GAJAH

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Journal of the Asian Elephant Specialist Group

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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 (https://www.asesg.org/gajah.php). 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>.

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Cover

A herd of elephants crossing an oil palm plantation in Tawau, Sabah
Photo by Mazidi Ghani
(See article on page 30)

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Editorial

Jennifer Pastorini (Editor)

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Gajah 53 includes two peer-reviewed research articles, one research paper, and three short communications dealing with Asian elephants. Two articles are from India, and from Thailand, Sabah and Sri Lanka we have one article each. The sixth paper is about captive elephants in Europe. In the News and Briefs section there is a book review, an obituary and a memorial.

In the **Peer-Reviewed Research Articles,** Alexander Greene writes about the development and status of human-elephant culture, describing the rituals Karen people in Thailand perform with their captive elephants. Christian Schiffmann describes in detail how to recognize musculoskeletal disorders in captive elephants. There are many photos provided, which will help elephant caretakers at any facility to look out for the symptoms.

In their **Research Article,** Cheryl Imm and co-authors present a case study on how to successfully involve oil palm plantations in elephant conservation. Better land-use planning was found to be crucial to keep elephants in the landscape.

In the **Short Communications**, Jyoti Bishya *et al*. evaluate the status of elephants in the Nagaon Forest Division in Assam. Elephant numbers have decreased drastically, mostly due to habitat loss. Tharindu Wijekoon and co-authors conducted a trial with the GnRH vaccine to reduce the musth period in four captive elephants. The results were promising with decreasing testosterone and cortisol levels in two bulls. Sarat Kumar *et al*. report on how they tried to solve the problem of a wild elephant bull, who kept breaking into the zoo and twice injured a female zoo elephant. The bull was translocated 50 km but might have come back to the vicinity of the zoo.

For **News and Briefs** A.J.T. Johnsingh wrote about the life of the former AsESG Co-chair Ajay Desai, who sadly passed away last November. Johnsingh brings back memories of Ajay's time in the field and his untiring efforts to conserve Asian elephants. Ravi Corea gives glimpses of the life of the former AsESG Chairman Lyn de Alwis, honouring his important contributions to elephant conservation. Paul Keil wrote a book review about Nicolas Lainé's "Living and Working with Giants: A Multispecies Ethnography of the Khamti and Elephants in Northeast India". *Gajah* 53 also presents abstracts from 59 recent scientific publications on Asian elephants and there are briefs of 27 newspaper articles published across Asia.

The **Chair** of the AsESG, Vivek Menon, gives us an update on the happenings of the AsESG. He explains the proceedings for the membership of the AsESG for the next 4-year term and informs about the updated assessment of Asian elephants for the IUCN Red List of Threatened Species.

The **Editorial Board** members worked hard to make this *Gajah* possible. Thanks to the funding from the **Wildlife Reserves Singapore Group** we are able to also print and mail out hard copies of *Gajah*. I am grateful to the **authors** who submitted their manuscripts to *Gajah* and kept working on their manuscripts until they were ready for publication. The help of four **reviewers** who reviewed manuscripts is greatly appreciated.

Last but not least I would like to sincerely thank **Jayantha Jayewardene**, who has indicated that he will not be able to continue with his News Briefs, which has been a prominent and popular feature of *Gajah* for over a decade.

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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

Hope this finds you well and that you and your family are safe from the current pandemic. 2020 was a very difficult time for all of us. I hope with vaccination started, 2021 brings in some respite from the pandemic and we are able to resume our work in full swing and are able to travel to other range states. I hope our governments and people learn from this pandemic and the negative repercussion of environmental damages on our life and take appropriate actions and safeguards to protect our forest and wildlife.

The sudden demise of our friend, member and former AsESG Co-Chair Ajay Desai was a great shock for all of us and for the entire research and conservation fraternity. Ajay was an institution in himself and his dedication for elephants and sense of humour was unparalleled. It is tragic to lose a loved one before their time and his loss to the field of elephant conservation in Asia will be long felt. The greatest homage to Ajay would be to continue working for the conservation of elephants in Asia that was so close to his heart.

The Red List Coordinator and team were successfully able to update the Red List assessment of the Asian elephant. The information was submitted in mid 2019, reviewed in 2020 and published in early December 2020. This was also possible because of the information generated from the research and conservation work of our members, other experts, organisations and range country governments that has helped in undertaking the assessment. On behalf of the group, I would like to thank all the members who have contributed in the assessment process and Christy for taking the lead. You can download the document at <https://www.asesg.org/PDFfiles/Asian%20Elephant%20Red%20List%20Assessment%202020.pdf>.

As we step into the new quadrennium (2021–2024), we are reviewing the current membership of our group. Although I will formally write to you after the upcoming World Conservation Congress in September 2021, when the new quadrennium will kick in, inter-alia the current members will continue to serve the group till we complete the review process so that the intervening period is not lost. I am happy that most of you (100 out of 111) responded to the self-assessment survey. It has helped us to understand the diverse research and conservation work being done by our members across the Asian elephant range states and the papers published. Thank you for also critically reviewing the AsESG Secretariat and the work of the Chair and the Program Manager. The outcome has been quite encouraging. Your feedback will help us in further improving our work and effective functioning of the group.

For the coming quadrennium we have constituted a new Membership Advisory Committee (MAC) for screening new memberships. The committee consists of Mr. Salman Saaban (Convener), Dr. Peter Leimgruber, Dr. T.N.C Vidya and Dr. Jennifer Pastorini. In our group, we would

Figure 1. Ajay Desai (left) posing with other (former) chairs of the AsESG: Raman Sukumar, Vivek Menon and Simon Hedges (left to right).

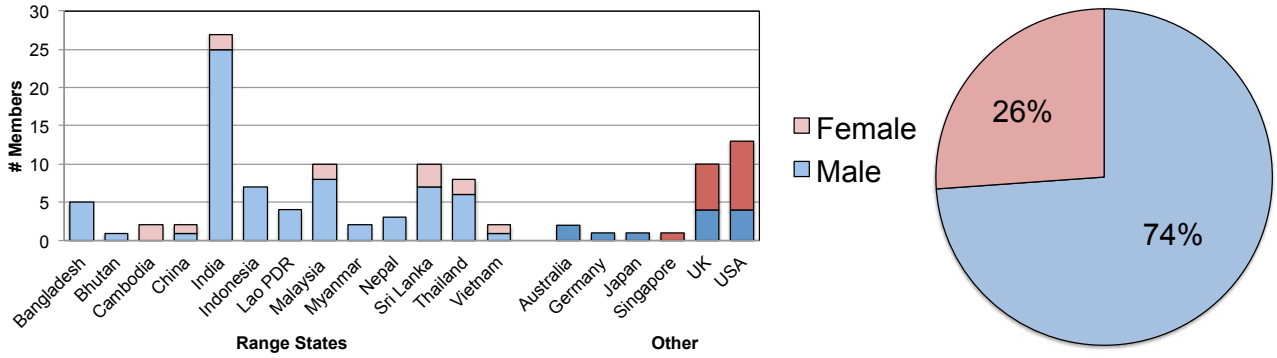

Figure 2. Country and gender of the 111 members at the end of the last quadrennium (2020).

like to have gender parity (Fig. 2), balance amongst youth (Fig. 3) and experience (Fig. 4), geographical balance (Fig. 2), more members from the countries that currently have less than five (Bhutan, Nepal, Myanmar, Cambodia, Vietnam, Lao PDR and China) and more representation in skill sets that are poorly represented. I request you all to proactively look for potential members and ask them to apply. They could submit the application to the Program Manager in the designated application form endorsed by two sitting AsESG members.

As informed earlier, I have also decided to depute two Deputy Chairs for the group as an essential step for leadership succession. I am glad that a few of you have indicated your willingness to take the responsibility. The AsESG and SSC are reviewing the applications and we will soon be able to decide on the names.

For the new quadrennium we would also like to formulate targets for the group. Based on your feedback, the AsESG Secretariat has produced tentative targets and a workplan and we will soon share this with the group for your comments and suggestions.

I thank you all for sincerely contributing to the research and conservation of the species and helping achieve the target of the group. I am looking forward to working with you again this quadrennium. I would also like to thank Gajah' editorial board, our institutional partners (Elephant Family and IFAW), range state officials and the SSC Chair office for all their support and assistance. Stay safe and wishing you all good health.

Vivek Menon
Chair IUCN SSC AsESG

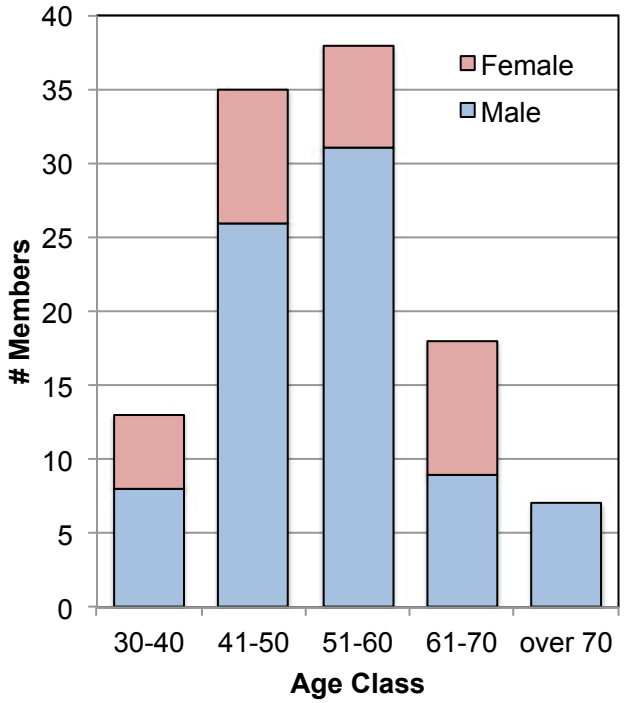

Figure 3. Age class of the 111 members.

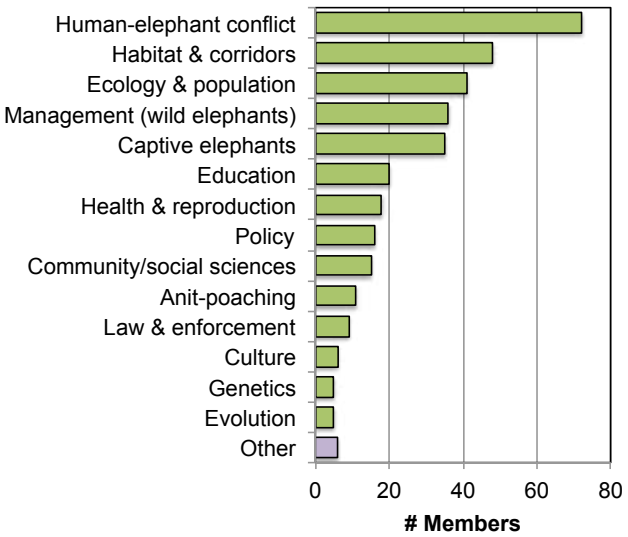

Figure 4. Area of expertise of 97 members.

Peer-Reviewed Research Article *Gajah 53 (2021) 4-19*

Speaking with an Upside-Down Tongue: Reflections on Human-Elephant Multispecies Culture in Northern Thailand

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Abstract. In Karen villages in northern Thailand, humans often coexist with captive wild Asian elephants, in what can be described as a multispecies culture. A variety of ethnographic data is presented here as evidence of this culture, including an elephant origin story, rituals performed throughout elephant lives, and associated beliefs and practices. Together these rituals and beliefs mediate and define the human-elephant relationship. This relationship exists not only on physical, intellectual and emotional levels, but also within the spiritual worldview of Karen people. In this worldview, elephants are entangled in the same complex relations with spirits, both within their bodies and within the landscape in which they live, that influence Karen human lives. The shared life between humans, elephants and spirits can be understood as a form of multispecies culture resulting from a long process of cultural co-evolution.

Introduction

"The fourteenth-century lexicographer Muhammad al-Damiri suggested that the elephant's tongue is upside down and if only it could be turned around this animal would be able to speak… Until such time, however, human beings are left to recount the life story of this species, even as we intrude upon the telling of the tale." (Stephen 2004)

The human-Asian elephant (*Elephas maximus*) connection is one of the most complex, dynamic and idiosyncratic relationships that have ever evolved between human and more-than-human beings. As Lorimer (2010) puts it, elephants are "too social and sagacious to be objects; too strange to be human; too captive to be wild, but too wild to be domesticated". Asian elephants have been entangled in human lifeways for more than 4,000 years as captives and companions, participating directly in all the strands of knowledge and practice that collectively comprise human culture: religion, art, construction, commerce, and war. Wild and captive elephants were present in ancient Egypt, Assyria, Persia, Central Asia and China, and at the dawn of the Aryan conquest of India (Singh 1963; Lobban & de Liedekerke 2000; Clarence-Smith 2019). A branch of Ayurvedic medicine, Gaja Ayurveda, was developed specifically for the care of elephants, who were an indispensable part of armies and the retinues of kings (Somvanshi 2006). But the connection goes deeper still: the widespread archaeological evidence of proboscidean hunting, bones used in construction, and the carving of elephant figurines in the upper Paleolithic indicates that elephants and mammoths were not only a key food source for ancient humans but likely played a significant role in their cosmology (Lev & Barkai 2016; Barkai 2019).

Today, this ancient relationship continues, despite significant changes in the nature of humanity's material entanglement with elephants. Two populations continue to exist: those who live free lives in the 'wild', and those who are raised and live in a state of constant companionship with humans. Yet the elephant-human relationship perfectly encapsulates the changing winds of modern scholarship and the steadily unravelling dependency on a nature/culture duality. Captive or companion elephants are not domesticated and never have been. Leery of breeding in captivity,

the elephants in human care often mate with free-roaming elephants (Locke 2014; Lainé 2018), producing offspring that are hybrids of the postulated 'wild' and 'captive' elephant cultures. Capturing free-roaming elephants is no longer common, but the 'wild' populations that roam the lowland and mountain forests of Asia not only thrive in human-altered landscapes but also constantly interact with humans, often in conflict and sometimes in peace (Fernando 2000; Lainé 2017a). To understand this complex entanglement requires us to shed the nature/culture divide and adopt a more flexible discursive space, one that recognizes the 'ambivalent intimacies' that weave together human and elephant lives (Münster 2016).

It is in this spirit of reaching for new modes of understanding that Locke (2013) has proposed a novel approach, ethnoelephantology, which is premised on the recognition of human and elephant sentience and coevolution and employs inter- and multidisciplinary tools. This study takes inspiration from the principles of ethnoelephantology to explore the multispecies culture of Asian elephants and the Karen, a highland people of Southeast Asia. As with all attempts to arrive at an 'anthropology beyond humanity' (Ingold 2013) by conducting 'multispecies ethnography' (Kirksey & Helmreich 2010), the challenge is clear: elephants cannot tell their own story. Cursed, or blessed, with an upside-down tongue, one half of the multispecies culture to be discussed remains mute, and so, as the quote that introduces this paper points out, we must 'intrude upon the telling of the tale.'

To do so, I rely on a range of ethnographic material: stories, beliefs and practices of Karen people in relation to their elephant companions. This material, which forms the backbone of my argument for the existence of an elephant-Karen multispecies culture, comes from four Sgaw Karen communities in the highlands of northern Thailand. I interpret this material from the perspective of an American researcher without a cultural connection to Asian elephants or elephant husbandry; however, my experiences in northern Thai elephant camps and friendships with mahouts, elephant owners and elephant conservationists directly inform the analysis presented here. After an introduction to Karen and elephant lifeways, I present an elephant origin story, then proceed through an elephant's life cycle, discussing relevant practices and beliefs at each stage. Finally, I argue that this material is evidence of a dynamic, coevolving multispecies culture that continues to shape the lives of humans and elephants in Karen villages today.

The Karen

A highland people of Thailand and Myanmar, the Karen have traditionally lived in small villages in mountainous areas cultivating rotating swiddens of upland rice (Fukushima *et al*. 2007). Their connection with elephants is long-standing, as this colonial-era quote attests to: "In some of the backward jungle districts especially amongst the Karen, elephants take a place somewhat akin to the horse or ox, living with their owner on easy terms of intimacy and liking" (Giles 1929). In the period in which this was written, and continuing today in some areas, one of the major practical roles elephants played in daily life was in agriculture. They were indispensable in bringing rice from the fields back to the village during the harvest, and also assisted during planting and other times of strenuous labour (Schliesinger 2010).

The Karen are the largest ethnic minority group in northern Thailand, but they are far more numerous in neighbouring Myanmar, where Karen military groups control Kayin State in opposition of the Myanmarese government. Decades of conflict in Kayin State have internally displaced hundreds of thousands of people, many of whom have fled to refugee camps on the Thai side of the border (Bartholomew *et al*. 2015). In the face of pressure from the governments of Thailand and Myanmar, many Karen have also responded with forms of non-violent resistance (Isager & Ivarsson 2002), including grassroots activism and millenarian religious movements (Gravers 2001). In Thailand, Karen groups have successfully opposed the appropriation of their ancestral lands by Thai government bodies (Trakansuphakorn 2008). In Myanmar, a partnership between Karen communities, the Karen National Union

(KNU) and the Karen Environmental and Social Action Network (KESAN) has recently founded the Salween Peace Park as a means of both de-escalating military tensions and promoting sustainable livelihood development in the Karen homeland (Kamiński *et al*. 2019).

Karen people have often been perceived in Thailand as environmentally friendly due to their use of sustainable and ecologically responsible methods of rotational agriculture and forest management (Santasombat 2004). But in recent decades, Thai government policies and market forces have pushed many communities to adopt intensive corn agriculture, resulting in deforestation and environmental degradation (Buergin 2002). These changes are due to the cascading effects of growth in population and per capita income throughout Asia, which has increased meat consumption, leading to expanded meat production and high demand for corn for animal feed (Machovina *et al*. 2015). These regional forces are coupled with attempts by the Thai government to pressure highland peoples to abandon rotational farming, convert to Buddhism and generally assimilate within the nationalistic agenda of the state-building enterprise (Trakansuphakorn 2008). The ways in which Karen communities respond to these external forces are complex and varied: of the communities visited during this study, two had transitioned much of their land to corn over recent decades, while one community had placed limits on corn agriculture, and another had banned it entirely.

The changes in the material relations between Thai Karen communities and their environment have been echoed by other cultural changes. Karen people traditionally practiced an animistic religion involving the propitiation of deities, landscape spirits and ancestors (Rajah 1984; Yamamoto 1991; Paul 2018). Today however, the majority of Karen communities have been converted to Buddhism, while a smaller but significant number have been converted to Christianity (Hayami 1996). However, elements of the traditional cosmology have been incorporated into these new religions and continue to shape many agricultural rituals, healing practices, and beliefs that Karen people hold about elephants, themselves, and their landscape.

Asian elephants

A common ecological claim is that Asian elephants have a profound impact on the ecosystems they inhabit. Their voracious feeding and herd movements create patches of disturbance within the forest, which play an important role in promoting plant succession. As they feed, travel and defecate, they redistribute undigested seeds in convenient packages of fertilizer, thus promoting seed dispersal and nutrient cycling (Harich *et al*. 2016). Some of the Karen knowledge holders interviewed during this study believe that as elephant populations decrease in Thailand, the mountain forests are becoming denser and more impenetrable, because elephants are no longer present to control the rampant growth of their favourite food, bamboo.

However, the full picture may be more complex: elephants are edge species, and benefit from moderate human disturbance such as swidden agriculture, selective logging and episodic fire (Fernando & Leimgruber 2011). Only when ecological succession is prevented, such as by urbanization or the transition from shifting to permanent agriculture, do elephant populations disappear. As such, the ecological disturbance of elephants and traditional swidden cultivators like the Karen are actually linked rather than opposing forces. A 'natural' disturbance regime in the highlands of Southeast Asia might be best characterized as the product of an ancient landscape management relationship coevolved between humans and elephants.

Another level on which elephant and human lives are interwoven is the spiritual plane; elephants occupy an important spiritual role in nearly all south and southeast Asian cultures. In Buddhism, elephants are closely linked with the life of Buddha, from the dream of Queen Maya that a white elephant came to her the night she conceived the Buddha, to the subduing of Mara mounted on an elephant (Ramanathapillai 2009). In the Jataka tales, Buddha was reincarnated

as an elephant several times before his final, human birth (Wisumperuma 2012). In Thailand, monks once rode elephants to the temple on the way to their ordination ceremonies as a symbol of having tamed the wild nature of their mind (Denes 2006). Today elephants can still be seen built into the bases of stupas and protecting the four corners of the roof on Buddhist temples.

In Hinduism, the religious significance of elephants includes the traditions of Ganesh and Erawan (*Airavata* in Sanskrit). Ganesh, the son of Shiva, has the body of a man and the head of an elephant. As both the god of knowledge and the remover of obstacles, Ganesh is propitiated first at almost every Hindu ritual (Padhy 2008). Even in Buddhist Thailand, Ganesh has prominent shrines in major cities and is venerated in many Thai elephant camps (Harrington 2005). Ganesh's spiritual attributes are clearly linked to the intellectual and physical capabilities of elephants, which are sufficient to remove nearly any obstacle in their path. In many ways the half-human, half-elephant figure of Ganesh encapsulates the multispecies human-elephant culture that has coevolved over millennia of interdependence.

Erawan, a divine white elephant with three heads, is the mount of Indra, the Hindu king of heaven and god of rain and fertility (Harrington 2005). Associations between elephants and fertility continue today. Thai couples will sometimes take photographs standing beneath an elephant, whose fertility is believed to descend into them. The association between fertility, kingship and sacred white elephants led many monarchies of Southeast Asia to develop strong traditions connected to white elephants. White elephants occur naturally and are recognized by their lighter-coloured (although not completely white) skin and hair, as well as other features (Bujarbarua 1979). In Thailand, all white elephants have traditionally belonged to the king, and as sacred symbols of divine kingship, have been employed in ceremonies and rituals (Denes 2006). Many provinces in Thailand continue to hold annual fertility ceremonies centred around the participation of elephants in parades and feasts.

Methods

The material presented here is based on fieldwork conducted at four Sgaw Karen villages in northern Thailand in 2018–2019. The human inhabitants of the villages, located in Chiang Mai and Chiang Rai provinces, ranged from 30 to nearly 200 households per village, while the number of elephant residents ranged from three to more than 50. Villages were selected based on the historical and contemporary presence of human-elephant culture, as part of a research project focused on how humans and elephants exchange and co-produce medicinal knowledge used in elephant veterinary care (Greene *et al*. 2020; Lainé 2020). Efforts were made to select field sites, which varied in age, elevation, landscape setting and forest type.

Each of the four villages operates some form of elephant tourism, ranging from 'elephant camps' in two of the villages to a more experimental method in two other villages based on the principles of compassionate conservation. Many older mahouts in all four communities had previous experience working on human-elephant logging teams in Thailand, Laos or Myanmar. More than 40 current and former mahouts, elephant camp operators and elephant owners were interviewed, with a primary focus on veterinary medicine and elephant healthcare. Individual interviews were semi-structured, open-ended and conducted in Thai to English or Pakinyaw to English (the Sgaw Karen language) with the help of interpreters. Focus groups were also held with groups of mahouts, often at the site of the elephant camp or program, in order to learn more general knowledge about elephant practices. Detailed life histories of older mahouts were recorded to provide in-depth data about the long-term elephant-human connection, and how this connection has changed within recent generations. Participant observation at the elephant camp or program of each village was critical to understand the daily rhythms of elephant-human coexistence.

The beliefs, rituals and practices reported here emerged as supplemental information during early interviews and focus groups. Later this

emergent material became an additional focus of the research, and early findings were corroborated and expanded upon by additional knowledge holders. To provide context, a literature review was conducted on elephant-human cultural practices with an initial focus on the Karen. When almost no comparative material was located, the scope was broadened to Southeast Asia, then throughout the Asian elephant range, and finally to encompass Africa and the African elephant (*Loxodonta africana*) as well. Although there is a vast literature touching on many different aspects of the elephant-human relationship, very little material was located that focuses in detail on the daily rituals and beliefs of human-elephant coexistence presented here.

Results and discussion

Origins

The following elephant origin story was told in only one of the four study sites; knowledge holders in the other communities claimed not to know the origin story of elephants. As such, it is reported here only with the understanding that it may not be representative or in wide circulation:

Once, a long time ago, a man got married and moved in with his wife's family. His father-in-law said to him, "When you stay in this house while I am away, please do not open this box," and he showed him which box he should not open. When his father-in-law went out, the man thought to himself, "What is in that box?" Overcome by curiosity, he opened the box, and a white fly flew out and flew up into his nose. He sneezed and sneezed and as he did, his nose got longer and longer. It got so long that he could not stay in the house anymore, so he moved down to the ground floor, beneath the house, where the buffalos and pigs live. Then one day the elephant said to his father-in-law, "Make me a saddle so I can help you carry the rice from the fields." So the father-in-law made a saddle and the elephant helped carry the harvested rice, heavy logs and many other things. But the father-in-law made the elephant work very hard, much harder than he expected, and one day the elephant said, "Why are you making me work so hard?" So the father-in-law plucked out the tongue of the elephant and put it back in upside down. From this day on, the elephant could no longer speak.

This story (Fig. 1) provides context for the widespread equation of elephants with people in Karen rituals. Originally human, elephants lost their human body and descended to the level of animal habitation due to an uncontrollable, inordinate curiosity. Anyone who has spent time with elephants knows that they are particularly curious beings, intent on exploring their surroundings. Unlike in the classical Greek story of Pandora's Box, in this tale the negative effects of curiosity become internalized, affecting only the being who transgressed the taboo and their descendants rather than the world at large.

The story also provides a justification for elephant participation in physical labour, explaining that the elephant, seeking to maintain their connection to their human family, voluntarily offered their services to the agricultural workforce of the village. It is also made clear, however, that people have taken advantage of this generous gift and made the elephant work much harder than they intended or expected. In the end, it is the elephant's own human father who cements their status as something less than human by removing their last human attribute, the ability to speak.

Figure 1. Artist's interpretation of the Karen elephant origin story, by Gloria Treseder.

What is clear throughout the story, however, is the presence of elephant sentience and agency. The elephant is a principal actor in their own story rather than a passive recipient that is acted upon from the outside. In expressing the elephant's human origin as well as the tragedy of their fall, this tale readily encapsulates the complex interdependencies, and also the power imbalance, intrinsic to human-elephant culture today.

The Karen are not the only people to believe that the elephant was originally human. Although in Hindu traditions the elephant manifests directly, rather than first through a human form (Edgerton 1931), several origin tales about the African elephant are remarkably similar to the Karen account. A Maasai elephant origin story goes:

"Once upon a time there was a girl to be married. She was warned by her parents not to turn back as she walked to her husband's house. On the day of her wedding she set out to travel to her husband's house and on the way, she looked behind her and all of her decorative jewellery disappeared. She continued walking and again looked behind her and she turned into an elephant, with her veil as the trunk" (Kioko *et al*. 2015).

Here we find the same basic frame: the elephant was human, married into another human family, transgressed by breaking a taboo and as a result, lost their human body. A significant difference is that the elephant is female instead of male, but this is less a result of gender than of the different social structures of the peoples in question: the Maasai are patrilocal, while the Karen are matrilocal. So what is important is that in both stories the elephant is human, but an *outsider* in some way, who enters into the already-existing human family, which can perhaps be understood as the archetypal family of the Karen/Maasai. However the elephant in both cases breaks the social pact between the outsider and the insider (which is delineated and reinforced by taboos) and as a consequence, loses their human form.

One additional origin story, this one from the Nuer people of Sudan, reinforces these observations:

One of the original Nuer… was called Loh. Loh's wife gave birth to a monstrous girl-child with long teeth. She was named Nyalou. Her appetite was enormous and increased with the growth of her body, so that when she was still quite young, the food of man was insufficient to satisfy her hunger. Every day she would go into the forest and fill her belly with grass and the branches of trees, with roots and heglig nuts, and every day she grew larger and larger. At last she swelled to such proportions that she could no longer squeeze herself through the door of her home. She called her people together and said to them, "The time has come for me to leave you. I must go to the forest and live there, for there only can I find sufficient food to feed me." Then she took her sleeping skins and attached them to her ears and straightway they became part of her body. " I am now different to you, " she said, "and my descendants will live in the forest apart from mankind. Men will want to kill me because of my huge teeth and because my flesh is fat and sweet. You also my people will want to kill me and you may do so with impunity only if you obey my words: you shall never throw the first spear, and when I am dead you shall cut flesh from off my back and eat it raw." She went off to the forest with her child, and has remained there ever since (Howell 1945).

In this story the elephant is born within the existing Nuer family. Nonetheless she is 'monstrous' – marked as an outsider by her long teeth and her insatiable appetite. There is no transgression; rather Nyalou's separation from her birth family is seen as an inevitable result of her individual nature. However, just as in the Karen origin story, the elephant Nyalou is the active agent. It is she who purposefully gives up her bodily association with humanity by marking herself with huge ears (African elephant ears are larger and more prominent than those of Asian elephants). And it is she who offers herself to the people, just as in the Karen story, although here the utility she offers is meat and ivory rather than labour.

In all three stories, the separation of the elephant from their human kin is effected through the loss of a human body. In none of the stories, however,

is there any implication that the elephant has lost their human mind. In fact, in the Nuer and Karen stories the elephant's continuing to speak after losing their human semblance clearly implies that they continue to think like a person. This observation is key, because it explains why in all three cultures, a degree of personhood is still ascribed to elephants today. Nuer people, for instance, consider the killing of an elephant to be identical to the killing of a human, and the killer must undergo the same ritual purification to safeguard themselves from ill effects (Howell 1945). Among the Karen, elephants are symbolically equated to people through a variety of rituals performed at their birth, throughout their lives, and at their death. The exact status of elephants remains ambiguous, as all of these stories indicate. Are they human? No longer. Are they people? Possibly. Are they like other animals? No. In considering human-elephant culture, it is important to recognize this ambiguity as well as the possibility that rather than dealing with a multispecies culture constituted between humans and animals, we may in fact be dealing with a culture constituted from two different kinds of people (Lev & Barkai 2016).

