbouring country is using electric wires to cordon off the hillocks adjacent to Sherpur on the border near Garo Hills to prevent elephants straying into the villages in Bangladesh.

The elephants come from Meghalaya and enter border areas in Mymensingh, Sherpur and Jamalpur and destroy properties and crops. Wildlife experts say cross-border movement of elephants is hampered by border fencing because many areas are within the elephant corridor. The animals are forced to divert their route through human habitat. Over 50 people were killed and more than 500 injured in elephant attacks in these areas so far. 20 elephants were killed in counter attacks as well, according to official figures.

9. Wild Elephants Invade Chinese Village in Search of Food (China)

Sputnik International – 8.2.2017

Fourteen hungry wild elephants in search of food invaded a village in Yunnan province in southwest China. The elephants were present in the vicinity from January 26 and wandered near the fields and farmland in search of food. The elephants trampled a few chickens and geese on a farm, roamed the highway and ate the village's crops. Police sent out special personnel for alarm announcements, traffic police warnings and evacuation of local residents. The government used a drone to track the escaped animals.

Wild Asian elephants in China are protected animals. They mainly live in the county of Xishuangbanna Dai, as well as in the cities of Payer and Linking in Yuannan province. Due to the lack of food in winter months, the animals are forced to leave their territories in search of food in nearby villages. According to the Forestry Administration, from 2011 to 2015 in there

were 48 thousand cases of elephant invasions in Yunnan province. Due to such incidents 18 people died, 27 were injured and the economic damage amounted to almost $14 million.

10. Malaysia: Elephants lost 70% of territory to human encroachment – study

Asian Correspondent – 10.2.2017

Elephants in Malaysia have lost nearly 70% of their roaming territory in human-dominated landscapes in the country over the past 35 years, according to a study on the "alarming rate" of encroachment into wildlife territory. Caroline Christine Russell, of conglomerate Sime Darby Berhad, said the research carried out by the Management and Ecology of Malaysian Elephants (MEME) project also recorded significant findings on the behaviour and ecology of the Asian elephant in forested areas of Malaysia, as well as their interactions with people.

She said alarmingly, conservationists started the new year with jarring news of the poaching of two Pygmy Elephants roaming protected areas in the eastern state of Sabah. Last month, she pointed out, Indonesian authorities seized ivory worth US$ 6700 in North Kalimantan, believed to be from Malaysia. Poaching appears to be an emerging threat to the Asian elephant population in Malaysia, a grave concern for all," she said.

In an effort to save the gentle giants, the foundation is extending support for the MEME project with a RM 1.9 million commitment for another three years from January this year until December 2019. This is the sixth year of support for the MEME project to preserve Asian elephants in Malaysia. YSD first sponsored the MEME project in January 2012, committing RM 3.36 million until December 2016.

11. Elephants turn TB carriers: India plan to wipe out disease by 2025 may be hit

Times of India – 21.2.2017

India plans to eradicate tuberculosis by 2025, five years before the WHO target of 2030. However, the target can be realised only if *Mycobacterium tuberculosis* is controlled both in humans and animals. Elephant is one of the animals known to carry the human TB bacterium. That TB has been found in wild elephants too may widen the scope of TB control strategy. TB control focus should include captive and wild pachyderms too.

It is not clear how many wild elephants have been infected by TB, as the latest research focussed only on the dead pachyderms. There have been several cases of TB infection passing on to humans from elephants in captivity. Though TB bacterium is also present in cattle and wild animals, it is a different species of the *Mycobacterium*. The authorities of Nehru Zoological Park are silent on whether or not the elephants in the zoo underwent tests for TB diagnosis.

Another researcher Dr. Susan K Mikota, director of veterinary programmes and research, Elephant Care International, USA said TB can be transmitted between elephants and humans.

12. Sri Lanka to hike damages for elephant attacks

Business Standard – 22.2.2017

Sri Lanka's Cabinet on Wednesday approved to grant a higher compensation to victims of wild elephant attacks in the island country. Compensations would be paid for damages caused by wild elephant attacks on individuals and properties, Xinhua reported. Following a proposal by Wildlife Minister Gamini Jayawickrama Perera, the government decided to increase the compensation paid for human deaths and permanent disabilities from the current Rs 200,000 (estimated $1200) to Rs 500,000 (estimated $3300). Several persons are killed in Sri Lanka each year in wild elephant attacks while those living in dry zones, especially in the south, have their properties damaged in such tusker attacks.

During the past 12 years, an estimated 1464 elephants have been killed, while 672 persons have lost their lives in elephant attacks.

13. Wild elephants sleep just two hours a night

The Atlantic – 1.3.2017

In April 2014, Nadine Gravett tranquilized two female elephants and fitted them with actiwatches. These small devices—the scientific version of Fitbits—record movement, and researchers can use them to measure how well volunteers are sleeping. They're usually worn around the wrist, but that's not an option when your subjects' limbs are literally elephantine. So Gravett had to implant them in the females' most mobile appendages—their trunks.

The skin around the middle of the trunk is so thick that the implants went unnoticed, and quietly recorded the animals' movements for a month. By analyzing their data, and looking for five-minute windows when the trunks were still, Gravett could deduce when the elephants were asleep. And she found that they slept for just two hours a day on average—the lowest duration for any animal thus far recorded.

"Sleep is such a weird behavioral state," says Paul Manger from the University of Witswatersrand, who led the study. "For animals, the main things in life are eating, reproducing, and not being eaten—but when we're sleeping, those things fall away. Sleep supersedes a lot of our survival instincts. We do know a lot about it in lab animals, but we don't know a lot in exotic species."

As a very rough rule, and for reasons that are still unclear, bigger mammal species tend to sleep less than smaller ones. Captive elephants reportedly sleep for just 3 to 7 hours a day, but for their size, you'd expect them to get even less. Proving that is hard, though. Elephants can sleep standing up, so it's difficult to eyeball whether they're awake or asleep, especially if you're tracking them through the bush at night. Brain activity sensors would give better answers, but an elephant's anatomy makes it exceedingly risky to surgically implant such devices. So Manger and Gravett settled for the actiwatches instead. They also fitted satellite collars onto the animals to track their whereabouts later.

14. Deadly garbage dumps pose elephantine problems (Sri Lanka)

Sunday Times – 5.3.2017

An elephant which had been regularly eating garbage at Manampitiya died last Saturday after suffering from a sickness for a month. This well grown male, about 20 years of age, was part of a herd that fed on garbage from a dump at Manampitiya. It had fallen ill in the third week of January. A veterinary surgeon and a team of wildlife officers tried to flush out any non-digestive materials from its stomach. At first they pulled out about 15 kg of polythene in a day and over a month about 30 kg were removed.

Dr. Pramuditha Devasurendra who had treated the elephant, rejected the idea that the polythene was the cause of death. He said toxic bacteria in rotting food may have been the cause. "The garbage pit contains lots of lunch sheets with rotten food. Deadly bacteria can grow on the food. This is main reason for the death of the elephant." A post-mortem did not find any polythene in the bowels of the dead elephant. Its liver and spleen were damaged.

Meanwhile, Dr. Prithiviraj Fernando, estimates that there are at least 50 locations where elephants come to forage at the dump. Dr. Fernando said piles of vegetables, over ripe fruit, flour, rice, bread and the like are more nutritious than what is found naturally. Elephants, which rummage for these at the dumps, are in better health, he said. But he said every day 500 elephants may be eating garbage. "In a year, how many of them would die as a result? How does this compare with other 'unnatural' causes of elephant deaths? Such as being shot, hakka patas, injuries from trap guns and nooses, train or vehicle accidents, starving to death inside parks after being driven in and restricted with electric fences," he asks.

15. New DNA system helps combat wild elephant trafficking (Thailand)

The Independent – 7.3.2017

It is illegal to traffic wild elephants into captivity.

Thailand has a new national DNA database of all captive elephants. It has shown its worth this week by proving two young elephants in a Thai tourist camp often frequented by UK tourists in southern Thailand are not in fact the offspring of captive elephant parents as claimed. This significant finding proves that the DNA registration system is working and could be the first of many incidents of this nature.

Last October, Thailand introduced a new law for all elephant owners to adopt a DNA registration system. The system will help better track captive elephants and prevent elephants being smuggled from the wild and disguised as captive elephants, fuelled by the lucrative tourist industry. To date over 3440 captive elephants - almost 99% of the animals' total documented population in Thailand – have already been registered for DNA checks to help verify their identity and origins, with the remainder of captive elephants to be completed by the end of this month.

With less than 50,000 Asian elephants left in the wild today, this crucial milestone will help protect both captive and wild elephants and ensure that the wild population doesn't continue to be further fragmented.