Birth

One way elephant personhood is acknowledged is when an elephant is born, through a ceremony held on the same day of the birth. The ceremony is a variation of the *giju* ritual, which is the Karen form of a widespread soul-calling rite performed throughout northern Thailand and Laos (*soukhuan* in Lanna Thai; *baci* in Lao). The *giju* is premised on the Karen belief that a human body is composed of numerous *kla*, or souls (Paul 2018), associated with different body parts (37 is commonly reported, although the number varies). Some of these *kla*, not the highest one residing in the head, but those associated with lower body parts, can leave the body at will and travel in other realms. In particular they may leave the body during times of sickness, shock or excitement, or stay behind when a person takes a long journey. The *giju* ritual is performed during all kinds of liminal states such as sickness, birth, after long journeys, etc. in order to call the missing souls back to the body, thus returning the person's (or elephant's) full vitality and power (Rajadhon 1962).

During the ritual, offerings are made, prayers are sung, and chicken or pig sacrifices were once performed (although this has been discontinued in many, particularly Buddhist communities) to entice the *kla* back to the body. White cotton threads are tied around the wrists of the people (or the tusks or ears of elephants) to bind the souls back into the body. This ritual is essential to the social fabric of Karen communities (and many other peoples of Thailand and Laos (Rajadhon 1962; Chai 2006)), so it is particularly indicative that it is also performed for elephants. No other animal receives this kind of welcome at its birth. In celebrating a version of the *giju* for elephants, the elephants are tacitly being acknowledged as members of the community.

It is common to save the umbilical cord of a newborn elephant, which is dried and used in a ritualistic manner to promote fertility. When a woman is pregnant, if her mother or mother-in-law possesses some of this dried elephant umbilical cord, she can secretly prepare a dish of food with it and feed it to her daughter/daughter-in-law in such a way that the pregnant woman is unaware of what she is eating. If this is accomplished, the birth will be easy and safe, and the child will be healthy and strong. In this practice the association between elephants and fertility, as well as the function of Ganesh as the remover of obstacles, are combined. It also shows how intimate the link is between humans and elephants, as part of the mother/baby elephant's body literally comes to constitute the mother/baby human's body.

The umbilical cord is of particular significance to Karen people. When a child is born, the umbilical cord was traditionally cut with a ritual bamboo knife specifically made for this purpose. Then it was placed in a bamboo container and hung in a large, healthy tree, usually one which bears fruit or has beautiful flowers (Maniratanavongsiri 1999; Paul 2018). Through this act, a deep connection between the tree and individual was created. Karen people believe that when a person's *kla* become lost, particularly when they are still a

baby or very young, the *kla* will return to this tree due to the link with the umbilical cord. So whenever a child took ill, the parents would go to that child's tree and pray for the *kla* to return to their body (Omori *et al*. 1999). Because of the importance of these *pga dei pau*, or umbilical cord trees, it was forbidden to cut, peel the bark or harm them in any way (Maniratanavongsiri 1999; Paul 2018).

In light of this belief, the use of the elephant's umbilical cord is far from random. The link established between the newborn elephant and the unborn human child can be compared to the protective relationship between a newborn child and their tree. By ritually feeding the elephant's umbilical cord to an unborn child's mother, a link is created that places the elephant firmly within the human family, and protected by its members. Indeed, elephants are considered members of the family in Karen villages (Schliesinger 2010). It is particularly interesting that although the hanging of umbilical cords in *pga dei pau* is no longer practiced in many villages, the use of the elephant umbilical cord is still widespread. This could be an indication that the deep link between elephants and Sgaw Karen people is even stronger and more resilient than the embeddedness of Karen people within their traditional sacred landscape.

The last practice relating to baby elephants is the naming ceremony. Traditionally, an elder or spiritual leader would choose three beautiful, powerful or auspicious names and write each name on a separate piece of sugarcane. After placing the three pieces on the ground in a row, the baby elephant would be led up to the line of sugarcanes. The name written on whichever piece the baby first picked up would become their name. This ritual is remarkable in that it instantiates the elephant's agency by allowing them to participate in the process of attaining status and individuality within the community, even to a greater extent than that allowed to human children (who do not choose their own names). This naming ritual continues to be practiced in two of the villages, and its use has responded dynamically to changing circumstances. In one village, which is now Christian, the local pastor is the one who chooses the names rather than the traditional animistic spiritual leader. This demonstrates once again that the elephant-human multispecies culture is dynamic and persistent in the face of significant cultural transformations.

Training

Baby elephants are left in the care of their mother for at least the first three years of their life. They follow their mother everywhere, often in close bodily contact, as they begin to supplement milk with forage and slowly learn the ways of their world. Karen people take care not to hinder this process of natural rearing; their interactions with baby elephants in these first years are restricted to playful exchanges and expressing affection physically, verbally and through the gift of treats like bananas and sugarcane. When elephants are between 3–5 years old, they begin to develop greater independence; in free-roaming populations, young males will eventually leave the maternal herd entirely. It is at this point that the process of elephant training occurs.

Elephant training is perhaps the most contentious issue between traditional elephant peoples and outsiders such as international tourists who have limited knowledge about elephant traditions. Numerous allegations of cruelty and abuse during elephant training have been levelled at elephant-keeping cultures, particularly by animal-rights groups like PETA (Laohachaiboon 2010). Alternately, others claim that these charges are inflated, inaccurate, or sometimes even falsified. Undoubtedly, there are many different techniques for training young elephants, ranging from unnecessarily cruel to painstakingly gentle. Here I discuss contemporary Karen elephant training methods in the communities where we worked, while acknowledging that it is difficult to obtain detailed information about this issue from many knowledge holders. The heated international debate around elephant training has made many mahouts fearful of allegations of cruelty and thus wary of sharing information freely.

Among the Karen, elephant training is the most critical period in the entire life of the elephant, as it will define the relationship between that individual and its human caretakers. As such,

it is undertaken with extreme care. Only a few individuals with a specific spiritual capacity are considered authorized to initiate the training process, and this capacity is often inherited along family lines (Schliesinger 2010; Lainé 2017a). In one village there was only a single community member with this capacity, and although he no longer dwelled in his natal village, he would travel back to perform the necessary rituals when any of the community's elephants were ready to be trained.

The basic process involves separating the baby elephant from its mother. To facilitate this, a wooden corral is constructed in the forest. The person overseeing the process constructs a small altar beside the corral and makes offerings and prayers to the elephant's guardian spirits, the local landscape spirits and the ancestor spirits of those involved to assist the training process. Then the young elephant is placed in the corral and the mother is led away.

In the absence of their mother, the young elephant is now able to begin forming emotional bonds with the humans who will care for them throughout their life. This is a difficult process, fraught with stress and anxiety for both the elephant and the humans. It may be several days before the young elephant develops enough trust to accept food from human hands. During this period the mahouts and the elephant trainer stay close to the elephant continuously, to familiarize the elephant with them and allow trust to begin to grow. In Lainé's (2016) analysis of the training ritual among the Khamti, he found that they use chants and songs during this process, such as "Stop! Leave your jungle heart and adopt man heart. Learn the words from man, listen to them."

Indeed, learning to respond to the human voice is critical to the training process. Once the elephants allow themselves to be fed and begin to trust their human caretakers, they are released from the corral and taught the basic elephant commands, such as 'stop', 'go', 'sit', 'stand', 'left', 'right', etc. The young elephant is slowly integrated back into the rest of the human-elephant community after having undergone this difficult rite of passage (Locke 2016) and begun the forging of an emotional bond with the mahouts who have trained them.

Working with humans

As the elephant origin story indicates, shared work is at the core of the relationship between Karen people and elephants. For centuries, before industrialization largely minimized their utility, elephants were indispensable for certain tasks, particularly the transportation of extremely heavy objects like hardwood logs. Lainé (2017b) has argued that among the Khamti people of northeast India, shared work between elephants and humans is what creates, sustains and in fact constitutes the complex of emotional, psychological, physical and economic bonds that tie the two species together. His observations of human-elephant labour teams indicate that elephants participate directly in the work, understanding their tasks and showing initiative and sometimes ingenuity in accomplishing them. The situation is very much the same for the traditional connection between Karen people and elephants. In Thailand today, the tides of culture and policy have turned against this form of interspecies work, and elephants rarely take part in any kind of useful practical labour. However, human-elephant labour is still common in Myanmar, parts of Laos and other areas.

Historically, the main work done by elephants involved agricultural labour and occasional selective logging for the construction of new houses in the village (Schliesinger 2010). This work was fairly limited and episodic, and during other times the elephants might remain in the village or be released into the forest. However, this changed during the colonial era, when European nations initiated extensive logging operations throughout their Asian colonial states. Thailand is one of only a handful of countries in the world that avoided colonization, although it came under intensive pressure from the U.K. to the west (from its colony Burma) and France to the east (from its colony Indochina).

One of the ways Thailand avoided being colonized was through a clever diplomatic process of offering, in a series of generous treaties with

colonial powers, exactly the resources that those powers wished to extract (Pupphavesa 2002). This resulted in the near wholesale logging of Thailand's teak and hardwood forests, which was implemented throughout the 19th and 20th centuries by human-elephant logging teams. The Karen, known for their elephant skills and knowledge, were recruited en masse to participate in the logging industry, not only in Thailand but also in Myanmar (Bryant 1997; Schliesinger 2010). This extractive process continued until nearly every corner of Thailand had been logged, at which point the Thai government implemented a ban on commercial logging in 1989 (Godfrey & Kongmuang 2009).

Without the opportunity to work in logging, nearly the entire population of village elephants in Thailand has been slowly transitioned into a new economic activity: elephant tourism. This history is clearly evident in the Karen villages visited during this study. Among the younger generation of Karen mahouts, aged 40 or younger, the only way of working with elephants that they know is through elephant tourism. Each of the four villages has initiated different forms, two starting traditional 'elephant camps', while the other two have partnered with foreign NGOs to develop alternative elephant tourism models.

The older generation of Karen mahouts, in their 50s–80s, universally participated in the logging industry, and this is the primary means by which their elephant knowledge and skills were developed. In the logging era, human-elephant teams would normally leave their home village for 3–6 months each year during the dry and winter seasons. They would often travel great distances to other parts of Thailand, or to Laos or Myanmar, to find employment. During these periods the elephant-human teams were completely dependent on each other, immersed in a world of constant multispecies companionship and labour. It is likely through the interdependence engendered by the logging world that the intensity of Karen-elephant multispecies culture was most deeply articulated and affirmed (Fig. 2).

Figure 2. A Karen mahout resting beside his elephant.

Upon the end of the logging season and the return to the village, elephants would be let loose into the surrounding forests, where their mahouts would check on them once or several times a week (Schliesinger 2010). As during other times of transition during an elephant's life, it was typical to hold a ceremony during this seasonal release. After the elephant walked into the forest, a small bowl with offerings of salt, chilli and rice would be placed on the footprint of the departing elephant, and prayers would be offered that the elephant would stay safe and away from people, neither hurting them nor disturbing their homes or crops. This ritual shows that despite the intensity of forced labour in the logging industry and the imbalance of power between humans and elephants needed to sustain that labour, elephants were still recognized as maintaining a degree of agency. They were respected as beings able to disrupt the lives of humans outside of the carefully curated boundaries of the multispecies relationship, and were not only given space within which to manifest their own lives, but trusted in the belief that they would use that space responsibly.

In today's world, where forests are fast disappearing in the Thai highlands and violent human-elephant conflict is all too common in other parts of Asia, this practice seems remarkable. Although it has largely been discontinued due to the changing nature of elephant-human politics and culture, it is still standard to bring elephants to the forest at night, usually restrained by a 20–30 m chain. This chain is long enough to allow them sufficient forage during the night,

and although elephants can break a chain of this length in anger or fear, they are unlikely to do so under ordinary circumstances. In only one study village is there still sufficient forest (the same village that has banned corn agriculture) to allow elephants to be left unchained and unattended for days at a time.

The *giju* ceremony performed at the birth of an elephant is also held for elephants throughout their lives (Lainé 2017a). During the logging era this would usually be done at the end of the dry season when the elephant-human teams would return home from the logging camps. Some villages celebrate this ritual on a family basis, with each family holding an elephant *giju* annually or every 2–3 years. Other communities hold an annual festival, which combines community-wide celebrations with family elephant *gijus*. Traditionally, a pig would be raised specifically to be sacrificed during the ritual, although in some communities this is being discontinued due to the influence of Buddhist teachings of non-harm. Food, rice wine, flowers, candles, certain plants and other objects are arranged in elaborate banana-leaf structures in a ritual altar. The *giju* leader, usually the family head, offers these objects to the spirits and makes prayers which apologize to the *kla* of the elephants for forcing them to work, thanks them for working and asks the spirits to help more elephants to be born. Cotton threads are tied around the elephants' ears and the wrists of the human participants, and then the elephants and people are fed. This ritual, which is not performed for any other animal, recognizes and re-enacts the unique bond between humans and elephants.

Protection

The release ritual is only one element of a complex set of practices and beliefs Karen people have developed in order to ensure their protection within the elephant-human relationship. With their enormous size and strength, elephants can easily squash a human companion with an unexpected movement or in a burst of anger. During musth, an annual period of elevated testosterone levels, adult male elephants become notoriously savage and violent and can attack humans as well as other elephants. Musth elephants are not safe to be around under any circumstances, and in all the various forms of human-elephant coexistence – villages, logging, elephant camps – they are always separated from people until the musth period has passed.

The respect that Karen people feel toward elephants and the care they take in working with them is partly in response to the ever-present danger of living and working in intimate contact with such powerful beings. Traditionally, a variety of spiritual objects were believed to confer protection from elephants on their human owners. A special kind of stone is said to grant protection from musth elephants as well as other dangerous animals. Similarly, some Karen people believe that if they put one female and one male of a certain kind of a farm snail (*klu tho*) in their pocket, this will both protect the bearer from elephants and lend him a certain degree of authority, making the elephant obey his directions more readily. It was also recounted that in the past, there were some people who possessed powerful *khatha* (Pali mantras or spells) that could be said over a piece of limestone and then fed to an elephant to exert power over them.

On the other hand, the power of elephants is also leveraged by Karen people to provide protection from strong or malevolent ghosts and spirits. Elephants themselves also possess *khatha*, and they have stronger *khatha* than the few other highly respected animals that are known to possess them. Tusks are particularly valued for protection, so they are often saved after an elephant passes away. Rings can be carved out of the tusk and worn for protection, or a miniature tusk can be carved out of the ivory and worn around the neck for the same purpose. If malevolent spirits have possessed someone and made them sick or crazy, tusks can be used as a tool in exorcism by pointing them at the person's body in a threatening manner while demanding that the spirit abandon the possessed (a practice also reported to me previously by Akha knowledge holders). If hairs fall from the tuft at the end of an elephant's tail (they must not be plucked) and these are collected, they can be woven into a ring, which is worn on the finger

(Fig. 3). This elephant-hair ring, which is also used in Myanmar (Shepherd 2002), conveys protection when travelling in areas with strong local spirits.

All of these latter beliefs relate to the Karen understanding that just as the human body is inhabited by *kla*, the local landscape is also inhabited by a host of spiritual beings, of differing levels of power and inclinations in relation to humans (Paul 2018). Some of these spirits actively assist people, and their dwellings – caves, springs or mountains – often become sacred natural sites that are visited and venerated for specific purposes. Other spirits, often those which are particularly powerful, can meddle in human affairs and even maliciously attack, causing some of a person's *kla* to flee their body, leaving the person listless, emotionally drained, sick or confused.

Wearing the ivory or elephant-skin rings or necklaces catalyzes the spiritual power of the elephant, in the capacity of Ganesh the remover of obstacles, to protect the bearer from any kind of spiritual harm. These beliefs indicate the degree of respect Karen people hold for elephants, which have spiritual capacities different from, and in some respects superior to those of humans. These practices also show that in considering multispecies culture, we must recognize the spiritual as well as the material level of entanglement between humans and elephants.

Death

Karen people say that when an elephant knows they are going to die, they will go alone into the forest. Today, of course, when most elephants are unable to go to the forest at will, elephants do sometimes pass away in the village. After an elephant's death, a funeral ceremony is held. This ceremony is always performed for elephants and humans and generally not for any other animal, although occasionally it is done for a very old and respected water buffalo. Candles are lit, offerings are made, and the ritual leader prays that the elephant's spirit will undertake a smooth journey to its destination, not remaining behind to bother people. This ritual has the same purpose as the human funeral, to help guide the elephant's *kla* successfully to the next world (the original world; the word for death in Pakinyaw is 'return').

Figure 3. A protective ring woven of blond elephant tail hairs.

After this ritual is concluded and the elephant's *kla* have departed, people harvest the tusks and then dig a massive grave in the forest and bury the elephant. The only part of the body which should not be touched after death is the single 'finger' at the end of the trunk, which is believed to have particularly strong *kla* residing in it which could drive away the *kla* of any human who touches it. For Karen people, as elsewhere in Thailand, under no circumstance are elephants eaten. The only parts of their bodies that are utilized are the tusks and the hair from the tip of the tail.

Conclusion

The growth of multispecies ethnography has led to a reappraisal of the human as anthropological subject. If anthropology is founded on the person as a single unit of being and meaning, an *in*dividual, how do we account for our bodies being ecosystems teeming with life, our minds populated with non-human beings, and our emotional bonds being sometimes stronger with dogs, cats, horses and elephants than with other humans? Lestel *et al*. (2006) have argued that a recognition of our shared life with non-human beings necessitates combining the studies of human and animal behaviour into a new field of eth(n)ology. Elephants are more than the companion species of humans (Lorimer 2010),

with whom we have ambivalent intimacies (Münster 2016) and affective encounters (Locke 2017). These are accurate ways of speaking about human-elephant relations, but they do not go far enough in recognizing the depth of human-elephant coexistence. In relation to the Karen, I argue that there is evidence of a long-standing multispecies culture in which humans and elephants are both defining agents, shaping each other's lives on spiritual, emotional and material planes.

In the Karen elephant origin story and the rituals performed throughout an elephant's life, elephants are equated to people – not exactly human people, but beings who once were human, and still have more human qualities than other animals. There is no illusion of equality in this relationship; humans are the dominant party, and it is they who maintain the continuing captivity of elephants. But elephants also play a part in shaping the relationship: the lives of Karen people, at least in the villages in which this study took place, are significantly determined by elephants, spatially, financially, emotionally and spiritually. Elephants are appealed to for protection against the unpredictability of local spirits, and spiritual forces in turn are appealed to for protection against elephants' own agentive powers of destruction. In every interaction between a mahout and an elephant, a subtle level of negotiation is present whereby both beings assert their will, recognize the will of the other, and arrive at a compromise of action. Too large, strong and powerful to be entirely dominated, elephants are granted a degree of determinative power in the human-elephant relationship, which is recognized in the ritual of release once performed at the end of the logging season, in the naming ceremony, and in the rituals of protection.

Mahout lives are shaped by their relationships with elephants, who may at any moment play the role of companion, captive, partner, child, or enemy, and often rotate between these roles. In negotiating the ambiguity of their position, mahouts call upon spiritual forces and use cultural rituals to define and reinforce the nature of their multispecies relationship. But elephants are also participants in these rituals, and their participation influences the possibilities of the human members of their community. Lederach (2017) has argued that "The *Campesino* was born for the *Campo*", and in the same way, the *caballo* makes the *caballero*, the cow makes the cowboy, and the elephant makes the mahout. In a human culture where most men are mahouts, the study of culture must enlarge its scope to embrace the multispecies nature of its subject.

The genderedness of this multispecies culture is important; with Karen people, as with most Asian elephant cultures, mahoutship is a masculine domain, inaccessible to the direct involvement of women (Sadashige 2015). Yet although Karen women may not ride on, command or physically work with elephants, they participate in most of the rituals of the human-elephant family. In their use of the elephant umbilical cord, women physically affirm the relationship of protection between themselves, their children and elephants. On another level, the rotational farming of Karen people, which is a female domain (Trakansuphakorn 2008), is also linked to elephants, who are partners in the culturally co-evolved process of landscape management.

However, the human-elephant landscape is not only a setting for culture, or the result of the practice of that culture. It is itself embodied, a living matrix populated with a variety of material and immaterial beings (Paul 2018). Karen people say that elephants in some regions are angrier and more aggressive, and in other areas more docile, because of the influence of the spirits that dwell in those regions. In the same way that spirits populate and influence the landscape, the *kla* animating human and elephant bodies provide many of the capacities and tendencies ascribed to individuals. These *kla* have the qualities of different animals, so a person's inner nature is understood to be a composite of human and animal qualities provided by the unique set of *kla* they possess. A mahout may be a man, but his stealth is the product of a tiger *kla*, his urge to travel due to the *kla* of migratory birds, and his strength and wisdom to the presence of elephant *kla*. Calling upon the capacities of different *kla* is one way of negotiating with the forces that shape a person's life.

In this way, human-elephant culture is not only constituted by two 'species' in the Darwinian sense. The multispecies culture of elephants and the Karen extends both within and without to embrace the spiritscape, the whole complex of consciousness within which people live. It is a composite culture, and cannot be separated from the lifeways through which it flows. Elephants, humans and spirits are caught up in an act of becoming, dynamically inhabiting each other's bodies and minds. The stories, rituals and practices of elephants and the Karen people are not only evidence of a multispecies culture, they are the means by which this culture is negotiated and enacted in the face of unpredictable spiritual and material forces.

References

Barkai R (2019) When elephants roamed Asia: The significance of proboscideans in diet, culture and cosmology in paleolithic Asia. In: *Animals and Human Society in Asia: Historical, Cultural and Ethical Perspectives*. Kowner R, Bar-Oz G, Biran M, Shahar M & Shelach-lavi G (eds) Palgrave Macmillan, Cham. pp 33-62.

Bartholomew TT, Gundel BE & Kantamneni N (2015) A dream best forgotten. *The Counseling Psychologist* **43:** 1114-1134.

Bryant R (1997) Kawthoolei and teak: Karen forest management on the Thai-Burmese border. *Watershed* **3:** 1-6.

Buergin R (2002) Change and identity in Pwo Karen communities in Thung Yai Naresuan Wildlife Sanctuary, a "global heritage" in western Thailand. In: *SEFUT Working Paper No. 11*. Buergin R, Krings T, Oesten G & Seitz S (eds) Albert-Ludwigs-Universität Freiburg, Freiburg.

Bujarbarua DD (1979) *Elephant Lore in Sanskrit Literature*. Ph.D. thesis, University of Gauhati.

Chai E (2006) *Of Soukhuan and Laos*. Working Paper Series No. 3, University Malaysia Sarawak.

Clarence-Smith WG (2019) Elephants in Mongol history: From military obstacles to symbols of Buddhist power. In: *Animals and Human Society in Asia*. Kowner R, Bar-Oz G, Biran M, Shahar M & Shelach-lavi G (eds) Palgrave Macmillan, Cham. pp 241-266.

Denes A (2006) *Elephants in Southeast Asia*. Presentation at the Freeman Workshop.

Edgerton F (1931) *The Elephant-Lore of the Hindus: The Elephant-Sport (Matanga-lila) of Nilakantha*. Yale University Press, London.

Fernando P (2000) Elephants in Sri Lanka: Past, present, and future. *Loris* **22(2):** 38-44.

Fernando P & Leimgruber P (2011) Asian elephants and seasonally dry forests. In: *The Ecology and Conservation of Seasonally Dry Forests in Asia*. McShea WJ, Davies SJ, Phumpakphan N & Pattanavibool A (eds) Smithsonian Institution Scholarly Press. pp 151-163.

Fukushima M, Kanzaki M, Thein HM & Minn Y (2007) Recovery process of fallow vegetation in the traditional Karen swidden cultivation system in the Bago Mountain Range, Myanmar. *Southeast Asian Studies* **45:** 317-333.

Giles FH (1929) Adversaria of elephant hunting. *Journal of the Siam Society* **23(2):** 61-96.

Godfrey A & Kongmuang C (2009) Distribution, demography and basic husbandry of the Asian elephant in the tourism industry in northern Thailand. *Gajah* **30:** 13-18.

Gravers M (2001) Cosmology, prophets and rebellion among the Buddhist Karen in Burma and Thailand. *Moussons* **4:** 3-31.

Greene AM, Panyadee P, Inta A & Huffman MA (2020) Asian elephant self-medication as a source of ethnoveterinary knowledge among Karen mahouts in northern Thailand. *Journal of Ethnopharmacology* **259:** e112823.

Harich FK, Treydte AC, Ogutu JO, Roberts JE, Savini C, Bauer JM & Savini T (2016) Seed dispersal potential of Asian elephants. *Acta Oecologica* **77:** 144-151.

Harrington J (2005) "If you have an elephant, you do not want to walk on the ground": The Thai elephant as a nexus between culture and nature. *Historic Environment* **19:** 18-24.

Hayami Y (1996) Karen tradition according to Christ or Buddha: The implications of multiple reinterpretations for a minority ethnic group in Thailand. *J. Southeast Asian Studies* **27:** 334-49.

Howell PP (1945) A note on elephants and elephant hunting among the Nuer. *Sudan Notes and Records* **26:** 95-103.

Ingold T (2013) Anthropology beyond humanity. *Suomen Antropologi: Journal of the Finnish Anthropological Society* **38(3):** 5-23.

Isager L & Ivarsson S (2002) Contesting landscapes in Thailand: Tree ordination as counter-territorialization. *Crit. Asian Stud.* **34:** 395-417.

Kamiński T, Arnez M, Middleton C, Beckenham S, Farnan RA, Chu D, Roszko E, Thitibordin A, Valente A & Zaręba M (2019) *Contested Knowledges of the Commons in Southeast Asia*. State of the Art & Theoretical Framework Working Paper Nº 1, CRISEA.

Kioko J, Kiffner C, Ndibalema V, Hartnett E & Seefeld C (2015) Maasai people and elephants: Values and perceptions. *Indian Journal of Traditional Knowledge* **14:** 13–19.

Kirksey SE & Helmreich S (2010) The emergence of multispecies ethnography. *Cultural Anthropology* **25:** 545-576.

Lainé N (2016) Voice, sound, melody: Music as a training tool and a way to interact with elephants in Northeast India. In: *SOAS Elephant Conference*. pp 1-14.

Lainé N (2017a) Bo mee xang pa kor bo mee xang (sans éléphants de forêt, il n'y a plus d'éléphants). *Peninsule* **75:** 73-99.

Lainé N (2017b) Travail interespeces et conservation. Le cas des éléphants d'Asie. *Ecologie & Politique* **54:** 45-64.

Lainé N (2018) Why did the Khamti not domesticate their elephants? Building a hybrid sociality with tamed elephants. In: *Hybrid Communities: Biosocial Approaches to Domestication and Other Trans-Species Relationships*. Stépanoff C & Vigne J-D (eds) Routledge, New York. pp 221-235.

Lainé N (2020) Pratiques ethno-vétérinaires sur les éléphants au Laos: Un savoir co-construit avec les animaux? *Rev. d'Ethnoecologie* **17:** 1-19.

Laohachaiboon S (2010) Conservation for whom? Elephant conservation and elephant conservationists in Thailand. *Southeast Asian Studies* **48:** 74-95.

Lederach AJ (2017) "The *campesino* was born for the *campo*": A multispecies approach to territorial peace in Colombia. *American Anthropologist* **119:** 589-602.

Lestel D, Brunois F & Gaunet F (2006) Towards an etho-ethnology and an ethno-ethology. *Social Sciences Information* **45:** 155-177.

Lev M & Barkai R (2016) Elephants are people, people are elephants: Human-proboscideans similarities as a case for cross cultural animal humanization in recent and Paleolithic times. *Quaternary International* **406:** 239-245.

Lobban RA & de Liedekerke V (2000) Elephants in ancient Egypt and Nubia. *Anthrozoös* **13:** 232-244.

Locke P (2013) Explorations in ethno-elephantology: Social, historical, and ecological intersections between Asian elephants and humans. *Environment and Society* **4:** 79-97.

Locke P (2014) The anomalous elephant: Terminological dilemmas and the incalcitrant domestication debate. *Gajah* **41:** 12-19.

Locke P (2016) Elephant training in Nepal: Rites of passage in an interspecies community. In: *SOAS Elephant Conference*. pp 1-5.

Locke P (2017) Elephants as persons, affective

apprenticeship, and fieldwork with nonhuman informants in Nepal. *HAU: Journal of Ethnographic Theory* **7:** 353-376.

Lorimer J (2010) Elephants as companion species: The lively biogeographies of Asian elephant conservation in Sri Lanka. *Trans. of the Institute of British Geographers* **35(4):** 1-16.

Machovina B, Feeley KJ & Ripple WJ (2015) Biodiversity conservation: The key is reducing meat consumption. *Science of the Total Environment* **536:** 419-431.

Maniratanavongsiri C (1999) *People and Protected Areas: Impact and Resistance Among the Pgak'nyau (Karen) in Thailand*. Ph.D. thesis, University of Toronto, Canada.

Münster U (2016) Working for the forest: The ambivalent intimacies of human-elephant collaboration in south Indian wildlife conservation. *Ethnos* **81:** 425-447.

Omori K, Greksa LP, Chomngandu P, Noimoung S & Sila S (1999) Morbidity and mortality patterns, health beliefs, and health risk factors of Karen highlanders of northwest Thailand. *Southeast Asian Journal of Tropical Medicine and Public Health* **30:** 789-803.

Padhy S (2008) Ethnobiological analysis from myth to science, XI: *Pancha Yajnya* (five sacrifices) - The philosophy of *Tantra* and religious ecology of India. *Journal of Human Ecology* **23:** 339-344.

Paul A (2018) *'With the Salween Peace Park, We Can Survive as a Nation': Karen Environmental Relations and the Politics of an Indigenous Conservation Initiative*. M.Sc. thesis, York University, Canada.

Pupphavesa W (2002) *Globalization and Social Development in Thailand*. CAS Discussion Paper No 39, Centre for ASEAN Studies.

Rajadhon PA (1962) The Khwan and its ceremonies. *Journal of the Siam Society* **50:** 119-164.

Rajah A (1984) 'Au' Ma Xae: Domestic ritual and the ideology of kinship among the Sgaw Karen of Palokhi, Northern Thailand. *Mankind* **14:** 348-356.

Ramanathapillai R (2009) A forest ride on wild elephants: The philosophy of wilderness in Buddhism. *Gajah* **30:** 29-33.

Sadashige J (2015) The mother of elephants: "Lek" Chailert, Elephant Nature Park, and the gendering of elephant husbandry. *Gender Forum* **55:** 83-106.

Santasombat Y (2004). Karen cultural capital and the political economy of symbolic power. *Asian Ethnicity* **5:** 105-120.

Schliesinger J (2010) Elephants and the Karen people. In: *Elephants in Thailand, Volume 1: Mahouts and their Culture Today*. White Lotus Press, Bangkok. pp 70-76.

Shepherd CR (2002) *The Trade of Elephants and Elephant Products in Myanmar*. TRAFFIC International, Cambridge.

Singh SD (1963) The elephant and the Aryans. *Journal of the Royal Asiatic Society* **95:** 1-6.

Somvanshi R (2006) Veterinary medicine and animal keeping in ancient India. *Asian Agri-History* **10:** 133-146.

Stephen A (2004) *Elephas maximus: A Portrait of the Indian Elephant*. Penguin, New Delhi, India.

Trakansuphakorn P (2008) Space of resistance and place of local knowledge in Karen ecological movement of northern Thailand: The case of Pgaz K'Nyau villages in Mae Lan Kham River Basin. *Southeast Asian Studies* **45:** 586-614.

Wisumperuma D (2012) Religious use of elephants in ancient Sri Lanka. *Gajah* **37:** 16-21.

Yamamoto K (1991) Religion and religious change in a hill Karen community of northwestern Chiang Mai Province. *Journal of the Siam Society* **79:** 124-137.

Peer-Reviewed Research Article *Gajah 53 (2021) 20-29*

Posture Abnormalities as Indicators of Musculoskeletal Disorders in 12 Zoo Elephants – a Visual Guide

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Abstract. Musculoskeletal disorders represent one of the many challenges in elephant care. In contrast to other species, elephants rarely express distinct lameness despite severe lesions. Therefore, alterations in their posture and weight distribution while standing seem to be easier to recognize. To raise the practitioners' awareness of these changes and facilitate the earliest possible recognition, a visual guide was compiled. Pictorial documents were collected by the author while visiting 70 elephant-keeping facilities across Europe. The resulting guide provides a description of the healthy baseline state and a series of common alterations. Awareness for corresponding visual cues will further improve monitoring of musculoskeletal disorders in elephants under human care.

Introduction

Musculoskeletal disorders represent a frequent health concern in elephants under human care (Mikota *et al*. 1994; Miller *et al*. 2016; Regnault *et al*. 2017; Bansiddhi *et al*. 2019; Edwards *et al*. 2019; Wendler *et al*. 2019). Apart from lesions in the structures of the elephant's foot, degenerative joint disease and presumably correlated conformational abnormalities have been reported in zoo elephants (Luikart & Stover 2005; Kaulfers *et al*. 2010; Johnson *et al*. 2018).

Degenerative joint disease is a progressive joint disease characterized by breakdown of cartilage and alterations of the underlying bone. Apart from clinical examination, radiography presents a practicable diagnostic tool in adult elephants for the foot and the carpal respectively tarsal joint (Hittmair & Vielgrader 2000). More proximal joints are difficult to investigate radiographically due to the thickness of the surrounding tissue (Hittmair & Vielgrader 2000; Kaulfers *et al*. 2010). Thermography has been shown helpful to diagnose inflammatory joint conditions, although further research is needed to validate this approach (Schmidt-Burbach 2009; Miller *et al*. 2016). Degenerative joint disease is supposed to occur more frequently under the circumstances of captivity compared to free-ranging elephants, although the underlying causes have not been fully investigated so far. Management and environmental factors such as substrate, enclosure size, activity level, stereotypic behaviour and overweight have been considered and at least partially confirmed to impact foot and joint health in captive elephants (Haspeslagh *et al*. 2013; Miller *et al*. 2016; Edwards *et al*. 2019; Wendler *et al*. 2020). Therefore, foot and musculoskeletal disorders present a relevant health concern in elephants living in human care. To address corresponding management aspects and improve them subsequently is critical to assure captive elephant welfare (Poole & Granli 2008; Meehan *et al*. 2019).

Although lameness is considered the most important clinical sign of musculoskeletal disorders in other species, elephants have been shown to rarely express distinct lameness patterns (Fowler & Mikota 2006; Lewis *et al*. 2010). This might even be the case in severe lesions (Lewis *et al*. 2010). Nevertheless, lameness is still postulated as the most important clinical sign associated with foot and joint diseases in elephants (Fowler & Mikota 2006). It is up to speculation whether elephants do really not express obvious lameness, or the keepers and veterinarians are not sufficiently skilled to recognize it. With respect to the painfulness of musculoskeletal disorders, the determination and monitoring of more subtle indicators compared to lameness

would be extremely helpful in the medical management and care of elephants. The latter might be of peculiar relevance in circumstances where diagnostics such as radiographic imaging or thermography are not available.

Material and methods

In the course of another population-wide research project (Schiffmann *et al*. 2018a, 2019), 70 elephant-keeping facilities across Europe were visited from 2016–2019. While visiting these institutions, pictorial documents were collected opportunistically. Where available, information regarding musculoskeletal disorders of individual elephants was recorded in parallel in a non-standardized manner. In order to complete these datasets, necropsy reports and published necropsy data of deceased elephants were collected as well if accessible. Collected pictures were analyzed regarding common posture patterns and potential visual indicators for musculoskeletal disorders. Based on these data a visual guide facilitating the assessment and monitoring of affected elephants was compiled.

Results

Data collection led to pictorial data of 12 individual elephants with confirmed musculoskeletal and/or foot disorders according to pre-mortem (all individuals) and/or post-mortem (available in 7 individuals) findings. This sample contains 3 female African elephant (*Loxodonta africana*) and 9 (2 male and 7 female) Asian elephants (*Elephas maximus*) living in zoological institutions across Europe. They ranged in age from 35 to 60 years. At the time of this report, only two of these elephants, namely one male and one female Asian elephant, were still alive.

The photographs showed recognizable alterations in weight distribution of varying severity compared to a normal standing posture (Figs. 1 & 2). It was observed that this weight shifting occurred in a lateral (Fig. 1) as well as in a frontal perspective (Fig. 2). An equivalent of this relieving behaviour could be recorded in elephants that repeatedly expressed specific postures of relief (Figs. 3 & 4), or even intermittently kept one leg lifted completely from the ground for a considerable amount of time (Fig. 5). Furthermore, obvious joint deformities of varying configuration were recorded (Fig. 6). Interestingly, exclusively the carpal joint was affected by severe deformities. This corresponded with information from post-mortem reports, where these joints were most often mentioned to show signs of degenerative joint disease (unpublished data). A less obvious but impressive indicator of musculoskeletal alterations was present in terms of secondary traces on the skin of one elephant (Fig. 7).

Figure 1. (a) Normal standing posture from a lateral view in a male Asian elephant. **(b-f)** Stages of increasingly shifting weight to the hind legs in order to relief the affected front limbs. Note that photographs represent animals that are standing, not animals in movement.

Figure 2. **(a)** Normal standing posture from a frontal view. **(b, c)** Relief of the right front leg by placing it laterally and shifting body weight to the left side in order to relief the right front leg in two female African elephants. Note: In both affected elephants shown here moderate to severe degenerative joint disease in the carpal joint of their right front leg has been confirmed post-mortem.

Figure 3. Specific postures of relief in an individual African elephant suffering from degenerative joint disease in the carpal joints. Note: Although the affected foot is consistently placed in a similar position, the elephant makes use of various environmental structures to do so.

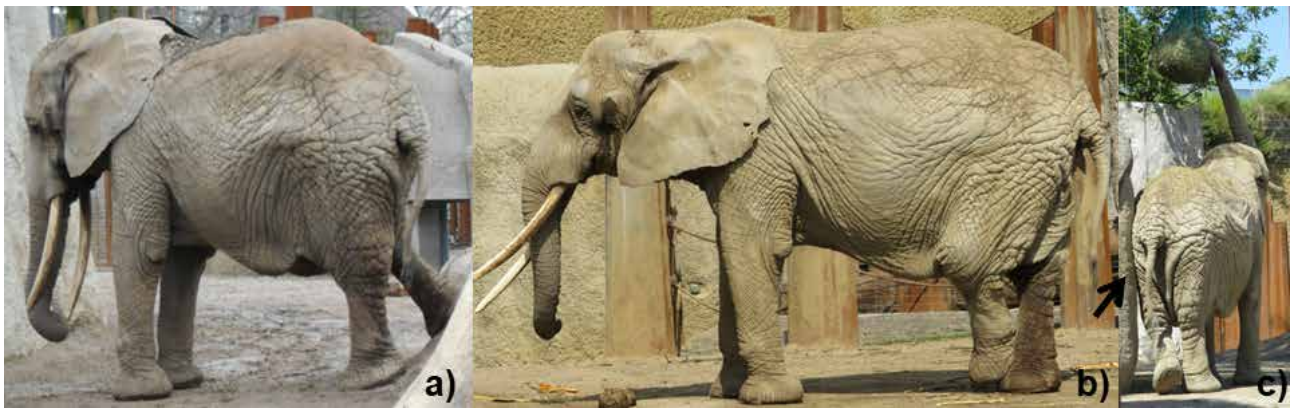

Figure 4. Temporary relief of a back leg by **(a)** placing it on a rock, **(b)** crossing it with the weight-bearing leg, and **(c)** by leaning with the hip/pelvic bone against a wall (note the arrow).

Figure 5. Geriatric female and male Asian elephants intermittently keeping one front foot in a lifted position while eating. In order to maximally relieve this extremity, both elephants repeatedly keep it from the ground for variable amounts of time (seconds up to several minutes).

Figure 6. Example pictures for various deformities of the carpal joint: **(a)** Lateral deviation (valgus deformity) of the foot in the right front leg of a female African elephant; **(b)** medial deviation (varus deformity) of the foot in the right front leg of a female Asian elephant; **(c)** caudal deviation of both carpal joints in a female Asian elephant; **(d)** inwards rotation of both front legs in a female Asian elephant.

As mentioned above, general or local stiffness of an elephant's gait might be observed, but seems only common in severe cases and difficult to capture on pictorial documents. Although I did not focus on gait patterns here, the application of slow motion video recordings might reveal more information on subtle lameness patterns and promote this approach as a diagnostic tool.

Discussion

Although compared to other species, distinct lameness patterns are less commonly observed in elephants (Fowler & Mikota 2006; Lewis *et al*. 2010), they do express specific alterations in their posture indicative of musculoskeletal disorders. These alterations are visually perceptible for the experienced observer. To facilitate the corresponding assessment and evaluation, attentively checking the following aspects is recommended.

1. Weight distribution and posture in a standing position

An elephant with a healthy musculoskeletal system will distribute its body weight evenly on its four legs, although the front legs do physiologically bear more weight than the hind legs (Schmidt-Burbach 2009; Panagiotopoulou *et al*. 2012). The leg joints of an elephant allow a distinct range of motion while walking, but show a column-like conformation when the elephant is standing (Fig. 8a). The latter means that in a normally standing elephant the carpal, elbow and shoulder joints of the front and the tarsal, stifle and hip joints of the hind leg are positioned in a vertical axis (Figs. 1a, 2a & 8a) (Weissengruber *et al*. 2006; Ahasan *et al*. 2016). This axis is consistently visible from a lateral as well as a frontal or rear view. When suffering from irritation or pain in a specific foot or leg, the elephant will change from this normal posture to a position allowing it the relief of the affected structure. This may become obvious by shifting weight in a corresponding direction (Figs. 1, 2 & 10) or placing the affected foot or leg out of the weight bearing vertical axis (Fig. 2). Additionally, a kyphotic posture of the thoracolumbar spine, in order to relieve the front legs, may be observed (Fig. 8). In contrast to the African species, this sign will be hard to detect in Asian elephants due to their physiologically kyphotic spine conformation. Such changes in weight distribution and posture due to painful conditions in feet or legs are well known for domestic species such as horses and cattle (Hood *et al*. 2001; Poursaberi *et al*. 2010) (Fig. 9). Luikart & Stover (2005) demonstrated the association of

Figure 7. Secondary traces of musculoskeletal disorders on the skin of a geriatric female Asian elephant. The sores and ulcerations developed after the elephant stopped lying down during the night and leaned against a vertical bar for a prolonged time to relieve her affected front legs. Note: The traces are on the same vertical level as the bar in the elephant's night house.

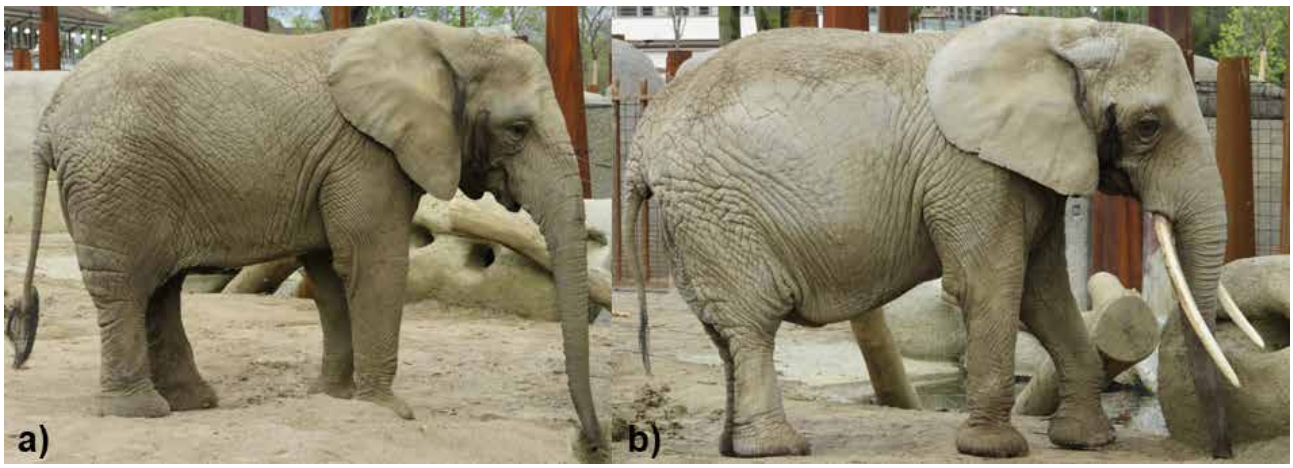

Figure 8. (a) Normal standing posture in a healthy female African elephant. Note the columnar-like conformation of the legs with the joints aligned in the weight-bearing vertical axis. **(b)** Caudal weight shift in a standing female African elephant suffering from degenerative joint disease in the carpal joints. Note the deviation of the joint position from the vertical axis and the kyphotic shape of the thoracolumbar spine.

abnormal or unequal weight distribution with the occurrence of chronic untreatable sole ulcerations in two Asian elephants. According to their report, abnormal weight distribution patterns should be considered of relevance since their underlying causes might lead to secondary diseases.

2. Positions to relieve a specific limb or joint

In elephants, various postures during standing rest have been reported and are characterized by giving some body weight to external structures by leaning against or placing a body part (trunk, tusks, head, leg) on them (Schiffmann *et al.* 2018b) (Fig. 10). These behaviours should not a priori be considered indicative of any musculoskeletal health issue. Rather, interpretation should be based on their frequency and intensity of occurrence. As an example, even sub-adult elephants with a perfectly healthy locomotor system may show postures with relieving one leg during daily resting phases. In contrast, elephants suffering from musculoskeletal disorders will express such specific positions much more frequently and independent of resting phases, always relieving the same leg. Furthermore, they may be observed to use various structures, depending on the enclosure they are kept in (Fig. 3). Johnson *et al.* (2018) report frequent weight shifting between the right and left front

Figure 9. Comparison of the abnormal standing posture in a horse suffering from painful laminitis and a geriatric elephant with severe front foot disorders. Note the caudal shift of body weight to relieve the front legs. Horse picture by Dr. med. vet. Hiltrud Straßer.

Figure 10. A geriatric female African elephant placing her tusks on a horizontal bar. In this individual degenerative joint disease in both carpal joints has been confirmed post-mortem. Note that the elephant expresses this specific position also while eating branches and therefore not exclusively during resting phases.

feet in a female Asian elephant suffering from a difference in leg length. After improving the latter by the application of glue-on shoes, the shifting behaviour stopped immediately. Intensity and frequency of specific relieving positions may present a helpful indicator for the progression and also treatment effect when monitoring the condition of an affected elephant.

3. Joint deformities

With respect to the lack of evidence-based reports, it can only be speculated why elephants show joint deformities and presumably associated degenerative alterations mainly in their carpal joints. Although degenerative joint disease has been reported to occur in multiple joints in elephants (Luikart & Stover 2005; Hoby *et al*. 2014), the carpal joints seem to be prone for these alterations. It was hypothesized that this is due to the unequal weight distribution between front and hind legs (Schmidt-Burbach 2009; Panagiotopoulou *et al*. 2012), the enormous forces acting in particular on the distal joints of the extremities (Steinmetz 2014), or to a correlation with the growth plate closure of the distal limb joints (Kaulfers *et a*l. 2010). Further research would be needed to investigate a corresponding relationship. According to the author's observations, a deformity in the direction of flexion represents an early stage of degenerative alterations in the carpal joint (Fig. 11). Moreover, affected elephants often showed an inwards rotation of both front legs (Fig. 6d).

Continuous monitoring of deformity development, ideally including photographic documentation, is recommended. These data may keep caring staff informed about the progress of joint disorders and enable timely implementation or adaptation of treatment. Radiographic imaging may represent another practical tool to diagnose and monitor joint deformities and severity of chondral degeneration. Although radiologic protocols for the elephant's limbs are available, a proper investigation of the more proximal joints can be complicated by the tissue masses surrounding them and the technique depends heavily on the training status of the elephant (Hittmair & Vielgrader 2000; Kaulfers *et al*. 2010).

4. Secondary traces

With increasing severity of the musculoskeletal disorder, the elephant will extend the amount of time spent in specific relieving positions (e.g. increased leaning rest vs. lying rest) (Schiffmann *et al*. 2018b). This change in behavioural patterns may lead to visually perceptible traces on the body of an elephant. The longer an elephant expresses relieving positions, the more extended secondary traces will be visible. To recognize them and figure out their etiopathogenesis, it is necessary to take an elephant's behaviour and interactions with specific structures of the environment into account. This should include day- as well as night-time behaviour and enclosures. Apart from skin alterations, a swelling on the tail base due to excessive leaning, and even traces on the tusks have been described (Schiffmann *et al*. 2018b). Furthermore, relieving positions as well as joint deformities lead to an uneven abrasion of the nails and pad. Depending on the specific conformation and pressure distribution, this will lead to a lack of wear and subsequent overgrowth of certain toenails (Fig. 12). At the same time other toenails may show signs of stress (e.g. recurrent cracks or chronic nail abscesses). Although continuous foot

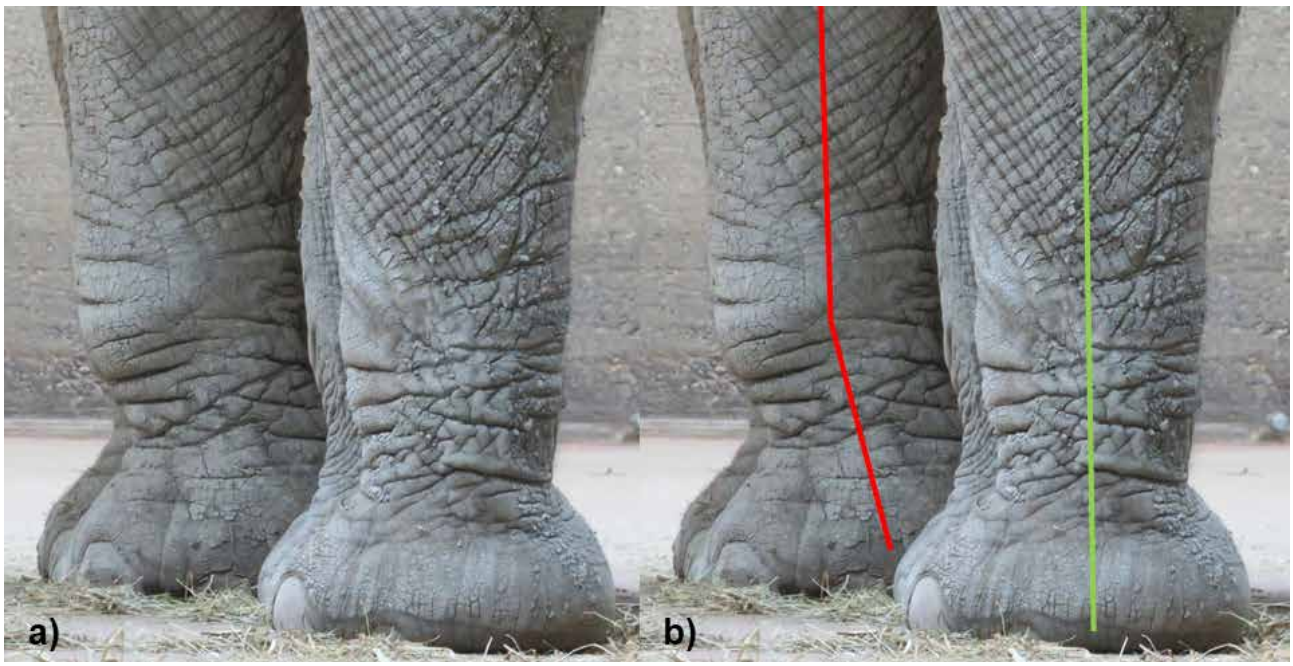

Figure 11. (a) Comparison of the carpal joint of a young-adult (22 years old) and a geriatric (46 years old) female African elephant standing right next to each other. **(b)** In the young-adult, the mechanical axis runs in a straight vertical line through the centre of the antebrachium, carpal joint and foot (green line). In contrast, there is a distinct angle of the mechanical axis in the carpal joint of the geriatric elephant (red line).

care will be required to control these alterations, they may persist as long as the underlying cause is not addressed and resolved (Luikart & Stover 2005).

5. Stiffness of gait and abnormal gait pattern

As mentioned above, obvious lameness is often missed in elephants even in cases of severe musculoskeletal disorders. Nevertheless, the continuous monitoring of an elephants' gait pattern, foot condition and activity level represents a critical part of musculoskeletal health assessment. The more familiar an observer will be with the individual gait pattern and activity level of an elephant, the quicker he will be aware of alterations therein. Video recordings and observation of gait patterns in slow motion might present an important tool and reveal subtle signs such as a shortening of the stride length.

Figure 12. Unevenly worn and overgrown toe nails in the front foot of a female African elephant suffering from post-mortem confirmed severe degenerative joint disease and deformities in her carpal joints (eg. Fig. 6a).

Conclusions

By continuously monitoring, assessing and documenting in a standardized manner all these aspects of an elephant's posture and behaviour, mahouts, elephant managers and veterinarians may be up to date of an individual's musculoskeletal health status. This will allow the timely implementation and adaptation of treatment. There is no doubt that visual and tactile examination has limitations compared to radiography and thermography (Miller *et al*. 2016). Further diagnostic tools to determine degenerative joint disease in elephants such as 3D radiographs and collagen biomarkers are being developed (Kilgallon *et a*l. 2015; Bentley *et al*. 2018). In contrast to these sophisticated techniques, the visual approach

represents a cheap, non-invasive diagnostic tool, which can even be applied from a certain distance. The latter might be of relevance especially in less cooperative or aggressive elephants. In addition, continuous behavioural observations should be conducted directly or by a closed circuit television (CCTV) system. Furthermore, gait observations including slow motion video recordings should be considered in training programs for elephant keepers.

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References

Ahasan AMSL, Quasem MA, Rahman ML, Hasan RB, Kibria ASMG & Shil SK (2016) Macroanatomy of the bones of thoracic limb of an Asian elephant (*Elephas maximus*). *International Journal of Morphology* **34:** 909-917.

Bansiddhi P, Nganvongpanit K, Brown JL, Punyapornwithaya V, Pongsopawijit P & Thitaram C (2019) Management factors affecting physical health and welfare of tourist camp elephants in Thailand. *PeerJ* **7:** e6756.

Bentley C, Cracknell J, Kitchener A, Martinez-Pereira Y & Pizzi R (2018) Detection of foot pathology by 3D radiography in elephants. Paper presented at the Joint EAZWV/AAZV/Leibniz-IZW Conference Proceedings, Prague, Czech Republic.

Edwards KL, Miller MA, Carlstead K & Brown JL (2019) Relationships between housing and management factors and clinical health events in elephants in North American zoos. *PLoS ONE* **14:** e0217774.

Fowler ME & Mikota SK (2006) *Biology, Medicine, and Surgery of Elephants*. Blackwell Publishing, Iowa, USA.

Haspeslagh M, Stevens JMG, de Groot E, Dewulf J, Kalmar ID & Moons CPH (2013) A survey of foot problems, stereotypic behaviour and floor type in Asian elephants (*Elephas maximus*) in European zoos. *Animal Welfare* **22:** 437-443.

Hittmair KM & Vielgrader HD (2000) Radiographic diagnosis of lameness in African elephants (*Loxodonta africana*). *Ultrasound* **41:** 511-515.

Hoby S, Aloisio F & Schumacher VL (2014) Bilateral ovarian cystadenoma in a geriatric African elephant (*Loxodonta africana*). *Journal of Zoo and Wildlife Medicine* **45:** 406-409.

Hood DM, Wagner IP, Taylor DD, Brumbaugh GW & Chaffin MK (2001) Voluntary limb-load distribution in horses with acute and chronic laminitis. *American Journal of Veterinary Research* **62:** 1393-1398.

Johnson G, Smith J, Peddie J, Peddie L, DeMarco J & Wiedner E (2018) Use of glue-on shoes to improve conformational abnormalities in two Asian elephants (*Elephas maximus*). *Journal of Zoo and Wildlife Medicine* **49:** 183-188.

Kaulfers C, Geburek F, Feige K & Knierim A (2010) Radiographic imaging and possible causes of a carpal varus deformity in an Asian elephant (*Elephas maximus*). *Journal of Zoo and Wildlife Medicine* **41:** 697-702.

Kilgallon CP, Larsen RS, Wong A & Yellowley C (2015) Analysis of a collagen II degradation protein C2C and a collagen II formation protein CP II in serum of Asian elephants (*Elephas maximus*). *Journal of Zoo and Wildlife Medicine* **46:** 146-149.

Lewis KD, Shepherdson DJ, Owens TM & Keele M (2010) A survey of elephant husbandry and foot health in North American zoos. *Zoo Biology* **29:** 221-236.

Luikart KA & Stover SM (2005) Chronic sole ulcerations associated with degenerative bone disease in two Asian elephants (*Elephas maximus*). *Journal of Zoo and Wildlife Medicine* **36:** 684-688.

Meehan C, Greco B, Lynn B, Morfeld K, Vicino G, Orban D, Gorsuch C, Quick M, Ripple L, Fournier K & Moore D (2019) The elephant welfare initiative: A model for advancing evidence-based zoo animal welfare monitoring, assessment and enhancement. *International Zoo Yearbook* **53:** 1-17.

Mikota SK, Sargent EL & Ranglack GS (1994) *Medical Management of the Elephant*. Indira Publishing House.

Miller MA, Hogan JN & Meehan CL (2016) Housing and demographic risk factors impacting foot and musculoskeletal health in African elephants (*Loxodonta africana*) and Asian elephants (*Elephas maximus*) in North American zoos. *PLoS ONE* **11:** e0155223.

Panagiotopoulou O, Pataky TC, Hill Z & Hutchinson JR (2012) Statistical parametric mapping of the regional distribution and ontogenetic scaling of foot pressures during walking in Asian elephants (*Elephas maximus*). *Journal of Experimental Biology* **215:** 1584-93.

Poole J & Granli P (2008) Mind and movement: Meeting the interests of elephants. In: *An Elephant in the Room: The Science and Well Being of Elephants in Captivity*. Forthman DL, Kane LF & Waldau P (eds) Tufts University Press, North Grafton. pp 2-21.

Poursaberi A, Bahr C, Pluk A, Van Nuffel A & Berckmans D (2010) Real-time automatic lameness detection on back posture extraction in dairy cattle: Shape analysis of cow with image processing techniques. *Computers and Electronics in Agriculture* **74:** 110-119.

Regnault S, Dixon JI, Warren-Smith C, Hutchinson JR & Weller R (2017) Skeletal pathology and variable anatomy in elephant feet assessed using computed tomography. *PeerJ* **5:** e2877.