16. Number of wild elephants in Thailand on the rise Pratch Rujivanarom

The Nation – 13.3.2017

The number of elephants in the wild in Thailand is increasing by up to 10%, according to the National Park, Wildlife and Plant Conservation Department (DNP). DNP deputy director-general Adisorn Noochdumrong revealed the good news for conservationists on Thai Elephant Day. Adisorn said the number of wild elephant was rising at a rate between 7 to 10%. Areas that had seen the most marked increase in wild elephants were the Western forest in Thungyai Naresuan Wildlife Sanctuary and Eastern forest in Dong Phayayen-Khao Yai forest complex.

"This is the outstanding outcome of our efforts to protect the forest ecosystem and conserve wild elephants. We have worked at reintroducing the wild elephants to the forest and building up food sources for the elephants in the forest," Adisorn said. "We are happy with this success but will still continue our efforts to preserve our national symbol and let the elephants live peacefully with the people."

17. First successful artificial mating in endangered Asian elephants in China

Global Times – 23.3.2017

Chinese researchers have for the first time used artificial breeding techniques to breed a baby Asian elephant. The Asian elephant is a first-class national protected animal that inhabits Southwest China's Yunnan Province, where the cub was delivered. A female elephant Weilai delivered the healthy 106 cm male cub on March 16 after 22 months' pregnancy, news portal chinanews.com reported Wednesday. The birth was engineered by the Asian Elephant Breeding and Rescue Center in Xishuangbanna Dai Autonomous Prefecture.

The cub is reported to be in stable health. "Having delivered a cub in 2010 in natural breeding, Weilai never got pregnant again although she went into heat several times," Bao Mingwei, a veterinary from the center was qouted as saying. Bao said they detected Weilai's hormone level and chose the best timing for her to mate with a male elephant Pailun in 2015.

Over the past ten years, employees from the Asian Elephant Breeding and Rescue Center have successfully bred three Asian elephants through natural mating. The birth of this cub has opened a new era in breeding Asian elephants with the assistance of new technologies.

18. RTI nails anthrax lie in elephant deaths at Similipal Tiger Reserve (India)

Times of India – 2.4.2017

It is not just anthrax, which killed 16 elephants at Similipal Tiger Reserve (STR) in the past two and half years. Contrary to claims by officials at Similipal, information obtained under RTI revealed that out of the 16, only five died due

to anthrax. Blood samples of all 16 elephants were sent for test at the Animal Disease Research Institute in Phulnakhara, Cuttack, out of which 11 turned out to be negative, the RTI pointed out. Of the five positive cases, three were from STR and two from Baripada forest division. This indicates that 11 elephants didn't die due to anthrax and poaching - by electrocution trap or poisoning - could be the reason behind their deaths.

The ADRI data seems realistic. Had the anthrax spread, as is being claimed by the Forest Department, it could have been an epidemic. It could have spread to the cattle in the nearby habitation area and other prey animals. But there has not been a single instance of anthrax spreading to other animals," WSO secretary Biswajit Mohanty said.

19. Khao Yai takes action against visitors who taunt elephant (Thailand)

Bangkok Post – 4.4.2017

Khao Yai National Park has filed a police complaint against a car owner seen on video taunting a wild elephant into chasing his vehicle. Park chief Kanchit Srinoppawan said on Tuesday that authorities had examined a video clip posted on Facebook on Monday and concluded that the Camry sedan driver in the footage had intentionally challenged an elephant walking on a park road to chase his car, just for fun.

"It can't run faster than my Camry," the driver says and laughs in the two-minute video, as a woman in the car films an elephant coming towards them. "It never catches up with me," the driver said. "It's fun, it's fun."The clip also shows the car stopping twice waiting for the elephant to come closer. It is not clear when it happened. The clip drew negative comments from viewers.

The maximum punishment is one month in prison and a fine of 1000 baht. The driver had also violated another law against cruelty to animals, it said. Mr. Kanchit did not mention the woman seen filming the elephant. Wild elephants are frequently seen on the roads up to Khao Yai National Park.

20. Killer elephant shot on rampage (Cambodia)

Khmer Times – 10.4.2017

Mondulkiri provincial authorities have shot and killed an elephant two days after it trampled its owner to death. The elephant destroyed seven houses before it was shot. Provincial governor Svay Sam Eang ordered police to kill the animal when it walked out of the forest and terrified villagers as it destroyed homes.