Schiffmann C, Clauss M, Fernando P, Pastorini J, Wendler P, Ertl N & Hatt JM (2018a) Body condition scores of European zoo elephants (*Elephas maximus* and *Loxodonta africana*): Status quo and influencing factors. *Journal of Zoo and Aquarium Research* **6:** 91-103.

Schiffmann C, Hoby S, Wenker C, Hard T, Scholz R, Clauss M & Hatt JM (2018b) When elephants fall asleep: A literature review on elephant rest with case studies on elephant falling bouts, and practical solutions for zoo elephants. *Zoo Biology* **38:** 1-13.

Schiffmann C, Clauss M, Hoby S & Hatt JM (2019) Body Condition Scores (BCS) in European zoo elephants' (*Loxodonta africana* and *Elephas maximus*) lifetimes – a longitudinal analysis. *Journal of Zoo and Aquarium Research* **7:** 74-86.

Schmidt-Burbach J (2009) *Thermografische Ermittlung physiologischer Wärmeprofile und pedografische Untersuchungen an den Extremitäten sowie Haltungsanalysen beim Asiatischen Elefanten (Elephas maximus) in menschlicher Obhut*. Dr. med. vet. thesis, Leipzig University, Leipzig, Germany.

Steinmetz H (2014) Biomechanics of the normal gait in Asian elephants (*Elephas maximus*). Paper presented at the International Conference on Diseases of Zoo and Wild Animals, Warsaw, Poland.

Weissengruber GE, Fuss FK, Egger G, Stanek G, Hittmair KM & Forstenpointner G (2006) The elephant knee joint: Morphological and biomechanical considerations. *Journal of Anatomy* **208:** 59-72.

Wendler P, Ertl N, Flügger M, Sós E, Schiffmann C, Clauss M & Hatt JM (2019) Foot health of Asian elephants (*Elephas maximus*) in European zoos. *Journal of Zoo and Wildlife Medicine* **50:** 513-527.

Wendler P, Ertl N, Flügger M, Sós E, Torgerson P, Heym PP, Schiffmann C, Clauss M & Hatt JM (2020) Influencing factors on the foot health of captive Asian elephants (*Elephas maximus*) in European zoos. *Zoo Biology* **39:** 109-120.

Research Article *Gajah 53 (2021) 30-38*

Can the Oil Palm Industry and Elephant Conservation Be Reconciled? A Case Study in Kalabakan, Sabah

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Abstract. Bornean elephants are a central issue in oil palm development in Sabah. An initiative was launched to find solutions to reduce the conflict by forming a multistakeholder working group. The main issues identified were insufficient land-use planning due to the development of new oil palm areas and incorrect placement of electric fences. Satellite-collared elephant movement data was used to guide site-specific management options. The working group proved to be a crucial platform where collaborative actions were implemented, including re-allocating land and the strategic placement of fences. These efforts allowed the continuation of elephant movement through the landscape, as indicated by the tracking data.

Introduction

Sabah, a developing state, depends substantially on agricultural industry to drive its economy, in which oil palm cultivation is one of the main components. The oil palm industry has been a mainstay in generating employment and development in rural areas. However, development and growth is often at the cost of biodiversity as in conversion of forests to oil palm plantations (Koh & Wilcove 2008).

Bornean elephants (*Elephas maximus borneensis*) are a central issue in oil palm development in Sabah. The Bornean elephant is predominantly found in Sabah with an estimate of 2,040 individuals (Alfred *et al*. 2010) and a small population occurring in the Nunukan district in northern Kalimantan, bordering Sabah (Suyitno & Wulffraat 2012; Wulffraat & Greenwood 2017). Genetic analyses suggest that the Bornean elephants are genetically distinct from other populations and are indigenous to the island, which warrants high conservation importance (Fernando *et al*. 2003; Sharma *et al*. 2018). Sabah, lists elephants as a "Totally Protected Species" under Schedule 1 of Wildlife Conservation Enactment 1997 and the IUCN Red List, as 'endangered' (Williams *et al*. 2020). Despite being legally protected, laws are often not adequate to safeguard the species. The Bornean Elephant Action Plan for Sabah 2020–2029 states that the main threats to the species are habitat loss and habitat fragmentation, retaliatory killing due to Human-elephant conflict and more recently, deaths due to poaching for their tusks and possible unintentional chronic poisoning due to chemicals used in plantations (Sabah Wildlife Department 2020).

The death of 14 elephants in 2013 in the Gunung Rara forest reserve was so far the biggest conflict incident in Sabah (Othman *et al*. 2013). In 2018, 31 elephants were found dead due to various causes including complications from wounds inflicted by snares and gunshots, and disease (Sabah Wildlife Department 2020). The factors underlying human-elephant conflict in Sabah are multifaceted and records of oil palm plantations experiencing conflict date back to the early 1990s (Sale 1994). Conflict can be linked to the massive land conversion during that period, which resulted in major habitat loss and conversion of forests into agricultural land and settlements. Subsequently, oil palm plantations were developed adjacent to and in forest reserves, which left some reserves such as the Kinabatangan floodplain and Tabin Wildlife Reserve, severely fragmented. Land

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use plans in elephant range often failed to factor in the large land area elephants need to survive and their basic requirements, particularly access to freshwater and food. As the plantations were developed, large plantation companies that could afford electric fences constructed them along their boundaries, often without considering habitat and movement needs of elephants. This created movement bottlenecks, leading to artificially high elephant densities and conflict in some areas, often with local communities and oil palm smallholders at the receiving end (Estes *et al*. 2012; Othman *et al*. 2019).

In the 1970s, oil palm was planted in approximately 38,433 ha, which increased to 715,736 ha by 1997 (Fuad *et al*.1999). Most of the early plantations have now ended one productive cycle of 20–25 years and are replanting. During this period, human-elephant conflict incidences have steadily increased.

The Kalabakan landscape

The Kalabakan landscape is 2380 km^2 and located in the Tawau District, in south-eastern Sabah. It is connected to the main Central Forest Block, which has a land area of approximately 9200 km^2 and is the largest forest block in Sabah (Sabah Forestry Department 2017). Kalabakan is a dynamic multiple-use forest landscape that lies within the Government of Malaysia-UNDP project area and is a conflict hotspot (Othman *et al*. 2013). It comprises parts of totally protected forests and production forests, fragmented forests such as the Brantian-Tantulit virgin jungle and the Ulu Kalumpang Forest Reserve and oil palm plantations, industrial tree plantations and to a lesser extent, rubber estates. Landuse change is still occurring in the Kalabakan landscape, as shown by the land use in 2016 in Figure 1 (Sabah Forestry Department 2019).

The plantations of Sabah Softwoods Berhad (SSB), an industrial tree plantation and oil palm plantation company, lie within the Kalabakan landscape. The plantations are in two blocks; Kalabakan in the west (19,100 ha) and Brumas in the east (41,500 ha). SSB has experienced elephant damage since 2004 despite using several measures to protect their crops such as crop protection patrols, trenches, using 'canon' blasts, translocation of problematic elephants and setting up electric-fences along their boundary.

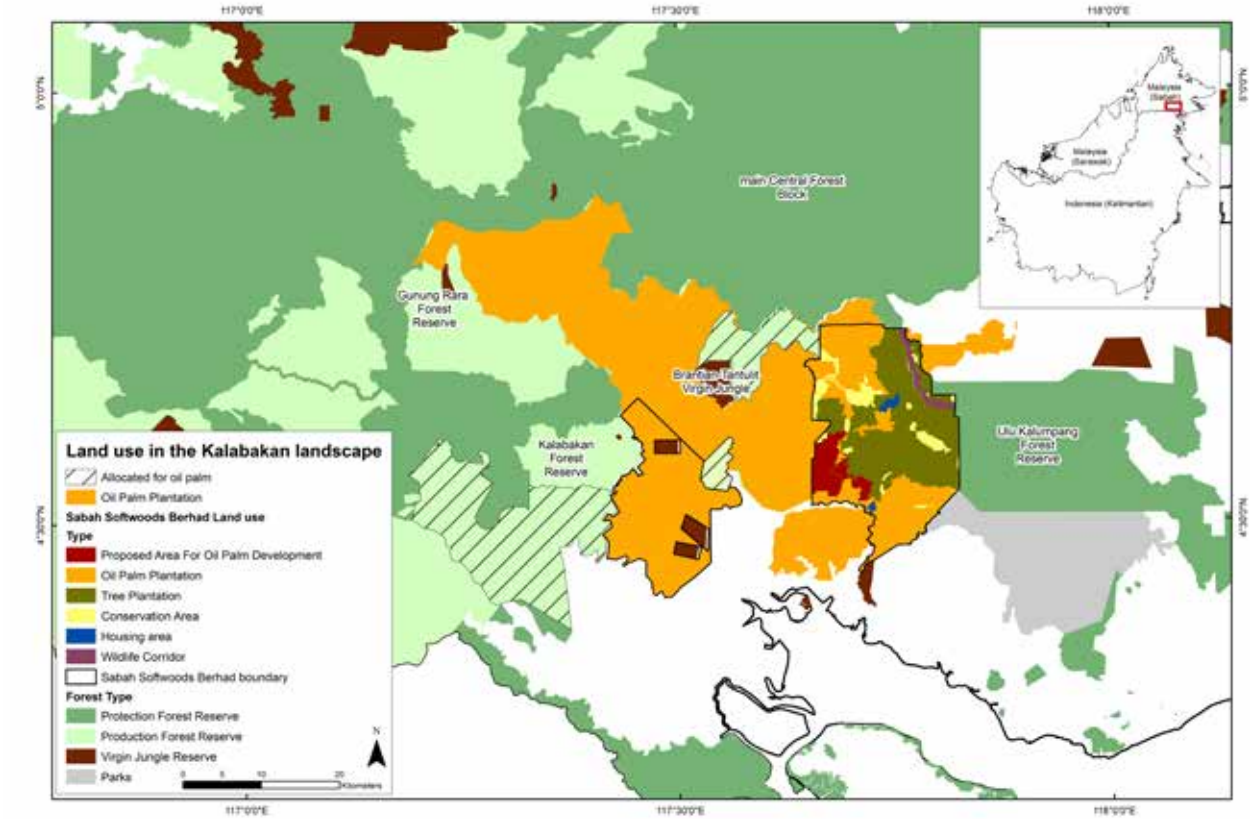

Figure 1. Land use in the Kalabakan landscape in 2016.

Collaboration between WWF and SSB

Since 2012, World Wide Fund for Nature (WWF) has engaged with SSB to find long-term solutions to address the conflict situation. As a result, in 2013 a 1067 ha (1.76%) of SSB land was set aside as a wildlife corridor to connect the fragmented Ulu Kalumpang Forest Reserve to the main Central Forest Block. This is the second largest area set aside by a plantation company for conservation in Sabah to date. The lost opportunity cost of setting aside this corridor – if planted with timber trees – would be RM 20 million for two rotations. The company also decided to restore the corridor with indigenous dipterocarps, pioneer species and fruit trees at their own expense. Furthermore, they agreed to strategically fence off their housing units and young oil palm trees (ages 8 years and below) based on WWF's recommendations (Fig. 2). Elephants were also allowed access to mature oil palm areas and tree plantation areas, since elephants caused minimal damages in them. Approximately 12,900 ha of young oil palm and 420 ha of housing units were fenced off by 2016, while 40 km of electric fences were removed from mature oil palm and tree plantation areas between 2015 and 2016.

Working group

As the main contributing factors of human-elephant conflict in the Kalabakan landscape was insufficient land-use planning and habitat fragmentation, a landscape-level approach and a platform for discussion was required to address the issue.

A multi-stakeholder working group for the Kalabakan landscape was set up in January 2016 with the purpose of minimizing human-elephant conflict through joint implementation of mitigation measures and to promote co-existence of plantations and elephants. It comprised the state forest and wildlife departments, Sabah Foundation, WWF as the facilitator, and eleven representatives of oil palm and tree plantation owners/licensees that were experiencing human-elephant conflict (SSB, Benta Wawasan Sendirian Berhad, Greenmax Sendirian Berhad, Samel Plantation Sendirian Berhad, Rinukut Plantation Sendirian Berhad, Usahawan Borneo Plantations Sendirian Berhad, Serijaya Industri Sendirian Berhad, FELDA Global Ventures Plantations Sdn Bhd, Yu Wang Plantation Sendirian Berhad, Golden Borneo Palm Sendirian Berhad and Hutan Kita Sendirian Berhad).

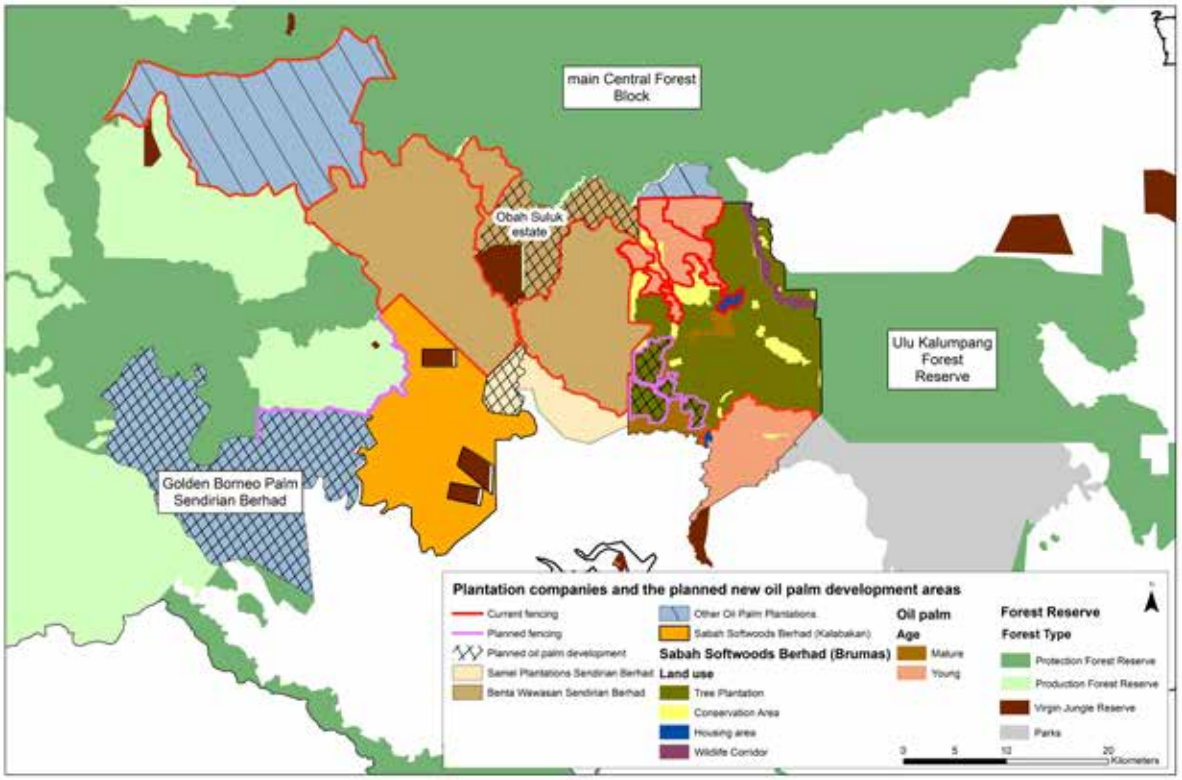

Figure 2. Different plantation company areas in the Kalabakan landscape and the location of the new oil palm development areas.

Through the working group deliberations, it was identified that the new oil palm development area (3200 ha) in SSB (Fig. 2) could become a potential conflict area. The area at the time was planted with fast-growing tree species *Albizia falcataria*, *Acacia mangium* and *Gmelina arborea* that had reached the harvesting stage. After harvest, the land was to be converted into oil palm. Once converted, the area had to be electric-fenced, to protect the young oil palm crops. The movement data from the collared elephants showed that they used the area. If it was fenced, it would restrict the movement of elephants from the neighbouring Samel Plantation Sendirian Berhad into SSB's tree plantation area.

Similarly, new oil palm development plans in Samel Plantation Sendirian Berhad and Benta Wawasan's Obah Suluk estate, were identified as potential conflict areas due to elephant presence there (Fig. 2). If these areas were planted with oil palm and fenced off, it would have further exacerbated the conflict.

Recognizing this issue, several site-specific mitigation options were identified by WWF to ensure that elephant movement could continue between the Ulu Kalumpang Forest Reserve and the larger Central Forest Block through SSB, Samel Plantation Sendirian Berhad and Benta Wawasan Sendirian Berhad.

The Golden Borneo Palm Sendirian Berhad was also identified as a potential conflict area, but because the land use to the south of it was dominated by oil palm with no remaining forests and because the company planned to install electric-fences along their boundary, no interventions were recommended at the time.

Information used for making decisions

The plantation maps, planting plans, land use and locations of electric fences for most plantations were obtained by WWF in 2016. The land use maps provided information on the location of the planted areas, unplantable areas, conservation areas and housing areas while the planting maps showed the year of planting of the palm trees within specific blocks in the plantation area. These maps were subsequently digitized using the ArcMap 10.1 (ESRI, Redlands, California) and areas that were undergoing oil palm development were identified. Information on elephant movements were obtained from four satellite-collared females belonging to four herds, collared between April 2014 to October 2016. These tracked herds represented approximately 90–100 elephants using the Kalabakan landscape.

Outcomes

As a result of the discussions held by the working group, it was decided to set aside connectivity areas for elephants that had the following criteria;

1. Low-lying terrain

A priori, elevations below 300 m were deemed suitable for elephants. Low-lying terrain was identified by determining the elevation of potential connectivity sites using a 30-m resolution Shuttle Radar Topography Mission (SRTM) Digital Elevation Model (DEM), which was obtained from the United States Geological Survey, Earth Explorer site (http://earthexplorer.usgs.gov/). The elevation data was extracted using the Spatial Analyst tool in ArcMap 10.1. and areas below 300 m were identified.

2. Riparian habitat in plantations

Where rivers flow through plantations into forests, it was decided to consider riparian borders as connectivity areas and to ensure that their access by elephants was not prevented by electric fences. The size of the riparian buffer/reserve in Sabah is related to the width of the river as stipulated by the Sabah Water Resources Enactment 1998 which states that rivers more than 3 m in width are required to provide a minimum of a 20 m vegetated zone on each riverbank. No land clearing or deforestation is allowed in riparian buffers.

3. Elephant presence

Elephant presence in the area was identified using satellite-collared movement data.

Site-specific mitigation measures

In order to allow elephant movement through the landscape, four site-specific measures were agreed upon by the working group (Fig. 3). These measures were to be implemented by the respective companies:

Sabah Softwoods Berhad

Due to the company's plan to convert a tree plantation area that had reached harvesting stage into oil palm, which could potentially exacerbate conflict, a potential connectivity site adjacent to Samel Plantation Sendirian Berhad was identified based on land use and planting plans. The site had low-lying terrain and a riparian area. It was decided to have the connectivity area as a "north-south" orientated strip, since it was the shortest distance (6.5 km) to connecting the tree plantations via the SSB conservation area (Fig. 2) and because the company's operational procedure was to start from the north in 2016 and end in the south in 2020. WWF's elephant tracking data from 2014 and 2015 indicated that elephants used the area.

Location of the corridor on the ground was made after field visits by a WWF and SSB team. During the visit, the topography and elevation of some points along the proposed connectivity site were assessed and a minimum width of 100 m in non-steep areas and 200 m width in steep areas was recommended. This was done taking into account the minimum reasonable width to facilitate elephant movement and the costs of setting aside the area. This information was shared in a follow-up discussion with the Sabah Wildlife Department and the company's senior management, to convince them to set aside the area. In April 2016, as a first case implementation of a joint solution, SSB agreed to set aside 80 ha of connectivity area, 6.8 km in length, with electric-fencing on the eastern side for newly planted crops (action point #1 in Fig. 3).

SSB also agreed to allow elephants to use their Umas-umas riparian area, which passes through the centre of connectivity area, by providing a 30 m buffer with electric fences on either side. This would enable the elephants to access the tree plantation area (Fig. 3). The river bisects the new oil palm development area, flowing northeast to southwest.

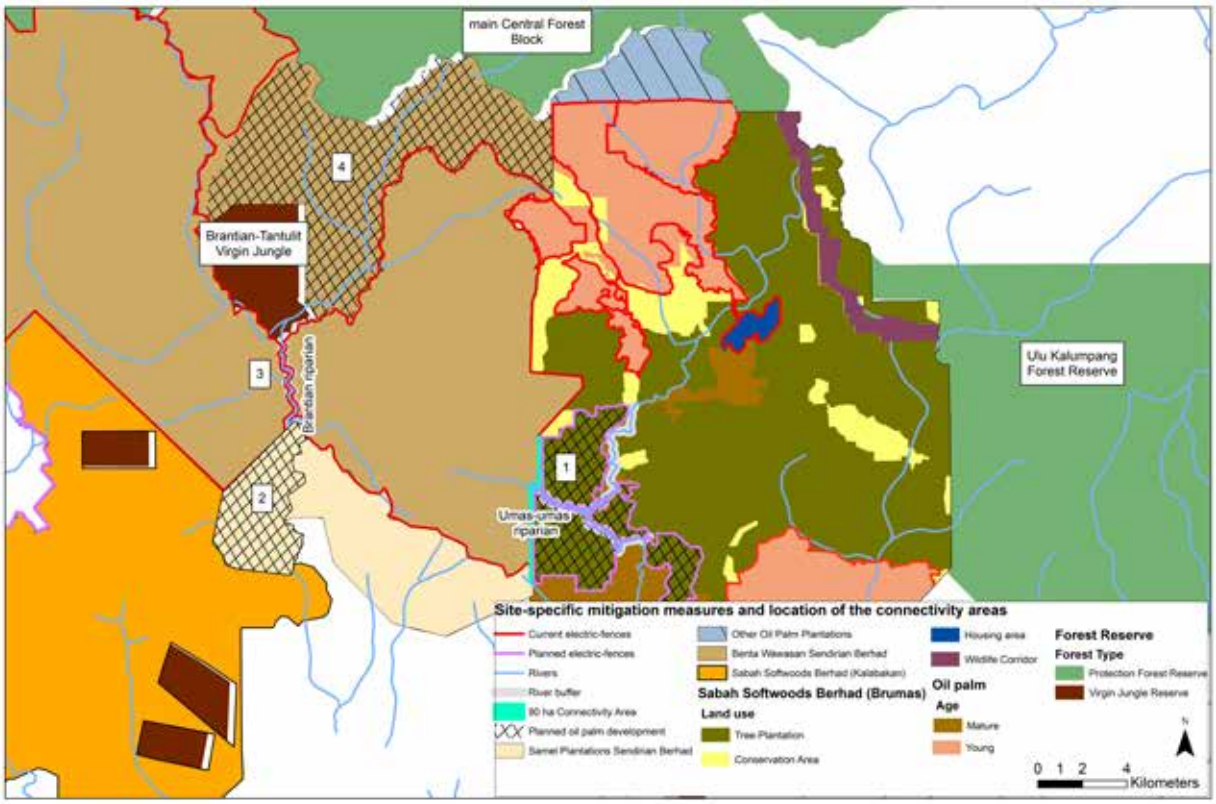

Figure 3. Site-specific mitigation measures and location of the connectivity areas. The numbers denote the locations of actions referred to in the text.

Samel Plantation Sendirian Berhad

The company agreed not to fence their boundary area adjacent to SSB and Benta Wawasan Sendirian Berhad (action point #2 in Fig. 3) and instead only to fence vulnerable areas (newly planted areas and housing settlements).

Benta Wawasan Sendirian Berhad

The company agreed to continue allowing the elephants to use their riparian area (Brantian river), without fencing off the whole plantation (action point #3 in Fig. 3). This enabled elephants to access the Brantian-Tantulit virgin jungle within their concession area and to move further north to the main Central Forest Block. The width of the riparian buffer that was set aside was 30 m on either side of the river, with electric fences installed at the edge of the buffer and for approximately 6 km. In addition, the company also agreed only to fence their vulnerable areas at the Obah Suluk Estate, when they begin operations. This would allow the elephants to use their unplantable areas, to access the main Central Forest Block (action point #4 in Fig. 3).

Of the four site-specific mitigation measures that were agreed upon, action points #1 and #3 were implemented by early 2017, by SSB and Benta Wawasan Sendirian Berhad, respectively. Some blocks of the new oil palm development area in Sabah Softwoods Berhad were planted in phases between 2017–2020, where areas planted with young palms were electric-fenced. Samel Plantation Sendirian Berhad decided not to install electric-fences for now due to licence issues, which meant that the elephants have continued to use their plantation (action point #2). Similarly, Benta Wawasan Sendirian Berhad's Obah Suluk Estate had also not begun operations, so no fences were installed (action point #4).

Movement patterns of collared elephants

The movement of two collared female elephants named 'Bang' and 'Sebatik' that were in separate groups, were monitored from December 2014 to December 2020. Figure 4 depicts the movement of Bang between January 2015 – December 2020 and Sebatik between October 2016 – December 2020. Their movement patterns show that they intensively used the tree plantation areas in SSB, presumably because of the abundant grass in them. However, the conservation areas, which are mainly water catchment areas and are steep, were avoided by the collared elephants. They also moved frequently in the "east-west" direction between SSB and Samel Plantation Sendirian Berhad. The elephants started to use a small part of the 80 ha connectivity area and the Umas-umas riparian corridor bisecting the new oil palm development area in mid-2017. By 2019–2020, the elephants started using more of these connectivity areas as the planting of oil palm progressed and the areas were fenced off. Their movement patterns also showed that they continued to move through Samel Plantation Sendirian Berhad and the Brantian riparian area to access the Brantian-Tantulit virgin jungle through Benta Wawasan Sendirian Berhad. The elephants then travelled northwards towards the main Central Forest Block and back again into SSB and Ulu Kalumpang Forest Reserve.

The movement of the collared elephants after the mitigation measures were implemented indicates that the efforts undertaken were effective. However, the landscape is still subject to land use conversion and therefore has to be continuously monitored over the long-term, to ensure future development does not disrupt elephant movement.

Reduction in electric-fencing costs

Another example of benefits accruing from having the working group, occurred in 2017 when SSB (Kalabakan estate) and a neighbouring plantation, Golden Borneo Palm Sendirian Berhad decided to set up a joint electric-fence, connecting both their boundaries to prevent double-fencing between the estates (shown in Fig. 2). The areas to the south of these two plantations were surrounded by oil palm, with no remaining forests up to the southernmost extent of the Sabah boundary. This partnership was a win-win solution as they were able to share and reduce the costs of installing and maintaining electric fences in newly planted oil palm areas.

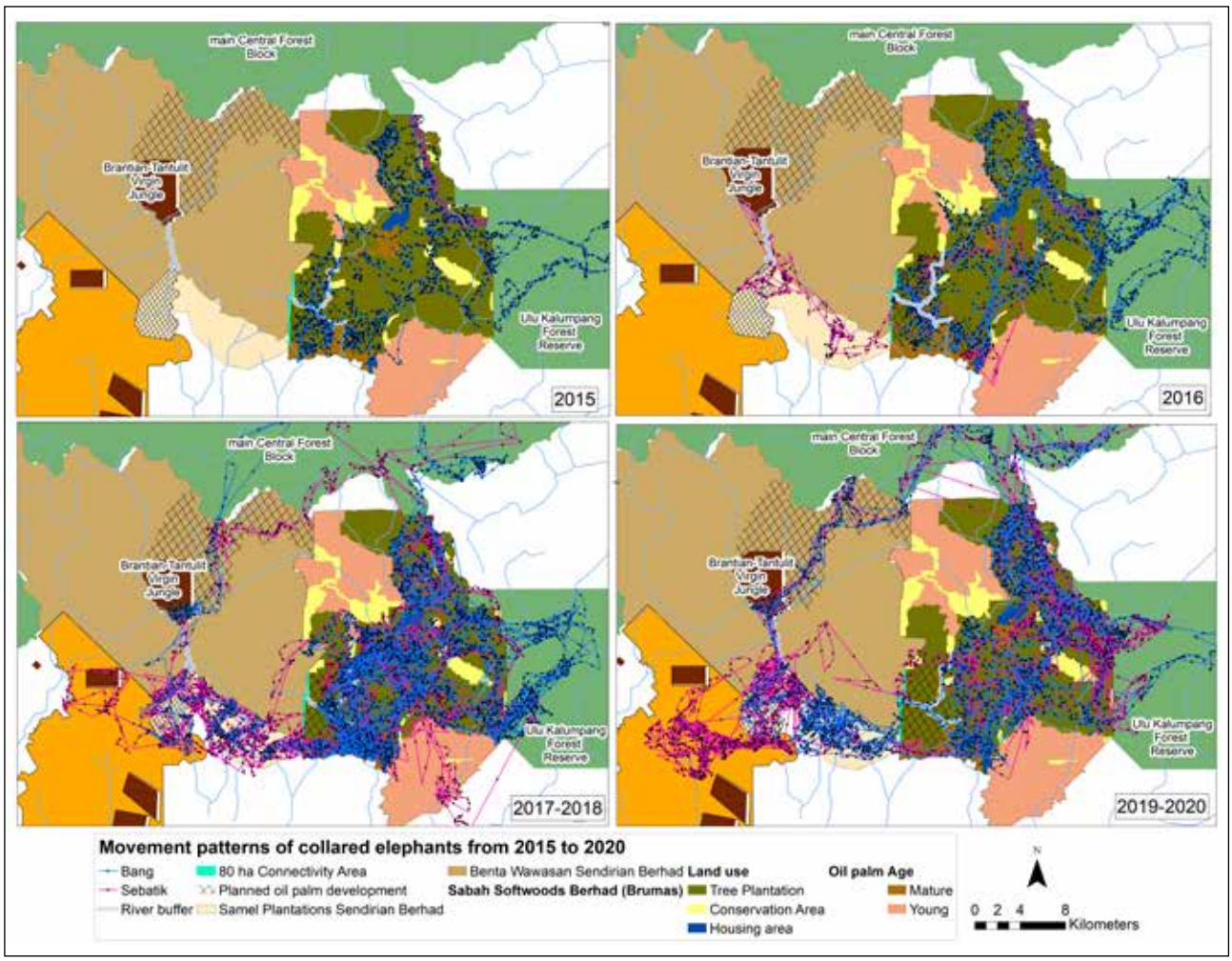

Figure 4. Movement patterns of two collared elephants Bang and Sebatik in two groups, before (2015 - Bang only), during (2016) and after (2017 onwards) the mitigation measures were implemented.

Working group function

During the working group meetings, it was realized that there was no single solution to reduce conflict that was applicable in all situations. The core business of plantation companies is to maximize revenue from their crops, and in order to gain their active participation in conservation, emphasis has to be placed on ways that they can benefit from supporting conservation. The buy-in from the working group was obtained by highlighting the importance of cooperation to find options to mitigate conflict. Through the implementation of the actions determined, the elephants were able to move through the plantation areas and access the main Central Forest Block as well as the fragmented Brantian-Tantulit Virgin Jungle and Ulu Kalumpang Forest. It is also important to note that the plantation owners and licensees agreed not only to allow the elephants to move through the identified connectivity areas, but also to allow elephants to use some parts of their plantations. These results indicate that elephants and plantations can coexist through proper land use planning and cooperation between plantation owners and conservation agencies.

Importance of connectivity in plantation landscapes

It is estimated that almost 70% of Asian elephants occur outside protected areas (Ning *et al*. 2016). Food preferred by elephants is more abundant in plantations and open habitats and they also provide elephants with easy access to food (English *et al*. 2014; Evans *et al*. 2018; Wadey *et al*. 2018). Therefore, it is imperative that connectivity be preserved to facilitate the movements of elephants through plantation landscapes into forested habitats, which may likely reduce conflict as well as encourage gene flow (Goossens *et al*. 2016).

SSB's efforts to establish and restore the 1067 ha wildlife corridor as well as setting aside the 80 ha connectivity area is a huge step forward for the plantation industry, as it indicates their commitment towards conservation. Some 60–70 elephants are now known to be present throughout the year in SSB lands, moving through the plantation with some degree of habituation towards people. In light of this, further initiatives have been taken to increase the plantation workers' safety through awareness programs with WWF.

The efforts by SSB in the Kalabakan landscape and a few others in landscapes such as the Kinabatangan floodplain (Othman *et al*. 2019) mark the beginning of a paradigm shift within the industry, where private companies are starting to play a role in conservation. These measures are crucial as the intensity of conflict increases and especially when the protection of forests alone is not enough to guarantee the species' long-term survival and address human-elephant conflict. These model plantations demonstrate that people and elephants can coexist in a shared landscape, using shared resources if proper mitigation measures are put in place.

Conclusion

While human-elephant conflict can be reduced and coexistence is achievable, we emphasize that mitigation can only reduce conflict and not eliminate it, as long as development continues in elephant habitat. The best for elephants and the oil palm industry is for people to be more tolerant and accepting of sharing land with elephants. We can see more plantations such as SSB step up and champion conservation, despite having to bear some costs by keeping elephants in their land. This is a significant success story for the industry and for the conservation of elephants in Sabah, although much more needs to be done. A strategy of evidence-based identification of solutions, collective decision-making and cooperative implementation among land managers, presents a new model of conservation practice for human-elephant conflict reduction in Asian elephant landscapes.

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References

Alfred R, Hamid Ahmad A, Payne J, William C & Ambu L (2010) Density and Population Estimation of the Bornean Elephants (*Elephas maximus borneensis*) in Sabah. *OnLine Journal of Biological Sciences* **10:** 92-102.

English M, Gillespie G, Ancrenaz M, Ismail S, Goosens B, Nathan S. & Linklater W (2014) Plant selection and avoidance by the Bornean elephant (*Elephas maximus borneensis*) in tropical forest: Does plant recovery rate after herbivory influence food choices? *Journal of Tropical Ecology* **30:** 371-379.

Estes JG, Othman N, Ismail S, Ancrenaz M, Goossens B & Ambu LN (2012) Quantity and configuration of available elephant habitat and related conservation concerns in the Lower Kinabatangan Floodplain of Sabah, Malaysia. *PLoS ONE* **7:** e44601.

Evans LJ, Asner GP & Goossens B (2018) Protected area management priorities crucial

for the future of Bornean elephants. *Biological Conservation* **221:** 365-373.

Fernando P, Vidya TNC, Payne J, Stuewe M, Davison G, Alfred RJ, Andau P, Bosi E, Kilbourn A & Melnick D (2003) DNA analysis indicated that Asian elephants are native to Borneo and are therefore a high priority for conservation. *PLoS Biology* **1:** 110-115.

Fuad MA, Rohana AR & Chua BG (1999) Socio-economic considerations in the development of jungle to oil palm. In: *Oil Palm and the Environment, A Malaysian Perspective*. Gurmit S, Lim KH, Teo L & David LK (eds) SP-Muda Printing Sdn. Bhd, Kuala Lumpur, Selangor. pp 1-7.

Goossens B, Sharma R, Othman N, Kun-Rodrigues C, Sakong R, Ambu LN, Jue NK, O'Neill RJ, Bruford MW & Chikhi L (2016) Habitat fragmentation and genetic diversity in natural populations of the Bornean elephant: Implications for conservation. *Biological Conservation* **196:** 80-92.

Koh LP & Wilcove DS (2008) Is oil palm agriculture really destroying tropical biodiversity? *Conservation Letters* **1:** 60-64.

Ning H, Wong EP, Chackrapani P, Solana-Mena A, Tan ASL, Nagulendran K, *et al*. (2016) MEME – moving towards a science-based conservation of Malaysian elephants. *Malayan Nature Journal* **68:** 191-197.

Othman N, Fernando P, Yoganand K, Ancrenaz M, Alfred RJ, Nathan S & Goossens B (2013) Elephant conservation and mitigation of human-elephant conflict in Government of Malaysia-UNDP Multiple-Use Forest Landscapes Project Area in Sabah. *Gajah* **39:** 19-23.

Othman N, Goossens B, Cheah CPI, Nathan S, Bumpus R & Ancrenaz M (2019) Shift of paradigm needed towards improving human-elephant coexistence in monoculture landscapes in Sabah. *International Zoo Yearbook* **53:** 1-13.

Sabah Forestry Department (2017) *Fact Sheets of Forest Reserves in Sabah*. Sabah Forestry Department, Sandakan, Sabah.

Sabah Forestry Department (2019) *Sabah Forestry Department Annual Report 2018*. Sabah Forestry Department, Sandakan, Sabah.

Sabah Wildlife Department (2020) *Bornean Elephant Action Plan for Sabah 2020–2029*. Kota Kinabalu, Sabah, Malaysia.

Sale JB (1994) *Management Plan for Tabin Wildlife Reserve*. Wildlife Department, Ministry of Tourism and Environmental Development, Sabah, Malaysia.

Sharma R, Goossens B, Heller R, Rasteiro R, Othman N, Bruford MW & Chikhi L (2018) Genetic analyses favour an ancient and natural origin of elephants on Borneo. *Scientific Reports* **8:** e880.

Suyitno A & Wulffraat S (2012) *The Elephant Groups of East Kalimantan*. Unpublished report, WWF-Indonesia.

Wadey J, Beyer HL, Saaban S, Othman N, Leimgruber P & Campos-Arceiz A (2018) Why did the elephant cross the road? The complex response of wild elephants to a major road in Peninsular Malaysia. *Biological Conservation* **218:** 91-98.

Williams C, Tiwari SK, Goswami VR, de Silva S, Kumar A, Baskaran N, Yoganand K & Menon V (2020) *Elephas maximus*. The IUCN Red List of Threatened Species 2020: e.T7140A45818198. Downloaded on 11 January 2021.

Wulffraat S & Greenwood C (2017) *The Environmental Status of Borneo*. Unpublished report, WWF-Heart of Borneo Programme.

Status and Distribution of Asian Elephants in the Nagaon Forest Division, Assam, India

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Introduction

The Asian elephant is distributed across 13 range countries with a population of about 41,000 to 52,000 (Sukumar 2006; Williams *et al*. 2020). The mainland subspecies *Elephas maximus indicus* has the highest number of individuals and is mainly found in India. The government conducted a synchronized elephant census throughout India in 2017 and found 27,000–29,000 elephants distributed in 23 states (MoEFCC 2017).

The state of Assam with around 5700 elephants is a key conservation area for Asian elephants in India (MoEFCC 2017). The forested area in the state is 26,832 km^2, which is 34.2% of its geographical area (DEF 2020). Of the forests, 14.9% is under National Parks and Wildlife Sanctuaries while the remaining 85.1% are unprotected. These unprotected forests are inhabited by many wildlife species, including elephants. Assam is divided into 34 Forest Divisions.

The present study evaluates the perceived status and distribution of elephants and migratory corridors in Reserve Forests (RF) in the Nagaon Forest Division.

Materials and methods

Study area

The Nagaon Forest Division is situated in the Brahmaputra valley, encompassing the forest areas of Nagaon, Hojai and Morigaon Districts of Assam. The Nagaon Forest Division is composed of the Northern, Western, Kathiatoli and Kampur Ranges (Fig. 1). The topography of the area consists mostly of plains with hilly terrain in the east, northeast and southeast. Forests cover 1085.37 km^2, which is 19.7% of the total area and comprise of 60 km^2 very dense forest, 405 km^2 of moderately dense forest and 620.37 km^2 of open forests (FSI 2019). The plains areas are composed of agricultural lands, marshy lands and swampy areas.

The climate is tropical with the three seasons; summer (March to May), monsoon (June to October) and winter (November to February). Like in other parts of India, summer season also coincides with the monsoon. The highest rainfall is in June and the driest month is January. The area receives around 2400 mm annual rainfall. The annual average temperature is 10–26.5°C with high humidity. There are approximately 176 villages within the Nagaon Forest Division. Human-elephant conflict (HEC) has become common in the area in the last few decades.

Data collection

Forest villages were visited between April 2018 and December 2019 and those with conflict identified. From each of 17 HEC affected villages, 8–13 older persons (aged 60 years and above) were interviewed (Fig. 2). Interviews were conducted in the vernacular. Respondents were asked about migratory corridors, and if there have been any changes over the decades.

The information thus gathered was discussed with Forest Department and people involved in Green Guard Nature Organization (a local NGO

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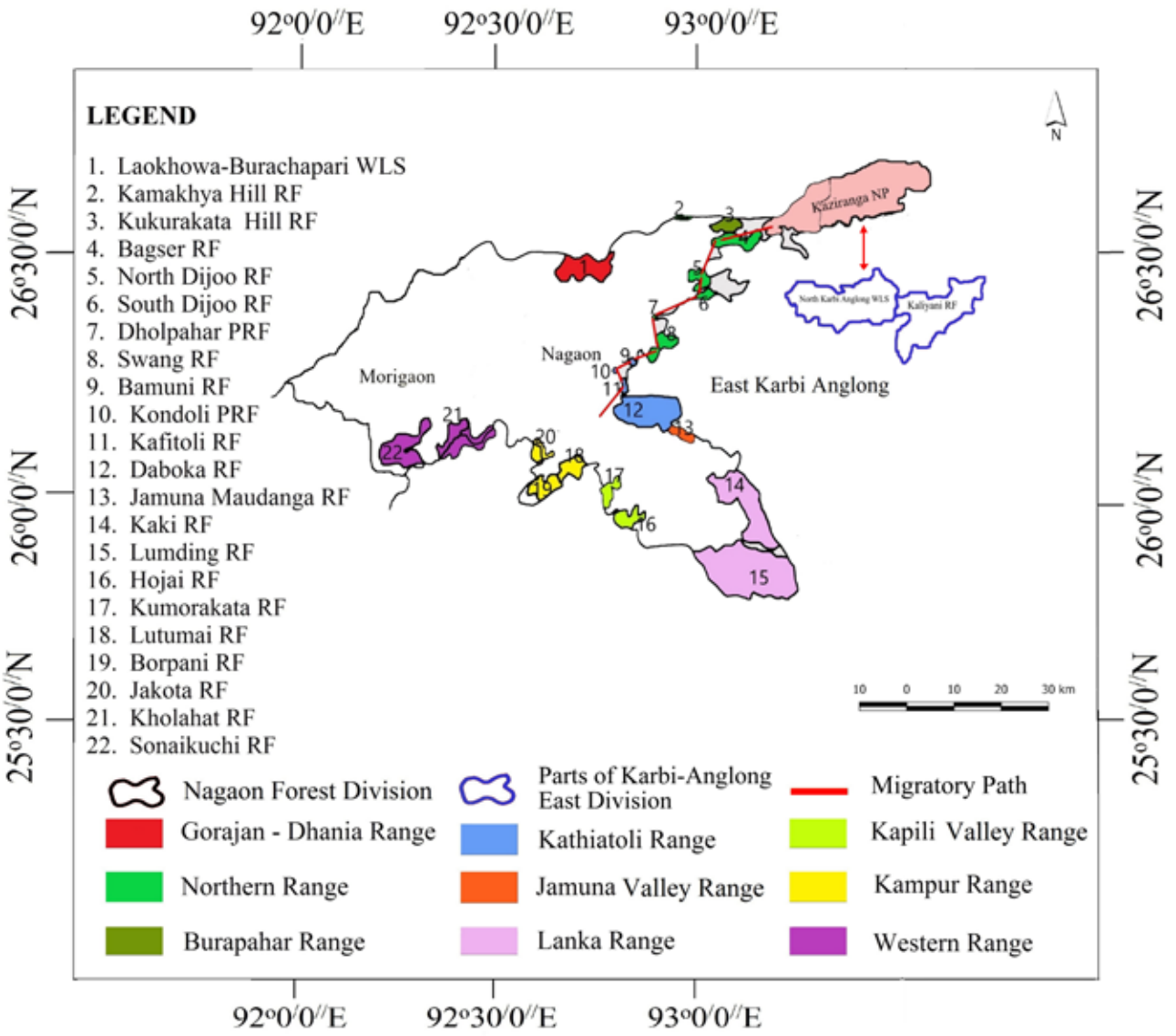

Figure 1. Map of the Nagaon Forest Division showing the reserve forests and protected areas and assumed migratory path of elephants in the Nagaon Forest Division. (RF = Reserve Forest, PRF = Proposed Reserve Forest, WLS = Wildlife Sanctuary).

working to mitigate HEC). Information such as the map of the divisional boundary, area of forest ranges and reserve forests and data on government elephant census in 2010 and 2017 were obtained from the Nagaon Forest Divisional Office.

Results

Elephant numbers

Census data indicates that the elephant population in the Nagaon Forest Division decreased from 140 in 2010 to 79 in 2017. Change in numbers in the specific ranges were 56 to 28 in Northern, 23 to 22 in Western, 21 to zero in Kathiatoli, 34 to 17 in Kampur Range and 2 to zero in Dhania Range while it increased in Gorajan Range from 4 to 12 (Fig. 3).

Elephant movement

Nagaon District is bounded in the south by the West Karbi Anglong and North Cachar Hills and in the east by the East Karbi Anglong and Golaghat districts. These areas are contiguous with the Kaziranga-Karbi Anglong Elephant Reserve. Large numbers of elephants are said to migrate through this corridor to different areas of Nagaon District every year. During the paddy harvesting period (October to December), elephant herds

Figure 2. Interview with the local people at Chapanola, Nagaon (Assam).

are often present in the foothills of the Nagaon District, especially in the areas bordering the Kaziranga-Karbi Anglong Elephant Reserve.

During the survey, presence of elephants was ascertained based on direct sighting and presence of evidence such as elephant trails, dung and footprints. GPS coordinates of the locations indicating elephant presence were recorded in the field and a total of 347 GPS locations were collected. Movements of elephants were ascertained based on the experience of the forest staff dealing with deterring elephants from agriculture fields. Thus, the corridor was identified based on winter crop-raiding which is contiguous from Kaziranga to Nagaon District, covering a distance of 78 km. Most of the elephant herds are thought to migrate from Kaziranga to Swang RF and up to Kathiatoli and Kampur via the Kondoli proposed RF of Nagaon District and return to Kaziranga-Karbi Anglong Elephant Reserve (Fig. 1).

Discussion

The elephant population in the Nagaon Forest Division has reduced drastically in the past decade. Elephant numbers in Northern and Kampur ranges have reduced to half of what was present in 2010. Both these ranges face multiple threats. Large areas of the two ranges have been encroached and replaced by rubber plantations and croplands. Expansion of tea gardens is also a major factor, especially in the Borapani RF of the Kampur Range. The area of tea gardens is not monitored periodically and consequently gradual expansion occurs into forest areas. Constructions of roads and stone mining have also increased in the two ranges. Additionally, in the Northern Range, the foothills of RFs are covered by invasive alien plant species such as *Lantana camara* and *Chromolaena odorata* resulting in decrease of native food plants and grassland habitats.

No elephants were found in Kathiatoli Range in the 2017 census. During our fieldwork in the range no evidence of elephant presence was observed, confirming the 2017 census result. The elephants that were there may have either shifted their range or may have been lost. The main threats in the Kathiatoli Range are timber logging, extensive mining of stone and newly constructed roads.

The only stable population of elephants in the Nagaon Forest division was in the Western Range. The elephants mainly occupy the Kholahat RF and Sonaikuchi RF there. The Western Range is contiguous with the west Karbi-Anglong district habitats and does not face the same threats as the others. It is less disturbed as human presence and activities are lower compared to the other ranges.

Increase of human population is a major challenge in maintaining forests. The human population density in the combined Nagaon and Hojai districts were 582 people/km^2 in 2001 and 711 people/km^2 in 2011 (Census of India 2011). Forests in the Nagaon Forest Division continue

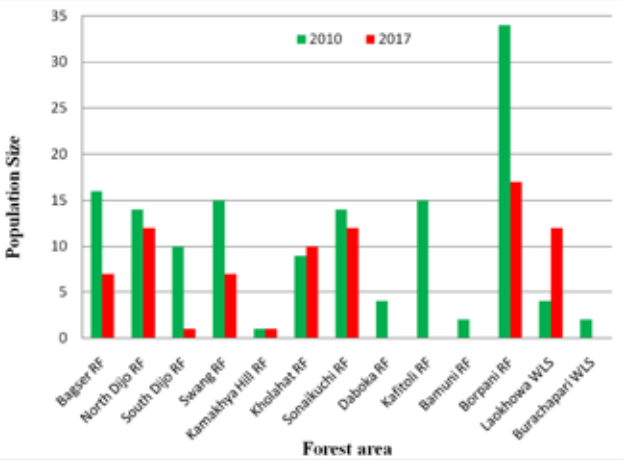

Figure 3. Number of elephants in the Nagaon Forest Division.

to be transformed into agriculture, tea and rubber plantations, human settlements and infrastructure as a result of this.

The assumed elephant corridor between Kaziranga National Park and Kathitoli RF is 78 km in length (Fig. 1). The previously continuous forest from Kaziranga to Karbi Anglong has declined over the last three decades due to increased human activity. Now the tract is heavily fragmented and consists of interspersed patches of forest and human-use land. Elephants have to move through human-use areas to go from one forest patch to another. Rain fed paddy is the main crop cultivated in the human-use areas and matures in November–December. Consequently HEC in the area is very common, especially in the winter when elephant numbers increase, making it difficult for farmers to harvest crops (Fig. 4). Cultivation is mostly by subsistence farmers and it is difficult for them to tolerate losses due to HEC. Therefore, conserving the extant forest patches and re-foresting so that they are once again connected is important to mitigate HEC.

Many forest areas in Assam are losing elephant habitats because of immense anthropogenic pressures on them (Das *et al*. 2012; Talukdar & Choudhury 2017). Similar to Assam only a fraction of the forests in India are protected. A major percentage of elephant habitats are in disturbed, unprotected and fragmented areas (MoEFCC 2017). Elephants in such areas are most vulnerable. Therefore, important unprotected habitats need to be identified and elevated to protected areas. In the Nagaon Forest Division elevating the status of the Western Forest Range into a protected area would be advisable.

Figure 4. Elephant herd approaching to the crop-field in Balijuri, Nagaon (Assam).

References

Census of India (2011) *Census 2011, Nagaon District, Assam*. Directorate of Census Operations in Assam. <https://www.census2011.co.in/census/district/162-nagaon.html>

Das JP, Lahkar BP & Talukdar BK (2012) Increasing trend of human elephant conflict in Golaghat District, Assam, India: Issues and concerns. *Gajah* **37:** 34-37.

DEF (2020) *A Glimpse of National Parks & Wildlife Sanctuaries in Assam*. Department of Environment & Forests (DEF), Government of Assam. <http://103.8.249.31/assamforest/NP_Sanctuaries/index.php>

FSI (2019) *State of Forest Report 2019*. Forest Survey of India (FSI), Ministry of Environment Forest and Climate Change, Dehradun, Uttarakhand, India. <http://www.fsi.nic.in/forest-report-2019>

MoEFCC (2017) *All India Synchronized Elephant Population Estimation*. Report, Ministry of Environment, Forest and Climate Change.

Sukumar R (2006) A brief review of the status, distribution and biology of wild Asian elephants *Elephas maximus*. *International Zoo Yearbook* **40:** 1-8.

Talukdar NR & Choudhury P (2017) Conservation status of Asian elephants in southern Assam, India. *Gajah* **47:** 18-23.

Williams C, Tiwari SK, Goswami VR, de Silva S, Kumar A, Baskaran N, Yoganand K, Menon V (2020) *Elephas maximus*. *The IUCN Red List of Threatened Species 2020*. e.T7140A45818198. <https://dx.doi.org/10.2305/IUCN.UK.2020-3.RLTS.T7140A45818198.en>

Using GnRH Vaccine During Post Musth in Captive Asian Elephants

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Introduction

During musth in elephants, testosterone levels increase severalfold (Ganswindt *et al*. 2002) and cortisol secretion is elevated due to possible stress (Yon *et al*. 2007). A positive correlation between testosterone and cortisol in musth bulls has been noticed, which indicates a possible role of the adrenal glands in modulating or facilitating their secretion (Brown *et al*. 2007).

Captive bull elephants in musth are difficult to manage and control, due to increased aggression and disobedience presumably caused by the elevated testosterone and cortisol levels (Lincoln & Ratnasooriya 1996). In general, serum testosterone and cortisol in male Asian elephants, could vary between 0.1–29.4 ng/ml and 4.6–98.7 ng/ml respectively (Brown 2006). Musth can occur at any time of the year (Eisenberg *et al*. 1971), but in a given elephant it occurs around the same period annually and may last up to 16 weeks (Rajaram 2006).

Musth in captive elephants can be divided into pre-musth, full musth and post-musth periods. During pre musth, the temporal glands become swollen, discharge begins and frequent urination and penile erection together with increased serum testosterone are noted while during full musth, these signs become more obvious with a further increase in serum testosterone (Rajaram 2006). In this report, we identify post-musth as the period after urine dribbling ends, until the elephant is released from the musth stable for its regular activities based on indication of complete obedience and absence of aggression.

Elephant keepers lose income when their elephants are in musth and several keepers have been killed while trying to release males too early in post-musth. Hormonal management of post-musth could prevent such occurrences. Musth can be prevented or postponed by using GnRH vaccine (Somgrid *et al*. 2016a; Piyadsa *et al*. 2017). It probably acts via suppressing testicular function by interrupting the hypothalamo-pituitary gonadal axis, leading to decreased production of testosterone (Somgrid *et al*. 2016a, 2016b) though the mechanism with regard to cortisol is not clear.

We monitored serum testosterone and cortisol levels of four captive male elephants in post-musth to assess whether administering GnRH vaccine could enable releasing them earlier than usual from their musth stables.

Materials and methods

Four adult captive bull Asian elephants (*Elephas maximus*) Saliya, Mangala, Bibila and Raja, which were privately owned, were used in the study. They had come into musth and stopped urine dribbling but still showed temporal gland secretion, hence were identified as being in post-musth. Their regular musth period, including pre- and post-musth, and the dates of sampling are given in Table 1.

The first GnRH injections were given 3–4 weeks prior to the anticipated date of release from the musth stables. Intramuscular injections of 4 ml (1.6 mg per dose) of GnRH (BOPRIVA®bovine immune castration vaccine, Zoetis GMS Australia) were administered on the given dates to 3 of the 4 animals (except Raja) and blood samples collected (Fig. 1). To control for diurnal variation in testosterone (Brown *et al*. 2010) blood samples were collected between 6 and

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Table 1. Details of elephants and their musth period.

Name	Age (years)	Usual musth period*	
		Months	Duration (months)
Saliya	44	Oct – Mar	6
Mangala	43	Nov – May	7
Bibila	26	Sep – Apr	8
Raja	40	Nov – May	7

*from pre-musth to release from the musth stable

8 am. Plasma was separated and was stored at –20ºC until analysis. Serum testosterone and cortisol were assessed using a Roche cobas e 411 analyzer at a commercial medical laboratory (Durdens Medical Laboratory).

The 'usual musth period' is from pre-musth to release from the musth stableIn spite of administering three doses of GnRH vaccine, Saliya's temporal gland secretion continued. Therefore on 3rd May 2019 he was taken away from the musth stable, given a bath and stabled about 800 m away from Raja who was in post-musth with temporal gland secretion. Behavioural monitoring of Saliya was continued at the new stable.

Results

Serum testosterone levels of Saliya were initially very low and continued to be low through the GnRH vaccine injections and afterwards (Table 2). He also continued to have temporal gland

Figure 1. Male being administered the GnHH vaccine.

secretions. After he was released from the musth pen, the fluctuation in his cortisol levels decreased, temporal gland secretion immediately stopped and he became obedient.

Both Mangala and Bibila had initially elevated levels of both testosterone and cortisol, which gradually reduced with the vaccine injections (Table 2). After the 2nd dose, both became obedient and were released from the musth stable for regular activities.

Raja had low serum testosterone and cortisol levels but was throwing his food and occasionally disobeying the keeper's commands, possibly due to the presence of Saliya in close proximity. Therefore, he was released from the musth stable for regular activities after the first sampling.

Discussion

Testosterone and cortisol in both Mangala and Bibila showed a continued decrease with GnRH vaccine injections. Saliya's testosterone levels were not impacted by GnRH, possibly because it was already low. GnRH vaccine is usually given before pre-musth to prevent or delay the occurrence of musth (Somgrid *et al*. 2016a, 2016b). However, our results suggest that the testosterone feed back regulatory mechanism can be disrupted even if GnRH vaccine is administered during post-musth. Such administration may help the early release of captive elephants from restrictions imposed in musth.

Levels of testosterone and cortisol are correlated in musth (Brown *et al*. 2007). However, serum cortisol tends to vary much more than testosterone as it is influenced by factors other than musth (Brown 2006). Saliya was in apparent post-musth and had low serum testosterone levels, but continued to have elevated cortisol levels. The discrepancy may have been due to the stress caused by the proximity of Raja who was also in post-musth. Raja was much bigger and heavier than Saliya hence likely to be dominant over him. The observed reduction in Saliya's cortisol levels upon moving him away from Raja supports this assumption. The observations on Saliya are also consistent with association between musth bulls being stressful (Claassens 2010), and that stress could be reduced by keeping musth males away from each other, especially from dominant males (Lincoln & Ratnasooriya 1996).

Table 2. Hormone levels and GnRH vaccine injection dates of the four bulls.

Elephant	Date	Testosterone (ng/ml)	Cortisol (nmol/l)	Comment
Saliya	7.3.2019	0.07	15.2	1st vaccine
	22.3.2019	0.05	50.5	2nd vaccine
	5.4.2019	0.06	11.2	3rd vaccine
	17.4.2019	0.06	30.6	
	3.5.2019	0.08	42.0	Released from musth stable
	6.6.2019	0.03	17.9	
	18.7.2019	0.08	20.1	
Mangala	5.4.2019	>15.00	10.4	1st vaccine
	22.4.2019	3.87	44.4	2nd vaccine
	6.5.2019	0.13	24.5	3rd vaccine
Bibila	6.2.2019	>15.00	33.0	1st vaccine
	17.2.2019	0.62	27.9	2nd vaccine
	1.3.2019	0.20	7.5	3rd vaccine
Raja	22.7.2019	1.40	14.2	
	5.8.2019	1.50	10.2	

The cortisol levels observed were much lower than reported elsewhere in Asian elephants during musth (Brown 2006; Claassens 2010). This may be due to the management of the study subjects being better and less stressful compared to others, and/or related to the analytical methods. Serum testosterone levels (0.03 to >15 ng/ml) observed were comparable with Jainudeen *et al*. (1972).

It would be interesting to study the variation in cortisol levels during musth in both captive and wild elephants. Our results indicate that human diagnostic laboratories could be used to determine serum testosterone and cortisol levels in elephants, which would facilitate conducting of such studies.

References

Brown J (2006) Reproductive endocrinology. In: *Biology Medicine and Surgery of Elephants*. Fowler M & Mikota S (eds) Blackwell Publishing, UK. pp 377-388.

Brown JL, Somerville M, Riddle HS, Keele M, Duer CK & Freeman EW (2007) Comparative endocrinology of testicular, adrenal and thyroid function in captive Asian and African elephant bulls. *General and Comparative Endocrinology* **151:** 153-162.

Brown JL, Kersey DC, Freeman EW & Wagener T (2010) Assessment of urinary diurnal cortisol excretion in Asian and African elephants using different endocrine methods. *Zoo Biology* **29:** 274-283.