The bull elephant named A Tork was more than 70 years old and had worked in the tourist industry for many years. Its owner, Cheung Tiem, 45, took him when he was young from the forest where he had been living wild. The elephant threw Mr. Tiem off his back and stomped on him in a fit of anger during the mating season.

According to Fauna and Flora International, there are now between 400 and 600 wild elephants in Cambodia, with the main concentration in the southwestern Cardamom Mountains and the eastern plains of Mondulkiri province.

21. Training for estimating elephant numbers conducted (Karnataka, India)

The Hindu – 29.4.2017

The Forest Department, on Saturday, conducted a training programme for field staff and volunteers for estimation of elephant numbers exercise scheduled to be held from May 16 to 19 across the country. Around 360 field staff and 60 volunteers participated in the programme, where senior officers of the department and researchers in wildlife offered training.

Dileep Kumar Das, Director, Elephant Project, said the estimation is conducted once in five years. The exercise would include one indirect and two direct methods. Sample block count and waterhole count are the direct methods, while line transect dung count is the indirect method. During the four-day estimation, the first would be spent providing basic information about the terrain and forest blocks to be covered.

On the second day, volunteers and staff would take up the counting of elephants spotted at respective blocks along the GPS location and other details of the mammal. Line transect dung count would happen on the third day, where elephant dung in the respective blocks would be counted. On the final day, participants would sit at one point such as a water hole, salt lick point or an open area and take photos of the elephants visiting these places. They would classify the elephants they spot on the basis of gender and age during the estimation, the experts said.

22. Safety worries as wild elephants steal from trucks (Thailand)

The Nation – 30.5.2017

Aggressive wild elephants are robbing fruit trucks and raising safety concerns in Prachuap Khiri Khan's Hua Hin district. Several people have recounted scary moments when giant pachyderms have come so close to them that they have been afraid they may cause physical harm.

Suwan Kaewpontrang, a pineapple agent, said: "Two nights ago, a big elephant with tusks cut in front of my truck and blocked my way. Then, it used its trunk to grasp pineapples into its mouth." He said the giant pachyderm knocked a wing mirror off and dented his six-wheeled truck.

He said they could not call for help because the cell-phone signal was dead. Fortunately, a police car drove past the incident and helped alert officials of the Kaeng Krachan National Park who rescued the family.

23. Tigers kill six elephants in Kerala's Wayanad as drought triggers fierce water war (India)

Hindustan Times – 6.6.2017

Eighteen elephants have died in Kerala's Wayanad Wildlife Sanctuary over the past four months, including at least six in tiger attacks that officials say could have been triggered by bitter turf wars over scarce water.

Officials say large-scale migration of animals from nearby Bandipur and Mudumali wildlife parks to the Wayanad sanctuary in search of water amid a debilitating drought have probably brought things to a head. While six elephants were killed by tigers, two tuskers died fighting each other. Tiger attacks on elephants are rare because the latter move in large herds.

"This year Wayanad is witnessing a mass influx of wild animals. Naturally high density of animals is bound to trigger intense fights between them," said Wayanad wildlife warden Dhanesh Kumar.

Wayanad witnessed 12 elephant deaths during the corresponding period last year. The current drought has been caused by successive failed monsoons. The southwest monsoon was deficient by 33.7% and the northeast monsoon less by 60%. A majority of the state's 44 rivers are also either dry or near-dry.

24. Captive elephants in Burma may be released to boost numbers

The Times – 10.6.2017

Hundreds of unemployed elephants in Burma, laid off from the once-booming timber trade, have emerged as potential saviours of the animal population. One of the largest surviving wild elephant populations in Asia is being pushed to the brink as hunters feed demand for their hides in neighbouring China.

Burma has just over 1000 left in the wild. Among the solutions being discussed is a proposal to release captive elephants, laid off after a slump in the timber trade, back into the wild. Burma has the world's largest captive elephant population, at about 5000.

Campaigners have spotted an opportunity. Three thousand of the captive elephants are state-owned. Many of the 2000 privately held animals are kept in poor condition, however, and it is these that activists are targeting.

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 evaluated by the editorial board of *Gajah*. Peer-reviewed articles will be sent out for review. 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 500 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.). A second abstract in the local language of the authors is optional (100 words max.). *Gajah* also publishes "**Peer-Reviewed Research Articles**". 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. 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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Baskaran N & Desai AA (1996) Ranging behavior of the Asian elephant (*Elephas maximus*) in the Nilgiri biosphere reserve, South India. *Gajah* **15:** 41-57.

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

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