Claassens CB (2010) *Serum and Fecal Cortisol Concentrations During the Annual Musth Cycle of Asian Elephant (Elephas maximus) Bulls*. Final report, research project: November 2009 – mid February 2010. Chiang Mai University, Chiang Mai, Thailand, Utrecht University, Utrecht, the Netherlands.

Eisenberg JF, McKay GM & Jainudeen M R (1971) Reproductive behavior of the Asiatic elephant (*Elephas maximus maximus*). *Behaviour* **38:** 193-225.

Ganswindt A, Heistermann M, Borragan S & Hodges K (2002) Assessment of testicular endocrine function in captive African elephants by measurement of urinary and fecal androgens. *Zoo Biology* **21:** 27-36.

Jainudeen MR, Katongole CB & Short RV (1972) Plasma testosterone levels in relation to musth and sexual activity in the male Asiatic elephant (*Elephas maximus*). *Journal of Reproduction and Fertility* **29:** 99-103.

Lincoln GA & Ratnasooriya WD (1996) Testosterone secretion, musth behaviour and social dominance in captive male Asian elephants living near the equator. *Journal of Reproduction and Fertility* **108:** 107-113.

Piyadasa K, Dangolla A, Rajapakshe C, Rajapakshe E, Horadagoda N, Pushpakumara A & Windsor P (2017) Postponement of musth in Asian elephants using a GnRH Vaccine. *Gajah* **46:** 32-35.

Rajaram A (2006) Musth in elephants. *Resonance* **11:** 18-27.

Somgrid C, Homkong P, Sripiboon S, Brown JL, Stout TAE, Colenbrander B, Mahasawangkul S & Thitaram C (2016a) Potential of a gonadotropin-releasing hormone vaccine to suppress musth in captive male Asian elephants (*Elephas maximus*). *Animal Reproduction Science* **85:** 111-120.

Somgrid C, Sripiboon S, Mahasawangkul S, Boonprasert K, Brown JL, Stout TAE, Colenbrander B & Thitaram C (2016b) Differential testosterone response to GnRH-induced LH release before and after musth in adult Asian elephant (*Elephas maximus*) bulls. *Theriogenology* **85:** 1225-1232.

Yon L, Kanchanapangka S, Chiyabutr N, Meepan S, Stanczyk FZ, Dhal N & Lasley B (2007) A longitudinal study of LH, gonadal and adrenal steroids in four intact Asian bull elephants (*Elephas maximus*) and one castrate African bull (*Loxodonta africana*) during musth and non-musth periods. *General and Comparative Endocrinology* **151:** 241-245.

Chemical Restraint and Translocation of a Bull Asian Elephant that Strayed into a Zoo

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Introduction

Incidences of wild pachyderms straying into human habitation are on the rise especially in areas bordering forests. Male Asian elephants (*Elephas maximus*) leave their family group as they approach sexual maturity and spend as much as 90% of their lives alone or in loose association with other bulls (Subramanian 2010). Some males, to gain in size and reproductive advantage raid crops causing human injury and death, thus are considered 'problem-elephants' (Fernando *et al*. 2012). Some such 'problem-elephants' are captured and relocated as a management measure (Nigam 2009; Fernando *et al*. 2012).

Nandankanan Zoological Park lies between 20° 23' 08" to 20° 24' 10" N and 85° 48' 09" to 85° 48' 13" E in the Khurdha District of Odisha, India, and is situated within the Nandankanan Wildlife Sanctuary. Another Wildlife Sanctuary, known for its elephant population, the Chandaka-Dampara Wildlife Sanctuary is contiguous with Nandankanan Sanctuary. On several occasions in the past wild elephants have been observed in the vicinity of the Nandankanan Zoo. The last such incident was in December 2004 when a group of three elephants came near the zoo.

The elephants in the zoo are housed in an enclosure, 20,000 m^2 in extent, with natural vegetation, tall trees and a pond. A night shelter is situated in the middle of the enclosure where the elephants are tethered when the zoo is closed for visitors. The elephants are taken for a walk of about 4 km daily into the sanctuary forest area, after returning they are let loose during daytime.

On 29.12.2014 early morning, a wild Makhna (tusk-less male) was discovered by the animal keepers, hiding behind the bushes inside the elephant enclosure. The Makhna had entered the enclosure by breaking a 1.5 m high brick wall and crossing a 3 m wide 1 m deep dry moat. He had injured a female elephant housed there. The female named Basanti suffered superficial skin lacerations on the left pinna and left forelimb. She was about 50 years old and was in oestrous on that day. She had previously given birth to three offspring, all of whom were independent and not housed with her. She was not bred after the third parturition, due to the absence of a suitable male, but she came into oestrous regularly.

The intruder was driven out of the zoo by means of firecrackers and beating of drums. He was very agile and ran very fast with his tail raised when chased. When confronted, he did not display any aggression towards us, but tried to move stealthily, hiding behind bushes. It took about 5 h for the zoo staff to drive the Makhna out of zoo boundary and about 2 km into the sanctuary forest area. The drive was called off after that presuming that it will go away in the night.

However, it returned on the intervening night of 1st and 2nd January 2015, further injured the same female elephant and went away. The left pinna was severely injured this time and a piece of cartilage was severed (Fig.1) probably due to biting and pulling of the pinna. There was also a puncture wound on the right pinna. During the incident Basanti's left forelimb and right hind limb were chained to iron poles located in front and back of the elephant. At the time, there were two more female elephants, aged about 61 years and 18 years, tethered in the same shelter. But the Makhna only injured Basanti on both the occasions.

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Considering the situation and the danger to the female, it was decided to capture and relocate the male.

Capture and translocation

On 2nd January 2015 morning, a capture team of fourteen, composed of a Forest Officer, a veterinarian, a biologist and other field staff searched for the male and found it inside the Wildlife Sanctuary forest about 1000 m from the zoo. It was then decided to allow the Makhna to re-enter the elephant enclosure and prevent its escape, so that it can be immobilised. Two Kunkies (trained elephants) were brought from the nearby Chandaka-Dampara Wildlife Sanctuary for the operation. In the intervening night of 2nd and 3rd January 2015, staff was stationed at vantage points all around the enclosure to detect the entry of the Makhna. Communication within the capture team members was maintained through VHF handsets.

On 3rd January 2015 about 2:00 a.m. the Makhna again entered the elephant enclosure along the same route it had followed previously. Upon entry, the escape routes were sealed by the capture team and the elephant kept under surveillance. Then the Makhna tried to escape through the same route, but all the exits were guarded and blocked by burning wood and tyres. Then the Makhna stood calmly behind the bushes inside the enclosure. At dawn, he once again tried to flee, but failed. A 5 ml dart was prepared with 4 ml Ilium Xylazil-100 (xylazine HCl 100 mg/ml, Troy Laboratories Pty Limited, NSW 2164) and 1 ml of Ketamil-100 (ketamine HCl 100 mg/ml, Troy Laboratories Pty Limited), with 63 mm long collared needle. The doses were determined based on an assessed body weight of 3000 kg and xylazine HCl @ 0.13 mg/kg body weight and ketamine HCl @ 0.03 mg/kg body weight.

Figure 1. Basanti's left pinna showing wrinkles after losing a piece of cartilage.

Chemical immobilization is commonly used in capture and translocation of elephants. In the present case xylazine HCl and ketamine HCl were successfully used to achieve standing sedation. Xylazine HCl has been used at a dose rate of 0.08 mg/kg to 0.14 mg/kg in sedating elephants due to its excellent analgesic and muscle relaxant properties, high therapeutic index and ability to induce trunk immobilization (Sarma & Pathak 2001; Fowler & Mikota 2006). When used alone, it produces hypothermia and decreased heart rate and cardiac output, followed by hypotension and respiratory depression (Fowler & Mikota 2006). Ketamine HCl on the other hand produces increased respiratory and heart rate, muscular tremors and stiffness of skeletal muscle (Pathak 1991; Fowler & Mikota 2006). Hence, when used in combination, ketamine HCl mitigates the hypotension and respiratory depression property of xylazine HCl (Nath *et al*. 2010) to achieve effective standing sedation. It also reduces the required dose of the individual drugs up to 50% (Nair *et al*. 2009). Xylazine HCl and ketamine HCl mixture has been extensively used in elephants to obtain an effective and balanced sedation where the animal can be coaxed to obey commands and retains the vital functions (Cheeran 2008; Nath *et al*. 2010).

The Makhna was darted employing a Dist-inject™ Model 60N syringe projector using a white cartridge from a distance of about 20 m. The drug was injected deep intramuscularly in the left thigh. As the dart hit, the elephant moved forward about 50 m, then remained standing there. The elephant showed signs of sedation ten minutes post injection, manifested by slowing of tail, trunk and ear movements and partial relaxation of penis. After another ten minutes there was complete protrusion of penis, flaccid trunk and salivation. The rectal temperature was recorded as 36.5°C, respiration

7 breaths/min, and heart rate 40 beats/minute. Rectal temperature was within the normal range (36–37°C). Respiration rate and heart beat, were on the higher side as against the reference value of 4–6 breaths/min and 25–30 bpm respectively (Subramanian 2010), possibly as a result of the excitement during tranquilisation. The elephant was approached from three sides using two Kunkies and a captive female elephant of our zoo. Bedi chains (chains meant for close tying of fore and hind limbs) were tied onto both rear and forelegs. Bedi chains of an 18-year old female elephant of the zoo fitted the Makhna. It was then made to move forward by pushing with Kunkies (Fig. 2) for about 30 m to reach the tethering place in the enclosure where the four legs were tethered separately. After tethering securely, the sedation was reversed using 50 mg of the antidote Reverzine (yohimbine HCl, Bomac Pty Limited, NSW 2077 Australia) intravenously. The elephant was kept tethered until the next morning. He accepted banana stems, *Ficus* branches, other fodder and water provided during the period.

Early morning the next day, the elephant was again sedated with the same drug and dose employing the syringe projector. After standing sedation was achieved, the four limbs were tied separately with thick sling straps and iron chains and then the four straps were gathered together at the top of the elephants back to facilitate hanging in a crane hook. For balancing, a conveyor belt was wrapped under the abdomen of the elephant with the help of thick sling straps. All the straps and chains were united by a safety strap and attached to the crane hook. The elephant was lifted off its

Figure 2. Makhna under sedation being guided by the Kunkies to the tethering place.

Figure 3. Lifting of the elephant in standing sedation.

feet in a standing position using a crane (Fig. 3) and placed in a truck. The procedure adopted for lifting the elephant was practiced previously by Nath *et al*. (2010) in the case of an aggressive captive male elephant. After placing in the truck, the straps on the four limbs of the elephant were tethered to hooks in the truck so that it could not move during transportation. Then the truck carrying the sedated elephant in standing position proceeded towards core forest area of Chandaka-Dampara Wildlife Sanctuary, about 50 km from the zoo.

After travelling for about 45 min, the elephant was found to be reviving and becoming aggressive. It was immediately re-anesthetized with 300 mg of xylazine HCl and 100 mg of ketamine HCl and transport was resumed. After another one hour of travel, we reached the release location. The four limbs of the elephant were freed from truck. The belts and ropes were fixed again in the crane hook and the sedated elephant was lifted and taken out of the truck using a crane. Five litres of fluid including dextrose normal saline, normal saline (0.45% w/v of NaCl) and Ringer's lactate were administered intravenously into an ear vein to reduce translocation stress and 50 mg of yohimbine HCl was administered to achieve reversal of anaesthesia. Seven minutes post injection, the sedation waned off and the elephant moved away slowly into the forest.

After about one month of its release into the Chandaka-Dampara Wildlife Sanctuary, villagers of Patharagadia, a village on the outskirts of

the sanctuary, reported a Makhna attacking and killing buffaloes. More such reports of buffalo attack by a Makhna were received from other nearby villages also, and forest officials of Chandaka Sanctuary confirmed that it was the same Makhna that was released, as it was of same height and there were no tusk-less males found in the herd of elephants inside the sanctuary.

In April 2015, three months after the release, a portion of the boundary wall of the sanctuary area of Nandankanan was found broken and elephant dung was found near it. Such incidents were repeated at intervals. On 11th January 2016, three sub-adult elephants (two males and one female) of 6–7 years age, from the 'Rearing Centre' of the Nandankanan Zoo, were moved to the enclosure. All six elephants in the enclosure were tethered in the same shed. On 23rd February 2016 morning, the keepers reported that the male tethered opposite Basanti had suffered injuries on the trunk and base of right pinna. The brick wall of the enclosure was also broken, elephant dung was found in the enclosure and there were signs of a fight between the two elephants. However, on searching no additional elephants were found in the sanctuary area. Similar incidences happened on 9th May 2016 and 26th November 2016 and the same male elephant tethered near Basanti was injured, with injury to pinna, trunk and there was bleeding from the base of the left tusk. It was assumed that the same Makhna was coming time and again to confront the zoo male.

Subsequently in December 2016, the boundary of the elephant enclosure was reinforced with strong iron bars and cross angles. After that, till now the Makhna has not been seen again near the sanctuary or zoo area.

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References

Cheeran JV (2008) Drug immobilisation – Yesterday, today and tomorrow. *Gajah* **29:** 35-38.

Fernando P, Leimgruber P, Prasad T & Pastorini J (2012) Problem-elephant translocation: Translocating the problem and the elephant? *PLoS ONE* **7:** e50917.

Fowler ME & Mikota SK (2006) Chemical restraint and general anaesthesia. In: *Biology, Medicine, and Surgery of Elephants*. Fowler ME & Mikota SK (eds) Blackwell Publishing, Oxford, UK. pp 99-110.

Nair KNM, Chandrasekharan K & Radhakrishnan K (2009) Management of surgical affections in captive elephants. In: *Health Care Management of Captive Asian Elephants*. Ajitkumar G, Anil KS & Alex PC (eds) Kerala Agricultural University Press, Thrissur, Kerala, India.

Nath I, Samantara S & Purohit KL (2010) problems encountered during translocation of an aggressive captive Asian elephant and its successful management. *Gajah* **33:** 65-67.

Nigam P (2009) Experiences of restraining elephants in 'musth'. *Indian Forester* **135:** 1377-1382.

Pathak SC (1991) Xylazine-ketamine anesthesia in Indian elephant (*Elephas maximus indicus*) trial on 53 clinical cases. *International Seminar on "Veterinary Medicine in Wild and Captive Animals"*. 8-10 November 1991, Bangalore, India. pp 21.

Sarma KK &Pathak SC (2001) Cardio vascular response to xylazine and Hellabrunn mixture with yohimbine as reversal agent in Asian elephants. *Indian Veterinary Journal* **78:** 400-402.

Subramanian KS (2010) *Veterinary Management of Captive Asian Elephants*. Tamil Nadu Veterinary and Animal Sciences University & Central Zoo Authority, Chennai.

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Memories of Ajay Desai (24.7.1957 – 20.11.2020)

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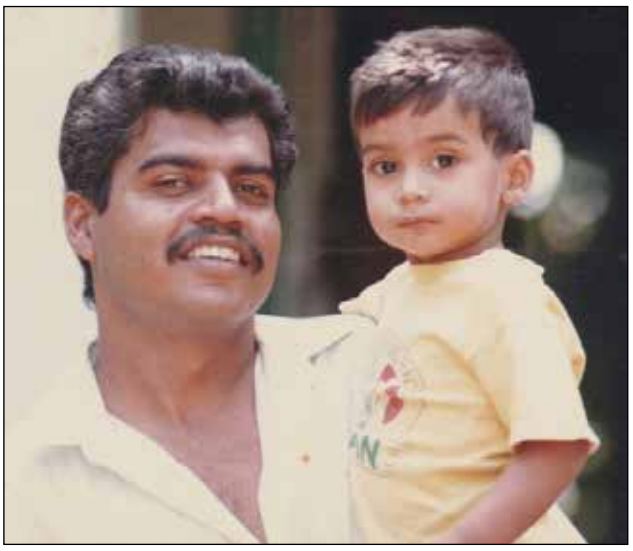
Many conservationists in India and almost all Asian elephant experts are paying glorious tributes to Ajay Desai, who was gathered to Heaven in the wee hours of 20th November 2020.

It was in the year 1982 that I met Ajay Desai for the first time, when he had come to the Bombay Natural History Society (BNHS) to appear for an interview, hoping to get selected as a research fellow in the BNHS Elephant Project funded by the US Fish and Wildlife Service. I had been appointed to help select and train two researchers for this important project. The late Mr. J.C. Daniel, former Chairman of the IUCN Asian Elephant Specialist Group (AsESG), was the overall in-charge of the project. Ajay was a post-graduate in marine biology from Karnataka University. He was exceedingly handsome, with dark hair (which in later years turned completely grey) and a finely trimmed black moustache with a fit physique – as he was a sprinter and football player and had represented Karnataka University in the inter-university meets. Ajay was knowledgeable and articulate and so he was the first to be selected for the project, along with N. Sivaganesan (Siva), who had done his Master's in Wildlife Biology from AVC College, Tamil Nadu. Siva was also a sprinter.

After returning from the Conservation Research Center, Smithsonian Institution, Front Royal in November 1981, and before moving to the Wildlife Institute of India in March 1985, I was living in Palayankottai with my wife and two sons. So I started the elephant project in the Mundanthurai Plateau, part of present-day Kalakad-Mundanthurai Tiger Reserve (KMTR), as there were four captive free-ranging elephants, a cow and three tuskers. The distance between Mundanthurai and Palayankottai is 60 km, both are in the Tirunelveli District, and so it was convenient for me to travel to and fro. The elephants had been brought to Mundanthurai from the Anamalai Wildlife Sanctuary to drag and pile the timber that had been felled in the area where the Servalar Reservoir has been built. At that time, I had with me about 70 scientific papers on elephants, and we (Ajay, Siva and I) spent time reading and discussing the papers and observing the elephants. With the help of V. Chelladurai, a reputed local botanist, we recorded and identified the plants in the habitat where the elephants were ranging, with special attention to the species on which the elephants had fed and avoided. Once, while carrying out vegetation studies on the hill in front of Mundanthurai Forest Rest House, I saw Ajay abruptly leap 2 feet up in the air. The reason was, he was about to step on a 3-feet long Russell's viper.

We went on several excellent treks in the southern Western Ghats, looking for and observing elephants, other animals and studying the flora. One night, we slept on the terrace of an unfinished building in Thalayanai in the Kalakad Range, part of present-day KMTR. That day, we spent a lot of time looking for a group of elephants, which were in the vicinity, as indicated by dung and



feeding signs, but we failed to locate the group. That night, the moon was full, and around 11 pm, we heard some heavy animals walking over the dry leaf litter. When we peeped over the short sidewall of the building, we saw a group of 10 elephants, followed by a tusker, walking along the trail close to the building. The tusks of the bull were gleaming in the moonlight. Although there was no wind and we were silent, the elephants, known for their enormous capabilities, sensed our presence, stood still for some time, and then walked towards the forest boundary.

The next morning, we tracked the elephants and found them feeding on the fronds of some palmyrah (*Borassus flabellifer*) trees which they had pushed down at night. On such occasions of tracking elephants on foot, I made it a point to brief Ajay and Siva of the importance of silence in walking, the wind direction, and the direction of the sun. With the wind on the face and the sun behind, a person if silent and using suitable cover, can approach a solitary elephant very close. This may not work while approaching a group of feeding elephants, as the group would often be dispersed. It would be much safer to approach elephants in broken terrain, as the steep slopes would give an opportunity to the observer to escape, if he/she was chased.

Ajay took note of all that I said very seriously and later became an expert in tracking elephants on foot. When I warned both Ajay and Siva that one should never give an opportunity to a wild elephant to chase them, Ajay said with a laugh "I am a sprinter, when chased by an elephant I will run faster than Carl Lewis and escape the elephant." It is to be remembered that Carl Lewis is an American track-and-field athlete who won nine Olympic gold medals during the 1980s and 1990s. My dictum in the elephant jungle was to see the elephants before they saw us and hear them before they heard us. This is possible as elephants often make some sort of sound, either while feeding or by rumbling or flapping their ears in hot weather.

One of our memorable treks was in April 1983 in the Thirukurungudi Range, the southern-most range of KMTR and the southern-most habitat of elephant, tiger and Nilgiri tahr in the Western Ghats. We spent two nights in Naraikadu (3000 feet), a property of Dhonavur Missionaries (to reach this place, one has to walk 9 km from the foothills, ca. 250 feet) and spent the third night below a large rock atop Kottangathatti (5000 feet) and the fourth night in a 'cave' known to Jothi, our 60+ year old local guide. Besides Jothi, three more had accompanied us: a local assistant to carry our provisions; Gurusamy, a famous volleyball player, my college mate in St. Xavier's College, Palayankottai (we both had played for the college team); and Sridhar who was practicing karate. Both Gurusamy and Sridhar were working in the State Bank of India and Sridhar had joined us on the trip seeking 'adventure'. The 'cave' at an altitude of 3600 feet was only a slanting rock facing east and, in the shelter of the slanting rock, about 10 persons can sleep on the ground.

Dusk was setting in and heavy mist was descending as we reached the 'cave'. As soon as I entered the 'cave', I noticed a pair of old leather sandals, a walking stick and a string pouch with some pesticide in it. When I walked to the edge of the 'cave' and looked down, I saw a skeleton and it immediately occurred to me that these objects could be the remains of a leopard that had been killed. In summer cattle were taken to the hills in the past for grazing where poisoning of the predators (tiger, leopard and dhole) was common. But when I went closer and observed the object carefully I found that it was an intact bleached human skeleton. It was the size of the skull that I had seen first that had given me the initial impression that the skeleton might be of a leopard.

Everyone came and saw the skeleton. Sridhar, on seeing the skeleton, started crying and pleaded with Jothi to take us to some other place for the night. But Jothi firmly told everyone that there was no other place to go to in the gathering darkness. Soon, a good amount of grass was cut and placed on the uneven ground to be used as a bed. The local assistant went down to the nallah below and brought water and firewood. Chapathi and some sabji were cooked and after our frugal supper, the question arose as to who would sleep at the end where the skeleton was lying. Brave Jothi told us that as he was old and was not going to lose anything at this age, would not mind sleeping closest to the skeleton.

Now, we had to decide who would sleep at the other end. Ajay had a sleeping bag and I had a long loose bag made of silk cloth, which could be used like a sleeping bag. So, I told Ajay that since he had the sleeping bag, he could sleep at the other end. Before I could finish saying this, he promptly threw his sleeping bag towards me and said that as I was older than him, I could sleep at the other end while he would happily sleep next to me on the inner side. Gurusamy gave Sridhar some gin to drink and encouraged him to sleep in the middle, where, he was told, he would be totally safe. After that, there was no further discussion about who will sleep where. The long walks during the last three days in the mountainous terrain had made everybody tired and we all slept peacefully.

In November 1983, we once climbed Perungundru (5600 feet) in the Anamalai Wildlife Sanctuary and saw about 40 Nilgiri tahr. In the same month, Ajay and I trekked along the Vengoli Ridge (3675 feet) in the Parambikum Wildlife Sanctuary and saw 12 tahr at the end of the ridge. Now tahr are seldom seen in the Vengoli Ridge. One of our favourite places to stay in Parambikulam was the Thunakadavu Forest Rest House, right on the south-eastern shore of the Thunakadavu Reservoir. Our great attraction there was the abundant blue-finned mahseer in the reservoir. Ajay was extremely fond of playing tricks on others and he was awfully good at it. One day while staying in Thunakadavu, he went out with my fishing rod and beaming, brought a 4-kg

mahseer and told everybody that he had caught the fish with the rod. When the fish was checked, we found that it had already been killed by an otter, which had chewed its head and left the remains on the shore – an inexplicable behaviour of otters.

Our major study site was Mudumalai Wildlife Sanctuary and the place of stay for the research team (Ajay, Siva and the famous Elephant Doctor Krishnamoorthy), was a building renovated by the BNHS, with permission from the Forest Department. This was in Upper Kargudi, where elephant and gaur often walked through the area. Sloth bears were also frequent visitors and in fact before renovation the building was often used by sloth bears as their den. That's why the building was called Karadi (sloth bear) bungalow. I may be correct that there were five rooms. The central room was used as a hall to receive visitors and served as the dining room. A kitchen, bathroom and toilet were behind the main building. Siva's room was at one end and Ajay's room was at the other end.

As I said earlier, Ajay was fond of playing tricks on others. He did not spare even elderly Dr. Krishnamoorthy, a chain smoker. Ajay would take out tobacco from Dr.'s cigarettes and fill them with elephant dung. Later while smoking Dr. would say "Ajay, the flavour of this cigarette is different". Eventually Dr. came to know about this but being a good-natured man he with a sense of humour accepted it light-heartedly. Dr. was an excellent cook and to assist him there was Bomma, a kuruba tribal, 4 feet tall. Some times Bomma would go with us to the field. Like all tribal assistants, for our safety in the elephant jungle he would go in front and while going

through tall grass often only his unkempt hair would be visible.

One night after Siva went to sleep, Ajay covered himself with a dark woollen blanket, went out of the building and scratched the glass window close to Siva's bed. Siva got up and saw a black form outside. Then Ajay growled and Siva thought it was a bear and so he screamed and ran to Ajay's room to tell him about the angry bear that was just outside his window. When he found that Ajay was not on his bed and his blanket was also missing, it dawned on him that Ajay had played a trick. This became a joke to talk and laugh about for several months to come. There was great fun in the field station.

Ajay's work in Mudumalai involved studying the behaviour of elephants and finding out their ranging patterns and habitat use. For this he even radio-collared some elephants. One radio-collared female known as Wendy and her group even crossed the traffic-high Kallar corridor, which is on the Mettupalyam-Ooty Highway (NH 181). This capability of Wendy to range ca. 90 km from the place of capture came to light only because of radio-collaring. Ajay has written about crucial elephant corridors and human-elephant conflict in South India and has studied the dispersal of elephants into Andhra Pradesh from Tamil Nadu.

One major threat which came to the elephant and tiger habitat in the lower Nilgiris in 2008–2009 was the plan to establish an India-based Neutrino Observatory (INO) in a man-made 2 km deep tunnel in the 2400 m Glenmorgan mountain, a potential Nilgiri tahr reintroduction site. The project and associated developments would have caused enormous disturbances to the elephant and tiger habitat. Ajay helped a lot in stalling the project by speaking about it and giving a useful report to the Ministry of Environment and Forests, which then was headed by Hon'ble Jairam Ramesh.

Another extremely valuable contribution by Ajay and his WWF India colleagues was the report against the proposed railway track from Sathyamangalam (Tamil Nadu) to Chamaraja

Nagar (Karnataka), which would have contributed to the fragmentation of prime elephant and tiger area in the Lower Nilgiris. Ajay was a guru, friend and advisor to Krupakar-Senani, Mysore based great friends, who have made the internationally famous film 'Wild Dog Diaries'.

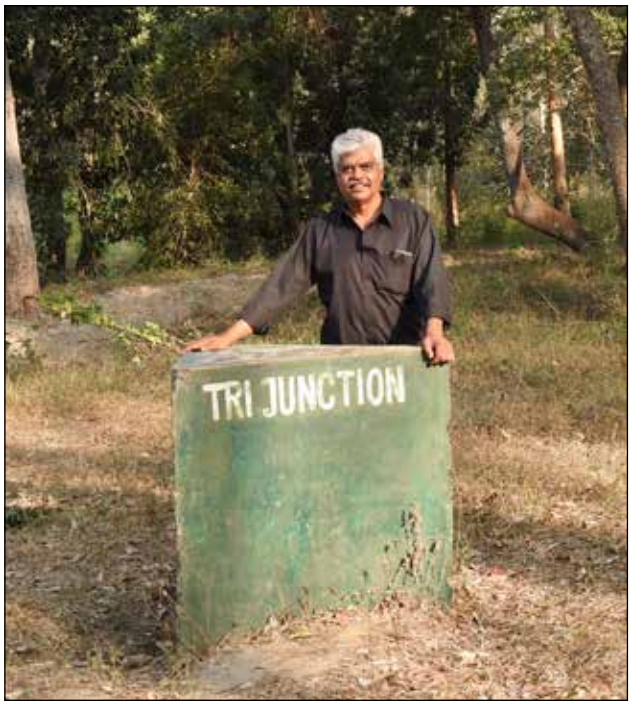
The Mudumalai landscape continued to be the main study area of Ajay. But he also visited other elephant areas in India, and over the years, his knowledge of elephants grew so much that he had the distinction to be Co-Chair of the AsESG and a member of several other important committees in India related to elephant conservation. Apart from India, he also worked on elephant and other large mammal conservation and conducted training of field officers in a range of countries – Sri Lanka, Bhutan, Nepal, Indonesia, Cambodia, Laos, Vietnam and Malaysia. Christy Williams, then working with WWF-International, facilitated most of Ajay's visits abroad.

As Ajay was knowledgeable, good-natured, humorous, and dedicated to conservation, he was immensely respected and liked by most of his colleagues, although some were put off by his overbearing and argumentative nature. He had developed a special rapport with the Kuruba tribals in Mudumalai who have an excellent knowledge of the forests and its denizens. Particularly he was very friendly with the tribal elephant mahouts and they had immense love and respect for Ajay. Taking immense time and effort, he trained many students from AVC College, Mayuram, Tamil Nadu, in various aspects related to elephant research and – as rightly pointed out by MD Madhusudan , a good friend of Ajay –

this was remarkable as these students were from a rural background and poor in basic knowledge of wildlife and in spoken and written English.

While working in Mudumalai, he had applied for a faculty position at the Wildlife Institute of India. He was selected for the 'C' position and he did not join as he possibly rightly thought that he deserved the 'D' position. Interestingly, in 1994, I had signed all five copies of his thesis on the 'Ecology and Behaviour of Elephants in Mudumalai Wildlife Sanctuary' and had asked him to submit the thesis in Saurashtra University, where he had registered under my guidance. Soon after signing, I left for Vietnam for three months and for reasons only known to Ajay, he failed to submit his thesis.

His recent assignment was as a part of the three-member committee (the other two were Justice K. Venkatraman, former judge, Madras High Court, and Praveen Bhargav, Trustee, Wildlife First) appointed by the Supreme Court of India to help the Government of Tamil Nadu to establish the Sigur (Singara) Corridor, a crucial elephant pathway in the Mudumalai landscape. Ajay went with the committee to the corridor area on 7th November 2020 and this was the only field visit Ajay had made, during the entire covid-19 period. In the corridor area, they had all climbed the Vibhuti hillock, from which one can get a good view of the corridor, and they also went to Ooty. According to Praveen, Ajay did not show any sign of discomfort either while climbing the hillock or while walking around in Ooty, which is at an altitude of ca. 7500 feet, about 4500 feet higher than the corridor landscape. Ajay was very dedicated to the establishment of this corridor and most likely this may have given him the extra energy for the field trip, suppressing his health problems, about which he kept silent and were not known to others.



Ajay suffered from gout and yet he was fond of non-vegetarian food including red meat. This combined with lack of exercise during the covid period and day and night hard work related to conservation, possibly gradually had taken a toll on his health, which he, being who he was, was not willing to talk to anyone. Ajay was a non-smoker and avoided drinks too, but he was a foodie. He loved all kinds of food from exotic to the plainest. A simple dal just boiled and eaten with plain rice was his favourite. This aggravated the gout he suffered from. His wife Shanti told me that ultimately it was the heavy work, going on day and night without much sleep, that took a toll on his health. Ajay suffered a massive heart attack in the wee hours of 20th November 2020 and passed away in his sleep.

On the evening of the 20th November 2020, I came to know about the extremely painful news of Ajay's death and I was unable to control my tears. I requested my friend K. Ravi Kumar, a talented plant taxonomist and a good friend of Ajay, to come and stay with me for the night. We both had supper, and talked and talked about Ajay and then around 11:30 pm, I went to sleep. Ravi stayed awake, checking messages in his mobile. I woke up around 3:00 am and the first thought that came to my mind was that Ajay was no longer alive. Warm tears streamed down my cheeks and I wished and prayed that it was only a horrible dream but that was not to be. Ajay has left an immense void in the life of many who knew him well, and has gone forever. Only time will slowly fill that enormous emptiness.

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Birth and Death Anniversaries of Lyn de Alwis (27.10.1930 – 22.11.2006), Chairman Asian Elephant Specialist Group 1985 – 1997

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This past 27th October and 22nd November 2020 marked respectively the 90th birth and 14th death anniversary of the eminent and world-renowned Sri Lankan wildlife and zoo expert, Lyn de Alwis.

How do you pay homage to an individual of the calibre of Lyn? Just narrating his accomplishments alone would not be a fitting eulogy for a person who was much more than the sum of his achievements. To portrait Lyn not only as an internationally acclaimed wildlife and zoo expert but also to highlight the man behind his true persona – the man who drew the respect, love and loyalty of a vast number of people ranging from scientists to wildlife trackers and the general public.

Delving into publications, tracing old interviews, contacting former colleagues and getting firsthand accounts and by reading through reminiscences of friends, contemporaries and adherents, I have strived to provide a succinct profile of probably Sri Lanka's greatest wildlife expert and conservationist. With the passing away of Lyn de Alwis one of the most glorious eras of wildlife conservation in Sri Lanka came to an end.

During Lyn's tenure as the Director of the Department of Wildlife, the first intensive behavioural and ecological studies of the Asian elephant (*Elephas maximus*) were conducted in Sri Lanka. In 1966, the Department of Wildlife and the Wildlife and Nature Protection Society made a request to the Smithsonian Institution in the USA to initiate a detailed study of the Sri Lankan elephant. The Smithsonian put together a team that included Drs. Fred Kurt, Melvyn C. Lockhart, George M. McKay, and Robert Olivier with Dr. John F. Eisenberg as the team leader. They conducted their studies from 1967–1978. Following up on it several additional studies were carried out by graduate students at the University of Peradeniya until the 1980s. The Ceylon Project, as it was known by the Smithsonian Institution, included research on elephants (1967–1978) and primates (1968–1982).

How much the Department of Wildlife, its personnel and especially Lyn was valued for their cooperation can be assessed when reading the acknowledgements of the publications that were published as a result of the project. In *An Ecological Reconnaissance of the Wilpattu National Park, Ceylon* (1972), John Eisenberg and Melvyn Lockhart mention how "in 1966, The Wild Life Protection Society of Ceylon and the Ceylon Department of Wildlife sent a request to the Smithsonian Institution for advice and/or help in the organization of an elephant study program." They also mention the support they received from Lyn: "Mr. Lyn de Alwis, Director of the Zoological Gardens at Dehiwala and Warden of the Wild Life Department of Ceylon – without the aid, assistance, and encouragement of Mr. de Alwis, the project could not have achieved success." George McKay makes a similar statement in his article on the *Behavior and Ecology of the Asiatic Elephant in Southeastern Ceylon* (1973): "My thanks to the entire staff of the Department of Wild Life, under the direction of Mr. W. [Lyn] E. de Alwis, who provided the cheerful cooperation without which none of this work would have been possible."

Another major achievement of Lyn was designing the award-winning Singapore Zoo and Night Safari. It was what Lyn had achieved at the Dehiwala Zoo that attracted the Singapore authorities to invite Lyn to set up their new zoo in 1970 in a 225-acre land. In a July 1996 interview

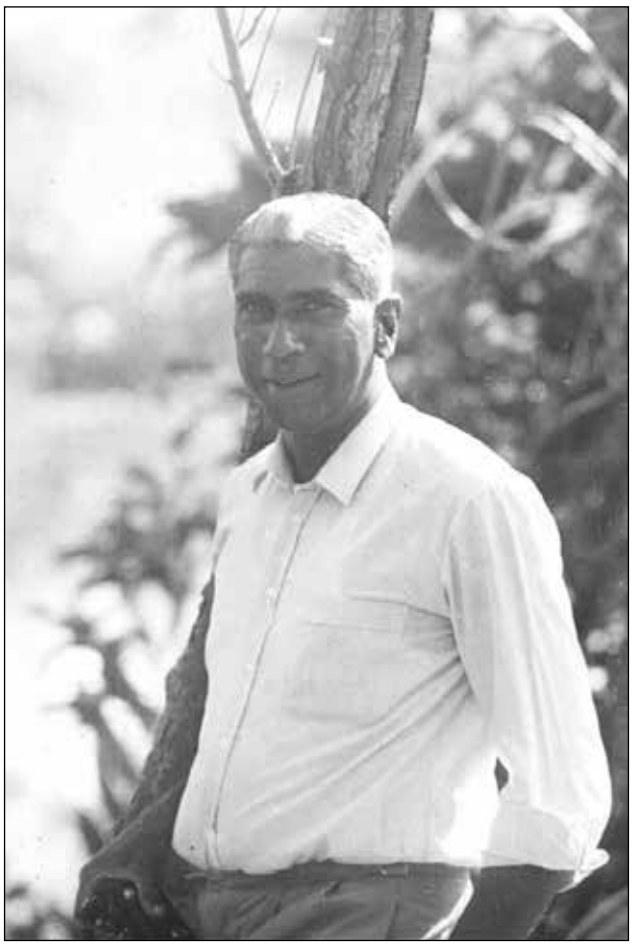
Lyn stated: "They [Singapore authorities] knew what they wanted, having toured many zoos, particularly in the US and Europe. They saw what we had at Dehiwela and decided to give us the job."

As the 2nd Chairman (1985–1997) of the IUCN/SSC Asian Elephant Specialists Group (AsESG), Lyn reached out to Vietnam, Cambodia, Laos, Myanmar (Burma at the time) and China, which were all countries that were closed to foreigners. As Lyn observed at the time: "We must look at the whole of Asia and not just a few countries… where the Asian elephant survives…"

And apparently Lyn got results: "Burma´s Minister of Forestry has been most enthusiastic and he personally invited us to his country. He sent us under escort to elephant country in difficult areas and himself organized a workshop. We made a similar approach to Cambodia and they were very open and very keen. We have also sent a group to Vietnam and right now we are getting into Laos… all three countries are keen on protecting this heritage…, AsESG is also involved with elephant conservation in Szechuan in southern China, where there is likely to be an estimated population of 300 elephants."

Another exemplary quality of Lyn's was to give the people who worked for him the due recognition for their work. At the 2nd Meeting of the AsESG held at the Sri Lanka Foundation Institute in August 1980, in the meeting minutes it's recorded Lyn stating: "He believed in the exchange of views not only of top-level administrators, but also those of field officers who actually carry out the practical tasks involved in effective conservation. That was why he had decided to let the meeting hear at first hand from those officers, rather than [Lyn] read a long and boring paper. Mr. de Alwis then introduced Messrs. C.V. Jayawardena, A.B. Fernando, M.M.D. Perera, and N. Ishwaran."

Dr. Natarajan Ishwaran (2020) reminiscing about the time he worked on his elephant research work stated: "My best moments with Lyn were when I started on the WWF/IUCN Project 1783: *Conservation and Management of the*



Wasgomuwa-Maduru Oya-Gal Oya Complex of Reserves. The project was a joint effort between the Department of Wildlife Conservation (DWC) and the Zoology Department of the University of Peradeniya and Lyn was Sri Lanka's head of the project. Between September 1980 and July 1982, I spent about 20–22 days/month in the field but came back to Colombo to meet Lyn. He always had time to talk to me and was open to discussing ideas very freely. Once he came to the field when I was in a little "Gam Udawa" house with others of the DWC staff who were responsible for the new Maduru Oya National Park. What was nice about Lyn was his calm confidence; he trusted his staff and was sure about the fact that his orders would be executed to the best of his personnel's abilities. In my view the DWC had the best times when he was the Director. The same goes for the Dehiwela Zoo; it was best run when Lyn was heading it. I did some captive elephant feeding observations in the zoo to complement my fieldwork with the Smithsonian Elephant Ecology Project in Gal Oya during 1975–1977. He would come strolling around and talk to us and see if everything was going well. Sri Lankan

wildlife conservation owes a lot to Lyn whose leadership of the DWC could be linked to some of its best moments."

Many knew Lyn as either the Director of Wildlife and/or the Dehiwala Zoo, since he was the only person in Sri Lanka who held both positions simultaneously. But for those who knew him personally, Lyn leaves behind a yearning nostalgia for an era that will never come back. For me it was an honour and privilege to have known one of Sri Lanka's eminent wildlife personalities.

I first learned of Lyn from a book he had published in 1969 titled *National Parks of Ceylon, A Guide*, which 25 years later Lyn autographed when he visited my home in the US in August 1996. I came to know Lyn when I joined the Young Zoologist Association in 1974 and was later selected to be a Student Guide Lecturer in the Education Department of the Dehiwala Zoo in 1978. By then Lyn was renowned nationally and internationally for his work and achievements. When I became the General Secretary of the Ruk Rakaganno (Tree Society of Sri Lanka) in 1982, Lyn was one of the Executive Committee members, which was an incredible opportunity to talk, to listen and learn from Lyn's knowledge and experiences.

In 1996, I experienced firsthand the incredible respect and regard the international community had for Lyn. After attending the 1996 International Zoo Directors Conference in San Francisco, Lyn was coming to New York. So, he asked me to arrange a meeting with the Director of the Bronx Zoo, Dr. William (Bill) Conway who was also the President of the Wildlife Conservation Society (WCS) that managed the Bronx Zoo and four other zoos in New York City and the Coney Island Aquarium in Brooklyn. Bill himself was regarded as a "God," by the international zoo community. So, it was remarkable when I spoke to Bill over the phone and told him that Lyn wanted to visit the Zoo – he was thoroughly excited and said he was honoured. When we arrived at the zoo, I was so impressed by the extent of the hospitality Bill extended to Lyn to ensure he had a memorable visit.

All of the senior vice presidents, including Dr. John Robinson who headed the international wildlife conservation division of the WCS, were there to meet Lyn. Bill himself personally took us around the zoo in a golf-car and made sure the chief curator, Jim Doherty and all the animal keeping staff were there to provide Lyn with any information he needed. Prior to hosting us for lunch at the VIP lounge in the Zoo Restaurant, when we were in Bill's office, I saw with what deference Bill and the other vice presidents spoke to Lyn and the high regard they had for what Lyn had accomplished such as designing the Singapore Zoo and Night Safari, as the Director of the Department of Wildlife Conservation and the Dehiwala Zoo, and as the Chairman of the IUCN/SSC AsESG. Personally, I felt fortunate to be there that day and be able to bask a tiny bit on the esteem Lyn was getting.

Lyn's dedication, perseverance, fortitude, vision and leadership—is opulently encapsulated in this statement he made in a 1996 interview: "…we all talk glibly about the need for political will. But it is we who must be the instrument of securing that will."

And there is no better way to end this eulogy other than with a message Lyn wrote in February 2005, which vividly captures the essence of the person he was:

How conservation goals were achieved in the past

That the leopard became the symbol of the Wilpattu National Park by the nineteen sixties and seventies was no accident. Even as late as 1950, to sight a leopard in the park, there had to be a combination of dry weather, a good selection of deer, sambur, pig and buffalo with young calves to bring a leopard out into the open even in the fast-falling darkness. Such was the fear and uncertainty in the mind of a leopard living in the so-called security of the park.

When I became Director in 1965, I headed early for Wilpattu which to me was the most beautiful haven for animals anywhere in the world – its rolling sand-dunes, towering rockscapes, a

miniature lake every 1 km, fringed with almost manicured green plains and finally breathtaking coastline. Bird life was plentiful and visitors were assured of beauty, excitement and jungle sounds well into the night.

Yet, there were less than 2000 visitors a year. Why? There were few roads that took visitors around, no lodges to encourage them to stay and poachers who moved around fearlessly on foot, bringing down spotted deer, wild boar, bear and the occasional leopard that ventured out into the open.

But I held the trumps – dedicated fearless rangers and guards, who were always ready to do battle in order to save the lives of the animals in their charge. They would track armed gangs on foot, often lying-in ambush to apprehend the intruder and bring them to book. There were no monetary rewards because the total annual allocation for the Department was just over Rs. 600,000 (~US$ 126,315). A ranger survived on a salary of Rs. 200 (~$ 42) a month, of which Rs. 150 ($ 32) had to be sent to their homes.

We tried our best to get something more, uniforms, a hat, a raincoat, a bicycle but no sob story would persuade even the extra Rs. 50 to make the staff feel they were doing a kind of national service. So, we put our heads together and invented new sources of income. Senior staff supported me in collecting money in what came to be known as a Wildlife Preservation Fund – we appealed to magistrates to give 50% of fines back to the Department. We organized "Festivals of Wildlife Photography," we had film shows, courtesy of generous visitors, all of which helped swell the fund.

There was no jeep, so appeals went out to mercantile firms to make possible some easy payment schemes. The only foreign components came from the World Wildlife Fund, IUCN and the Fauna Preservation Society, who gave generously.

And so, we built up our little kingdoms in Yala, Wilpattu, Kumana and Gal Oya. Those were our small beginnings and by 1968–1969, Wilpattu was showing off its magnificent leopards and the battle was temporary won.

Unfortunately, the 1970s saw some reversals when I had to go to Singapore for a couple of years and the Department came to be run by bureaucrats. They were followed by foreign NGOs who introduced textbook conservation, which to the average wildlife official was incomprehensible. So, the millions of dollars from GEF, from the ADB and World Bank seem to be spent in vain. The field staff remain in the same straits as 25 years ago with very little coming their way to help in their work, improvement of social status or housing, education etc., which will raise the standards of the Department. They get very little to challenge the human-elephant conflict, the rehab of other threatened wildlife etc.

Lyn de Alwis
30 Hotel Road
Mount Lavinia

Sri Lanka lost a truly great and wonderful person the day Lyn passed away. I lost a mentor, advisor and a friend who encouraged me to venture forth, seek my dreams, passions and adventures. Lyn was a monument, a keystone, a pillar and a founding father of Sri Lanka's wildlife conservation forum. The very essence of Lyn will live on and resonate through the many people whose lives he enriched and enlightened. We are fortunate to have as founding pillars of the conservation forum in Sri Lanka, people of the calibre of Lyn. The greatest honour we can do them is to keep building on the foundations they have left for us. Lyn's outlook in life, his dedication and achievements should be an example to us all who are committed to saving species and their habitats all over the world.

Footfalls in the Wild: Reflections & Writing of the Late Deshabandu Lyn De Alwis is a posthumous compilation of Lyn's articles, speeches and presentations. For those who would like to acquire a copy please contact the Lyn de Alwis Memorial Wildlife Trust. The book can also be purchased from Amazon and Ebay.

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Book Review

Nicolas Lainé's *Living and Working with Giants: A Multispecies Ethnography of the Khamti and Elephants in Northeast India*

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Living and Working with Giants: A Multispecies Ethnography of the Khamti and Elephants in Northeast India explores the relationship between Asian elephants and the Tai-Khamti of northeast India. The Khamti are one of several 'tribal' ethnic groups in the region, a Buddhist community who maintain a culturally unique and non-institutional form of elephant keeping.

Living and Working with Giants' ethnographic research draws on Nicolas Lainé's extensive fieldwork conducted from 2008–2010, where he spoke with past and present elephant owners and catchers and observed their interspecies practices. As an anthropologist, Lainé's analysis is informed by the cultural perspectives of the Khamti, valuing how context-specific local knowledge can offer new insights into the human-elephant relationship. The core of the book is detailed descriptions of Khamti belief systems and the embodied interactions of both species, analysing in three distinct sections the activities of capturing, training and working with elephants.

The first section examines the practice of capturing wild elephants. Lainé offers a rare, 21st century documentation and analysis of *melah shikar*. This analysis includes a description of the role of *phandi* in Khamti society, how the *kunki* elephant skilfully collaborates when catching a wild elephant, and the practicalities of organizing and performing the capture, including ritual objects and negotiation with local forest and village spirits. Interestingly, the deities worshipped during *melah shikar* have connections both to accounts from the Ahom period and mahout culture in Myanmar.

The book's second section focuses on the transformative process in which the forest elephant becomes a village elephant. Lainé conceptualizes this process as more than mere 'training' or behavioural reinforcement but one of socialization: where the elephant learns to live and act within the norms of the human society and among other working elephants. The ethnographic accounts are nuanced, sensitive to both the violence and care essential to the task of socialisation. One chapter offers a fascinating analysis of the elephant training songs performed by the Khamti and explores the centrality of sound to the development of the mahout-elephant bond.

Section three analyses human and elephant entanglement through the task of logging; a practice given context within a broader political and environmental history of the northeast region. Lainé's ethnography stands out for its detailed accounts of the reciprocating interaction and shared labour of human and elephant. This is a cognitive ethology that rightfully situates elephant thinking, action, and initiative as part of an interspecies team – an intelligent collaboration and complementary performance of human and elephant bodies and minds solving common tasks and problems.

The fourth and concluding section offers an extended reflection on the book's conceptual concerns, such as: the elephant as a nonhuman labourer, the interconnection between forest and village elephants in the Khamti worldview, and – fittingly for an anthropological analysis – the need to consider the existence of elephantine culture. Lainé argues that an elephant caught learns the skills of the trade and the norms of

the Khamti human-elephant community through social transmission from other working elephants. Further, the skills learnt by the elephant as free-roaming juvenile are also necessary to the task of being a *kunki*.

Lainé explores how the cultural and economic aspects of Khamti life are organised through this interspecies relationship. However, Lainé's ethnography goes beyond a community composed of two labouring animals. The social world depicted in the book includes vital interconnections with local wild elephant herds, spirits of the forest and the village, as well the trees and plant-life which both sustain and are modified by the economic and biological needs of both human and elephant. This is an ethnography of a more-than-human community, a culturally specific, multi-species socio-ecology, and one that has evolved and continues to persist despite the dramatic political and environmental shifts in the region over the last two hundred years.

Living and Working with Giants is an exciting and unique book, documenting practices and beliefs surrounding working elephant practices in India that are dwindling in the 21st century. For that reason alone, this book is worth reading. The language and ethnographic descriptions are clear and not overburdened with jargon, and Lainé's terminology and supporting references draw on both ethnological and ethological research. The text is valuable for anyone interested in working elephant cultures beyond the problems of management. The ethnographic description of training is a welcome reprieve from sensationalized and biased accounts that dominate popular discourse on captive elephants. And for those open to alternative worldviews, the perspectives of the Khamti represented in this book can serve to challenge accepted ideas about who elephants are in society and the kinds of relationships that we can have with them.

Citation

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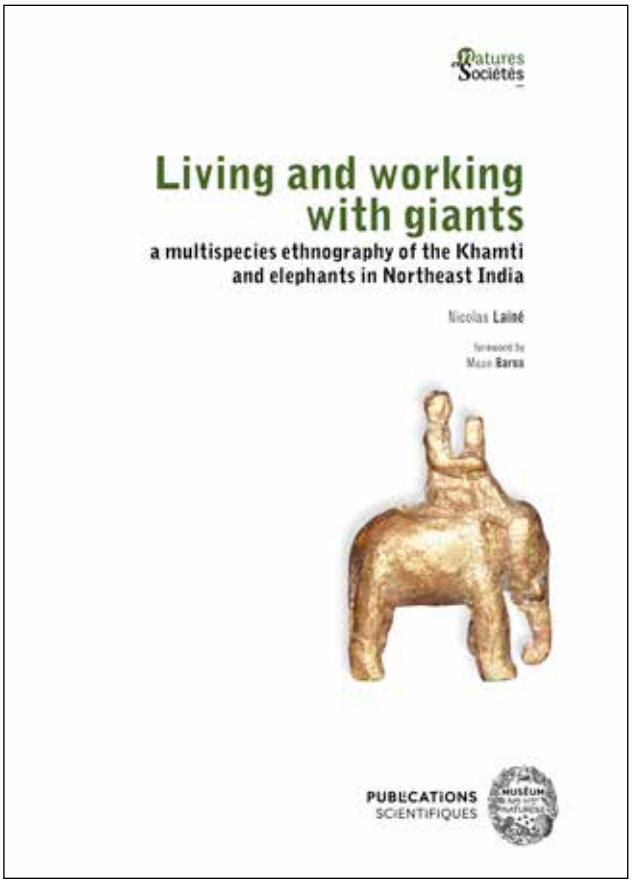

Recent Publications on Asian Elephants

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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 (2021) publications on Asian elephants.

U. Bechert, J.M. Christensen, J. Kottwitz, D. Boothe, S. Alshahrani & S. Mohammed

Pharmacokinetics of orally administered flunixin meglumine in African (*Loxodonta africana*) and Asian (*Elephas maximus*) elephants

Journal of Zoo and Wildlife Medicine 51 (2020) 905-914

Abstract. *Flunixin meglumine* is the most commonly used nonsteroidal anti-inflammatory drug used to treat elephants; however, no pharmacokinetic study for flunixin has yet been conducted in these species, and dosages used range widely. Pharmacokinetic parameters of flunixin were determined in African (*Loxodonta africana*) and Asian (*Elephas maximus*) elephants after single-dose oral administration of 0.8 and 1.5 mg/kg flunixin paste in each species. Elephant compliance to oral administration of banamine was occasionally challenging, especially among older, female African elephants. After administration of 0.8 mg/kg flunixin, mean serum concentrations peaked in approximately 1.3 h at 2.1 ± 0.8 μg/ml for Asian (n = 8) and 2.8 h at 2.5 ± 0.7 μg/ml for African (n = 8) elephants. Dosages of 1.5 mg/kg flunixin resulted in mean serum concentration peaks of 7.2 ± 1.5 μg/ml in Asian elephants (n = 7) and 4.4 ± 0.7 μg/ml in African elephants (n = 6). However, multiple-dose trials using 1.1 mg/kg flunixin resulted in peak serum concentrations that were again less in Asian than African elephants (2.7 μg/ml versus 4.4 μg/ml, respectively). Asian elephants consistently had lower time to maximal concentration, greater area under the curve, and longer mean residence times compared with African elephants. In other species, flunixin is excreted unchanged primarily via hepatic routes with small amounts in the urine. Asian elephants may engage in some level of enterohepatic recycling of flunixin, as was previously reported for phenylbutazone. This study supports that different oral dosing regimens should be used for Asian (1.0 mg/kg SID) and African (1.2 mg/kg SID) elephants, and oral administration techniques used should ensure complete dosage delivery. © 2020 American Association of Zoo Veterinarians.

L.E. Cartier, M.S. Krzemnicki, M. Gysi, B. Lendvay & N.V. Morf

A case study of ivory species identification using a combination of morphological, gemmological and genetic methods

Journal of Gemmology 37 (2020) 282-297

Abstract. Twenty-one items sold as mammoth ivory in China were submitted to the Zurich Institute of Forensic Medicine (University of Zurich, Switzerland) and SSEF for testing. The aim of this case study was to identify these samples using macroscopic morphological diagnostics, microscopic examination, FTIR spectroscopy, trace-element analysis and additional minimally destructive DNA analysis (of approximately 100 mg of powder) of a region of the cytochrome b gene to assign taxonomic identification. Morphological features (Schreger angles) shown by five of the samples were characteristic of extinct Proboscideans (mammoths), and one other specimen displayed unnatural layering that identified it as an ivory imitation. FTIR spectroscopy further showed the imitation was an artificial resin, while infrared spectra of the other samples displayed overlapping features characteristic of carbonated hydroxyapatite (i.e. ivory or bone). Like FTIR spectroscopy, trace-element chemistry cannot be used to separate

species. DNA analysis could in some cases differentiate extinct (mammoth) from extant (African and Asian elephant) Proboscidean species, and also identified one specimen as cattle bone. Combining morphological, gemmological and genetic approaches can increase the amount of evidence available to identify the species origin of ivory. © 2020 Gem-A.

R. Cazzolla Gatti & A. Velichevskaya

Certified "sustainable" palm oil took the place of endangered Bornean and Sumatran large mammals habitat and tropical forests in the last 30 years

Science of the Total Environment 742 (2020) e140712

Abstract. Tropical forests inhabited by endangered orangutans, rhinos, tigers, and elephants in South-east Asia are threatened by deforestation, including oil palm expansion. Certification has been proposed to label sustainable palm oil production. However, from a remotely sensed time-series and imagery analysis (1984–2020), we discovered that most of the currently certified grower supply bases and concessions in Sumatra and Borneo are located in the 1990s large mammals habitat and in areas that were biodiverse tropical forests less than 30 years ago. In light of this dramatic evidence, we suggest that certification schemes claim for the "sustainable" production of palm oil just because they neglect a very recent past of deforestation and habitat degradation. © 2020 Reprinted with permission from Elsevier.

E. Chaudhary, P. Jouquet, C. Rumpel & R. Sukumar

Chemical parameters of decomposing dung in tropical forest as indicators of feeding behaviour of large herbivores: A step beyond classical stoichiometry

Ecological Indicators 115 (2020) e106407

Abstract. Feeding behavior of large herbivores determines the composition of their dung and together with environmental factors the intensity of decomposition processes leading to the recycling of nutrients in tropical forests. Large herbivore dung and its decomposition has so far been characterized by stoichiometric analyses of elements such as C and N. The objective of our study was to examine the suitability of biomarker analyses and analytical pyrolysis to infer large herbivore feeding behavior and the decomposition of their dung in different environments. Our conceptual approach included exposure of fresh dung of a grazing ruminant (gaur, *Bos gaurus*) and a non-ruminant mixed-feeder (the Asian elephant, *Elephas maximus*) in two tropical forest types (dry and moist) and analysis of dung biochemical composition in two seasons (dry and wet). To this end we characterized the dungs' lignin and carbohydrate (sugar) signatures and pyrolysis products before and after 28 days of exposure. Our results showed that stoichiometric as well as biomarker analyses were able to differentiate gaur and elephant dung independent of season and forest type, while analytical pyrolysis products did not differ between dung types. The lignin signature of fresh dung additionally indicated the forage preference of animals in different forest types and seasons. During decomposition, C and N contents decreased and the chemical composition of both dung types converged. The lignin signature of dung at the end of the experiment showed higher lignin decomposition in moist forest and wet season than dry forest and dry season. We conclude that detailed biochemical analyses can provide deeper insights into the main controls of large herbivore dung and its decomposition in tropical forests than stoichiometric analysis. In particular lignin may be a suitable indicator to investigate large herbivore feeding behavior and the environmental conditions of their habitat. © 2020 Reprinted with permission from Elsevier.

H.M. Chel, T. Iwaki, M. Hmoon, Y.N. Thaw, N.C. Soe, S.Y. Win, S. Bawm, L.L. Htun, M.M. Win, Z.M. Oo, M.A. Masum, O. Ichii, R. Nakao, N. Nonaka & K. Katakura

Morphological and molecular identification of cyathostomine gastrointestinal nematodes of *Murshidia* and *Quilonia* species from Asian elephants in Myanmar

International Journal for Parasitology: Parasites and Wildlife 11 (2020) 294-301

Abstract. Gastrointestinal nematode parasites have long been recognized in Asian elephants. The most common parasites belong to the subfamily Cyathostominae of the family

Strongylidae, which are small to medium-sized with a cylindrical buccal capsule surrounded by coronal leaflets. Diagnostic keys of such parasites are provided from old illustrations in the form of line drawings. However, there very few photomicrographs and no genetic information of these parasites exist. In the present study we obtained adult worm specimens from faeces of Asian elephants after anthelmintic treatment in two elephant camps in Myanmar. Here, we provided photomicrographs for five cyathostomine parasites, *Murshidia falcifera*, *Murshidia indica*, *Murshidia neveulemairei*, *Quilonia renniei*, and *Quilonia travancra* almost 100 years after their original drawings. In addition, we determined the mitochondrial cytochrome c oxidase subunit I (COI) gene sequences of these species. Phylogenetic analysis of the COI genes of *Murshidia* and *Quilonia* species from Asian and African elephants revealed parasite speciation in each elephant host. The present study also indicated that several *Murshidia* and *Quilonia* species were widely distributed in Asian elephants in Myanmar, providing new insight into control strategies and evolution of cyathostomine gastrointestinal parasites in elephants.

S.E. Childs-Sanford, A.J. Makowski & J.J. Wakshlag

The vitamin D status of Asian elephants (*Elephas maximus*) managed in a northern temperate climate

J. of Zoo and Wildlife Medicine 51 (2020) 1-12

Abstract. Knowledge about the normal metabolism and involvement of vitamin D in elephant calcium homeostasis is essential to understanding the possible role of vitamin D in Asian elephant (*Elephas maximus*) health, as well as to informing accurate diet formulation. This study provides an evaluation of analytes involved in vitamin D metabolism, in conjunction with dietary intake and ultraviolet light (UV) exposure, in Asian elephants managed in a northern temperate climate. Once monthly, for a total of 12 mo, serum from six adult Asian elephants was analyzed for 25-hydroxyvitamin D [25(OH)D], 24,25-dihydroxyvitamin D [24,25$(OH)_2$D], 1,25-dihydroxyvitamin D [1,25 (OH)2D], parathyroid hormone (PTH), total calcium (Ca), ionized calcium (iCa), phosphorus (P), and magnesium (Mg). The diet was analyzed monthly for vitamin D, Ca, and P. Monthly average vitamin D–weighted UV daily sums were determined to gauge average UV light exposure within the vitamin D action spectrum. No serum or diet parameters were affected by time or season. Average serum 25$(OH)D_2$ was 7.02 ± 0.85 ng/ml. 25$(OH)D_3$ levels were nondetectable in all samples despite supplementation of the diet with recommended levels of vitamin D3, and UV exposure was at sufficient levels for cutaneous vitamin D synthesis for 6 mo of the year. Levels of 24,25$(OH)_2$D averaged 31.7% higher than 25(OH)D, and average 1,25$(OH)_2D_2$ was 11.24 ± 1.04 pg/ml. Values for PTH, Ca, iCa, P, and Mg were within expected ranges for Asian elephants. The information gained from this research expands the knowledge base for these analytes, evaluates 24,25-dihydroxyvitamin D for the first time, and provides new information regarding vitamin D metabolism and test interpretation in the Asian elephant. © 2020 by American Association of Zoo Veterinarians.

J.A.H. Crawley, M. Lahdenperä, Z.M. Oo, W. Htut, H. Nandar & V. Lummaa

Taming age mortality in semi-captive Asian elephants

Scientific Reports 10 (2020) e1889

Abstract. Understanding factors preventing populations of endangered species from being self-sustaining is vital for successful conservation, but we often lack sufficient data to understand dynamics. The global Asian elephant population has halved since the 1950s, however >25% currently live in captivity and effective management is essential to maintain viable populations. Here, we study the largest semi-captive Asian elephant population, those of the Myanma timber industry (~20% global captive population), whose population growth is heavily limited by juvenile mortality. We assess factors associated with increased mortality of calves aged 4.0-5.5 years, the taming age in Myanmar, a process affecting ~15,000 captive elephants to varying degrees worldwide. Using longitudinal survival data of 1,947 taming-aged calves spanning 43 years, we showed that calf mortality risk increased by >50% at the taming

age of four, a peak not seen in previous studies on wild African elephants. Calves tamed at younger ages experienced higher mortality risk, as did calves with less experienced mothers. Taming-age survival greatly improved after 2000, tripling since the 1970's. Management should focus on reducing risks faced by vulnerable individuals such as young and first-born calves to further improve survival. Changes associated with reduced mortality here are important targets for improving the sustainability of captive populations. © 2020 The Authors.

K. Denninger Snyder & D. Rentsch

Rethinking assessment of success of mitigation strategies for elephant-induced crop damage

Conservation Biology 34 (2020) 829-842

Abstract. Crop damage is the most common impact of negative interactions between people and elephants and poses a significant threat to rural livelihoods and conservation efforts. Numerous approaches to mitigate and prevent crop damage have been implemented throughout Africa and Asia. Despite the documented high efficacy of many approaches, losses remain common, and in many areas, damage is intensifying. We examined the literature on effectiveness of crop-damage-mitigation strategies and identified key gaps in evaluations. We determined there is a need to better understand existing solutions within affected communities and to extend evaluations of effectiveness beyond measurement of efficacy to include rates of and barriers to adoption. We devised a conceptual framework for evaluating effectiveness that incorporates the need for increased emphasis on adoption and can be used to inform the design of future crop-damage mitigation assessments for elephants and conflict species more widely. The ability to prevent crop loss in practice is affected by both the efficacy of a given approach and rates of uptake among target users. We identified the primary factors that influence uptake as local attitudes, sustainability, and scalability and examined each of these factors in detail. We argue that even moderately efficacious interventions may make significant progress in preventing damage if widely employed and recommend that wherever possible scientists and practitioners engage with communities to build on and strengthen existing solutions and expertise. When new approaches are required, they should align with local attitudes and fit within limitations on labor, financial requirements, and technical capacity. © 2019 Society for Conservation Biology.

G.J. Drake, J. Haycock, A. Dastjerdi, H. Davies & F.J. Lopez

Use of immunostimulants in the successful treatment of a clinical EEHV1A infection in an Asian elephant (*Elephas maximus*)

Vet Record Case Reports 8 (2020) e001158

Abstract. Elephant endotheliotropic herpesvirus haemorrhagic disease (EEHV - HD) poses a significant threat to the captive population of juvenile Asian elephants (*Elephas maximus*) and also affects elephants in the wild. In human and veterinary medicine, increasing attention is returning to the interferon system, a crucial mediator in the immune response for control of infection. We describe the first reported use of the Zelnate DNA immunostimulant and recombinant human interferon alpha (rhIFNα) as additional medications in the successful treatment of a case of EEHV1A - HD in a juvenile Asian elephant at a UK zoo. Despite an exponential rise in viraemia to a peak of 2.82×106 viral genomic equivalents/ml, only mild clinical signs developed and the calf survived with no adverse effects attributed to the novel treatments. This case is compared with a previous fatal case within the same herd where Zelnate and rhIFNα were not given. © 2020 British Veterinary Association.

S. Dror, F. Harich, O. Duangphakdee, T. Savini, Ákos Pogány, J. Roberts, J. Geheran & A.C. Treydte

Are Asian elephants afraid of honeybees? Experimental studies in northern Thailand

Mammalian Biology 100 (2020) 355-363

Abstract. In many parts of South and Southeast Asia, rural farmers living at the borders of protected areas frequently encounter Asian elephants (*Elephas maximus*) raiding their crops and threatening farmers lives and livelihoods. Traditional deterrent methods often have limited success as elephants become habituated or alternate their movement and behavior. While African bees (*Apis mellifera scutellate*) have been shown to effectively and sustainably deter African

elephants (*Loxodonta africana*) little is known about their Asian counterparts. We conducted two experiments to estimate the effectiveness of bees as an Asian elephant deterrent method. We analyzed the behavioral reaction of seven captive Asian elephants when confronted with a fence of *A. mellifera* hives blocking their way to a desired source of food. In addition, we explored the defensive reaction of five *A. cerana* hives and six *A. mellifera* hives to an artificial disturbance during both day and night time. The elephants crossed the beehive fence in 51% of the cases, the probability of crossing increased over time and the number of exposures had a significant effect on an elephant's crossing probability, indicating that elephants became habituated to the presence of the beehive fence. In the bee experiment, only one out of five *A. cerana* hives and one out of six *A. mellifera* hives reacted to the disturbance during the daytime, while during nighttime, none of them reacted defensively after being disturbed. We, therefore, conclude that neither *A. mellifera* nor *A. cerana* bees are likely to be effective in deterring wild Asian elephants from entering crop fields.

M.E. England, P. Pearce-Kelly, V.A. Brugman, S. King, S. Gubbins, F. Sach, C.J. Sanders, N.J. Masters, E. Denison & S. Carpenter

Culicoides species composition and molecular identification of host blood meals at two zoos in the UK

Parasites & Vectors 13 (2020) e139

Abstract. *Culicoides* biting midges are biological vectors of arboviruses including bluetongue virus (BTV), Schmallenberg virus (SBV) and African horse sickness virus (AHSV). Zoos are home to a wide range of 'at risk' exotic and native species of animals. These animals have a high value both in monetary terms, conservation significance and breeding potential. To understand the risk these viruses pose to zoo animals, it is necessary to characterise the *Culicoides* fauna at zoos and determine which potential vector species are feeding on which hosts. Light-suction traps were used at two UK zoos: the Zoological Society of London (ZSL) London Zoo (LZ) and ZSL Whipsnade Zoo (WZ). Traps were run one night each week from June 2014 to June 2015. *Culicoides* were morphologically identified to the species level and any blood-fed *Culicoides* were processed for blood-meal analysis. DNA from blood meals was extracted and amplified using previously published primers. Sequencing was then carried out to determine the host species. A total of 11,648 *Culicoides* were trapped and identified (n = 5880 from ZSL WZ; n = 5768 from ZSL LZ), constituting 25 different species. The six putative vectors of BTV, SBV and AHSV in northern Europe were found at both zoos and made up the majority of the total catch (n = 10,701). A total of 31 host sequences were obtained from blood-fed *Culicoides*. *Culicoides obsoletus*/*C. scoticus*, *Culicoides dewulfi*, C*ulicoides parroti* and *Culicoides punctatus* were found to be biting a wide range of mammals including Bactrian camels, Indian rhinoceros, Asian elephants and humans, with *Culicoides obsoletus*/*C. scoticus* also biting Darwin's rhea. The bird-biting species, *Culicoides achrayi*, was found to be feeding on blackbirds, blue tits, magpies and carrion crows. To our knowledge, this is the first study to directly confirm blood-feeding of *Culicoides* on exotic zoo animals in the UK and shows that they are able to utilise a wide range of exotic as well as native host species. Due to the susceptibility of some zoo animals to *Culicoides*-borne arboviruses, this study demonstrates that in the event of an outbreak of one of these viruses in the UK, preventative and mitigating measures would need to be taken.

E. Evison, A. McKenzie & L. Holmes

Social and environmental impacts on sleep in captive Asian elephants (*Elephas maximus*)

Zoo Biology 39 (2020) 397-404

Abstract. Modern zoos strive to improve standards of animal management, husbandry and welfare of their animals as part of a continual evaluation process. Elephants (Elephantidae) have received particular attention in recent years due to the challenge of providing environments which promote natural behavior and opportunities for social interaction. A number of measures have been proposed to measure wellbeing, with sleep quality increasingly being used. Sleep is a vital aspect of life for cell replenishment as well as optimal development of young. Sleep deprivation can lead to immunosuppression and illness; therefore animal managers have a responsibility

to ensure they reduce the potential for disturbance through noise, light, or other environmental factors. The social environment also plays an essential role in wellbeing, particularly for species that live in multi - generational family units. In this study the nocturnal behavior of a multi - generational captive herd was observed to determine impacts of husbandry changes on sleep duration and bout length (measured as recumbent rest). As expected, average total duration of sleep was higher in younger elephants and rates were comparable to those reported in other studies of Asian elephants. Overnight access to an outdoor paddock in warmer weather increased overall average bout length of sleep in the herd. Average total duration of sleep also increased for the herd following the movement of an unrelated adult female who had previously shown weak bonds with other herd members. This indicates that social compatibility is a vital component of elephant welfare, impacting not only behavioral interactions but sleep quality and duration.

K.M. Ewart, A.L. Lightson, F.T. Sitam, J.J. Rovie-Ryan, N. Mather & R. McEwing

Expediting the sampling, decalcification, and forensic DNA analysis of large elephant ivory seizures to aid investigations and prosecutions

Forensic Science International: Genetics 44 (2020) e102187

Abstract. The illegal ivory trade continues to drive elephant poaching. Large ivory seizures in Africa and Asia are still commonplace. Wildlife forensics is recognised as a key enforcement tool to combat this trade. However, the time and resources required to effectively test large ivory seizures is often prohibitive. This limits or delays testing, which may impede investigations and/or prosecutions. Typically, DNA analysis of an ivory seizure involves pairing and sorting the tusks, sampling the tusks, powdering the sample, decalcification, then DNA extraction. Here, we optimize the most time-consuming components of this process: sampling and decalcification. Firstly, using simulations, we demonstrate that tusks do not need to be paired to ensure an adequate number of unique elephants are sampled in a large seizure. Secondly, we determined that directly powdering the ivory using a Dremel drill with a high-speed cutter bit, instead of cutting the ivory with a circular saw and subsequently powdering the sample in liquid nitrogen with a freezer mill, produces comparable results. Finally, we optimized a rapid 2 -h decalcification protocol that produces comparable results to a standard 3-day protocol. We tested/optimised the protocols on 33 raw and worked ivory samples, and demonstrated their utility on a case study, successfully identifying 94% of samples taken from 123 tusks. Using these new rapid protocols, the entire sampling and DNA extraction process takes less than one day and requires less-expensive equipment. We expect that the implementation of these rapid protocols will promote more consistent and timely testing of ivory seizures suitable for enforcement action.

P. Fernando, S.K.K. Ekanayaka & J. Pastorini

The elephant at the fence: Almsman, panhandler, friend or foe?

European J. of Wildlife Research 66 (2020) e97

Abstract. Feeding of wild Asian elephants at the Udawalawe National Park perimeter electric fence by the general public is longstanding. We monitored the elephants and feeding activities, and conducted questionnaire surveys of stakeholders. Over 50 individual adult male elephants engaged in the activity. The exclusive male presence was consistent with a high-risk high-gain male strategy. The elephants were mostly offered fruits and vegetables. Over a thousand people a day watched and fed the elephants. Most people bought food for elephants from roadside stalls and vendors had significantly more sales if elephants were present. The feeding of elephants brought significant economic benefit to communities bordering the park. We found the impacts of feeding on the elephants and environment to be largely neutral. Impacts on people and conservation were mainly positive. Actions taken by authorities to stop the feeding have targeted the elephants and resulted in the decrease of feeding but not its elimination. Managing the activity instead would help increase economic benefits and ensure safe interaction between people and elephants. Such management, by directly benefitting local communities, could make them partners in the conservation process and form the

basis of an effective outreach program. © 2020 The Authors.

A. Fuery, T. Pursell, J. Tan, R. Peng, P.D. Burbelo, G.S. Hayward & P.D. Ling

Lethal hemorrhagic disease and clinical illness associated with elephant endotheliotropic herpesvirus 1 are caused by primary infection: Implications for the detection of diagnostic proteins

Journal of Virology 94 (2020) e01528-19

Abstract. Elephant endotheliotropic herpesvirus (EEHV) can cause lethal hemorrhagic disease in juvenile Asian elephants, both in captivity and in the wild. Most deaths associated with the virus are caused by two chimeric variants of EEHV1 (EEHV1A and EEHV1B), while two other EEHVs endemic within Asian elephants (EEHV4 and EEHV5) have been recognized but cause death less often. Whether lethal EEHV infections are due to primary infection or reactivation of latent virus remains unknown, and knowledge of the anti-EEHV antibody levels in young elephants is limited. To close these gaps, we sought to develop a serologic assay capable of distinguishing among infections with different EEHVs using a luciferase immunoprecipitation system (LIPS) for antibody profiling and a panel of conserved EEHV recombinant proteins and proteins unique to EEHV1. The results showed that elephants dying from EEHV1 hemorrhagic disease or ill from EEHV infection were seronegative for the EEHV species that caused the disease or illness, indicating that the events were associated with primary infection rather than reactivation of latent virus. We also demonstrated that waning of EEHV1-specific antibodies can occur in the first 2 years of life, when a threshold protective level of antibody may be needed to prevent severe EEHV1-related disease. Use of the LIPS assay to identify putative "diagnostic" proteins would be a valuable asset in determining the EEHV immune status of young elephants and responses to candidate EEHV vaccines in the future. Whether clinical illness and deaths associated with elephant endotheliotropic herpesvirus (EEHV) infection result from primary infection or reactivation of latent virus is a longstanding question in the field. By applying a relatively new assay, the luciferase immunoprecipitation system (LIPS), combined with the genomic sequences of the viruses, we gained the insights and tools needed to resolve this issue. Our EEHV1-specific LIPS assay should be useful for assessing the vulnerability of elephant calves to infection with different EEHVs and evaluating antibody responses to anti-EEHV vaccines. A significant proportion of the Asian elephant population is under some form of human care. Hence, the ability to screen for EEHV immune status in elephant calves should have a major impact on the management of these animals worldwide. © 2020 The Authors.

S.S. Glaeser, K.L. Edwards, N. Wielebnowski & J.L. Brown

Effects of physiological changes and social life events on adrenal glucocorticoid activity in female zoo-housed Asian elephants (*Elephas maximus*)

PLoS ONE 15 (2020) e0241910

Abstract. Ensuring good health and welfare is an increasingly important consideration for conservation of endangered species and includes breeding of individuals managed under human care. Understanding how factors in the captive environment affect individual animal wellbeing can be aided by long-term monitoring of biological functioning. This study involved longitudinal assessments (4 to 28 years) of reproductive and adrenal hormones in zoo-housed female Asian elephants (*Elephas maximus*) (age range 4 to ~71 years) to elucidate patterns in adrenal glucocorticoid (GC) activity in association with reproductive and demographic factors, and examine individual response to major social changes. Concentrations of serum and urinary cortisol covaried more consistently with physiological changes (ovarian cycle phase, puberty, pregnancy, lactational anestrus, and age) than with social life events (births, deaths, and facility transfers). Cortisol fluctuated across the ovarian cycle with mean concentrations being higher in the follicular than in the luteal phase, and concentrations were highest in lactational anestrous compared to all other reproductive states. The elephants in this study exhibited substantial individuality in adrenal GC response to major social change, reinforcing the need to assess welfare on an individual

basis and to consider factors influencing the impact of perceived stressors, such as social relationships, social support, temperament, and life history. Outcomes from this study deepen our understanding of Asian elephant physiology and highlight the importance of taking intrinsic patterns of hormone secretion into account when evaluating the impact of external factors. Finally, a better understanding of the impact of social change and resiliency in response to real and perceived stressors allows us to improve social management to enhance welfare in both captive settings and free-ranging environments.

B.G. Grenus, E. Latimer, A. Cullinane, P. Lyons, G. Creighton & F.B. Nutter

Evaluation of the efficacy of two different sampling sites for the detection of elephant endotheliotropic herpesvirus (EEHV) in three Asian elephant (*Elephas maximus*) in Ireland

Journal of Zoo and Wildlife Medicine 51(2020) 303-307

Abstract. Elephant endotheliotropic herpesvirus (EEHV) causes a disease that primarily affects juvenile Asian (*Elephas maximus*) elephants, causing acute hemorrhage and death. Due to the severity of the disease, many zoos have developed EEHV active surveillance programs. Currently, trunk washes are the standard for testing elephants for shedding of EEHV, but it has also been detected from other mucosal surfaces. This study compared the efficacy of oral swabs and trunk washes for the detection of EEHV shedding using previously validated quantitative polymerase chain reaction (qPCR) methods. Oral swab and trunk wash samples from three juvenile elephants at the Dublin Zoo in Ireland were collected in tandem and tested from April to September 2017. Of the 51 paired samples, 21 trunk wash samples were positive for EEHV1, while only 2 of the oral swab samples were positive for EEHV1, suggesting that trunk wash samples are more effective for detecting shedding of EEHV in Asian elephants compared with oral swabs. © 2020 American Association of Zoo Veterinarians.

C. He, J. Du, D. Zhu & L. Zhang

Population viability analysis of small population: A case study for Asian elephant in China

Integrative Zoology 15 (2020) 350-362

Abstract. Small populations are at risk of extinction from deterministic and stochastic factors. Less than 250 Asian elephants (*Elephas maximus*) remain in China, and are distributed in a few isolated areas; yet, population viability analyses of this endangered population have not been conducted. Here, the current genetic status of the Pu'Er-Mengyang Asian elephant populations in China was analyzed, and the risk of extinction was predicted over the next 500 years. Factors affecting the viability of this population were determined through simulations. The genetic diversity of the population was very low (mean allele number: 3.1; expected heterozygosity: 0.463), even though a recent population bottleneck was not detected. The effective population size was approximately 24.1 adult elephants. Enough adult breeding individuals exist to maintain population viability. VORTEX simulation model showed that this population would not go extinct in the next 500 years. However, illegal poaching and harvesting could negatively affect population size. A sensitivity analysis showed that the mean stochastic growth rate of the study population is sensitive to sex ratio, number of breeding females, mortality of females of different age classes, carrying capacity, and lethal equivalents. Based on our results, we suggest that action should be taken to alleviate inbreeding and any further loss of genetic diversity, by connecting fragmented elephant habitat or by translocating individual elephants. In addition, human-elephant conflict should be mitigated using various modern approaches, including crop guarding techniques, and by encouraging farmers to switch to crops and income sources not vulnerable to elephant raids. © 2020 International Society of Zoological Sciences, Institute of Zoology/ Chinese Academy of Sciences and John Wiley & Sons.

P. Hengtrakul, P. Sudlapa, N. Chaisurat, S. Sodsaengthien, C. Chamnankij, S. Noimoon, C. Punkong, S. Phatthanakunanan, P. Lertwatcharasarakul & S. Sripiboon

Biological and environmental factors associated with the detection of elephant endotheliotropic herpesvirus in Asian elephants (*Elephas maximus*) in Thailand

Journal of Veterinary Medical Science 82 (2020) 1808-1815

Abstract. Elephant endotheliotropic herpesvirus (EEHV) infection is one of the most common diseases in young elephants, causing severe fatal hemorrhagic disease. Subclinical infection was previously described; however, information about the factors associated with virus shedding and reactivation were scarce. To identify the biological and environmental factors related with EEHV detection, blood and oral swab samples were collected from nine captive Asian elephants in Thailand for one year and tested for EEHV presence using real-time PCR. Data including hematological values, management, environmental temperature, and serum cortisol levels were also recorded and analyzed. Results showed that the viral detection frequency ranged from 0–25%. The highest detection frequency was found in the two youngest elephants, aged less than 15 years. Three types of viruses, EEHV1, EEHV4, and EEHV5, were found in this study, which also detected mixed infection in five elephants. Additionally, the study found that sample type, changes in hematological values, management and health issues, and serum cortisol levels were not associated with herpesvirus detection in the elephants. However, EEHV detection percentage was significantly increased in the summer (mid-Feb to mid-May), possibly due to body fitness reduction from food source limitation and low nutrient content. To obtain a broad aspect of EEHV management, long-term EEHV monitoring is highly recommended in every captive elephant herd. © 2020 The Japanese Society of Veterinary Science.

C. Huang, X. Li, W. Hu & X. Jiang

Predicting indirect effects of transportation network expansion on Asian elephants: Implications for environmental impact assessments

BioTropica 52 (2020) 196-202

Abstract. The rapid proliferation of transportation networks (TNs) threatens the viability of species with wide geographic ranges via habitat fragmentation, road kill, and indirect socio-ecological interactions. Environmental impact assessments of TNs are mostly descriptive and focus on the direct impacts of the linear features of TNs, while the indirect and cumulative impacts are largely neglected. Using spatially explicit data of elephant-caused damage from 2012 to 2015 in southwest China, we quantified the barrier effects of TNs on Asian elephant populations and predicted future patterns of damage under a TN expansion scenario using maximum entropy algorithms. The TNs acted as a strong barrier for the elephants, even in herds that have inhabited highly fragmented landscapes for years. Overall damage patterns were highly asymmetric around roads, with only 18% of events occurring on the far side of roads (relative to the core home range). Models predicted that TN expansion would reduce elephant habitats, exacerbating herd isolation and human-elephant conflict locally. Thus, we suggest that future environmental impact assessments should integrate mitigation of indirect conflicts. © 2019 The Association for Tropical Biology and Conservation.

J. Jackson, K.U. Mar, W. Htut, D.Z. Childs & V. Lummaa

Changes in age-structure over four decades were a key determinant of population growth rate in a long-lived mammal

Journal of Animal Ecology 89 (2020) 2268-2278

Abstract. A changing environment directly influences birth and mortality rates, and thus population growth rates. However, population growth rates in the short term are also influenced by population age-structure. Despite its importance, the contribution of age-structure to population growth rates has rarely been explored empirically in wildlife populations with long-term demographic data. Here we assessed how changes in age-structure influenced short-term population dynamics in a semi-captive population of Asian elephants *Elephas maximus*. We addressed this question using a demographic dataset of female Asian elephants from timber camps in Myanmar spanning 45 years (1970–2014). First, we explored temporal variation in age-structure. Then, using annual matrix population models, we used a retrospective approach to assess the contributions of age-structure and vital rates to short-term population growth rates with respect to the average environment. Age-structure was highly variable over the study period, with large proportions of juveniles in the years 1970 and

1985, and made a substantial contribution to annual population growth rate deviations. High adult birth rates between 1970 and 1980 would have resulted in large positive population growth rates, but these were prevented by a low proportion of reproductive-aged females. We highlight that an understanding of both age-specific vital rates and age-structure is needed to assess short-term population dynamics. Furthermore, this example from a human-managed system suggests that the importance of age-structure may be accentuated in populations experiencing human disturbance where age-structure is unstable, such as those in captivity or for endangered species. Ultimately, changes to the environment drive population dynamics by influencing birth and mortality rates, but understanding demographic structure is crucial for assessing population growth.

S. Jakeer, M. Varma, J. Sharma, F. Mattoo, D. Gupta, J. Singh, M. Kumar & N.A. Gaur

Metagenomic analysis of the fecal microbiome of an adult elephant reveals the diversity of CAZymes related to lignocellulosic biomass degradation

Symbiosis 81 (2020) 209-222

Abstract. No permission to print abstract.

A. Jeffrey, T.S. Evans, C. Molter, L.L. Howard, P. Ling, T. Goldstein & K. Gilardi

Noninvasive sampling for detection of elephant endotheliotropic herpesvirus and genomic DNA in Asian (*Elephas maximus*) and African (*Loxodanta africana*) elephants

Journal of Zoo and Wildlife Medicine 51 (2020) 433-437

Abstract. Elephant endotheliotropic herpesvirus (EEHV) hemorrhagic disease (EEHV-HD) threatens Asian elephant (*Elephas maximus*) population sustainability in North America. Clusters of cases have also been reported in African elephants (*Loxodonta africana*). Risk to range country elephant populations is unknown. Currently, EEHV detection depends upon sampling elephants trained for invasive blood and trunk wash collection. To evaluate noninvasive sample collection options, paired invasively collected (blood, trunk wash and oral swabs), and noninvasively collected (chewed plant and fecal) samples were compared over 6 wk from 9 Asian elephants and 12 African elephants. EEHV shedding was detected simultaneously in a paired trunk wash and fecal sample from one African elephant. Elephant γ herpesvirus-1 shedding was identified in six chewed plant samples collected from four Asian elephants. Noninvasively collected samples can be used to detect elephant herpesvirus shedding. Longer sampling periods are needed to evaluate the clinical usefulness of noninvasive sampling for EEHV detection. © 2020 American Association of Zoo Veterinarians.

F. Jiang, P. Song, J. Zhang, Z. Cai, X. Chi, H. Gao, W. Qin, S. Li & T. Zhang

Assessing the impact of climate change on the spatio-temporal distribution of foot-and-mouth disease risk for elephants

Global Ecology and Conservation 23 (2020) e01176

Abstract. Elephants are the largest extant terrestrial animals and are important for maintaining regional ecosystem balance and community diversity. However, poaching, population growth, habitat fragmentation, and viruses are major threats to global elephant populations. Foot-and-mouth disease (FMD) is one of the major threats to the health of elephants. Global warming has a serious impact on wildlife and accelerates the spread of viruses. In this study, the effects of climate change on the risk of disease in elephants were evaluated based on 1833 sites with reported FMD cases. Maximum entropy (MaxEnt) was used to model the current and future geographic distributions of FMD and to assess the risk of FMD in elephants under climate change. The results showed that the average annual temperature and annual precipitation were higher in elephant habitats than in the range of the FMD virus. The mean temperature in the driest quarter, temperature seasonality, annual mean temperature, and precipitation in the driest month had relatively large contributions to the risk of FMD, with a cumulative contribution rate of 82.8%. Both Asian elephants and African elephants had high overlap with the FMD virus with respect to altitude, annual mean temperature, and annual precipitation. An overall high risk of disease was detected at a certain band, mainly concentrated from 10°N to 50°N in the

northern hemisphere and from 10°S to 35°S in the southern hemisphere. The risk of FMD was higher for the Asian elephant than the African elephant. The FMD risk increased gradually from the southeast to northwest in habitats of the Asian elephant, and presented a pattern of high north–south risk and low intermediate risk in the habitats of the African elephant. The area proportions of high risk, medium risk, and low risk in the distribution of both the Asian elephant and African elephant were all higher than the proportions of all risk types worldwide. Under global warming, the FMD risk was not expected to change significantly in most of the habitat areas of the Asian elephant or the African elephant in the 2050s and 2070s. Moreover, the areas and proportions of high risk, medium risk, and low risk were likely to change slightly. These results could benefit the conservation of elephants and provide relevant data for the prevention of FMD in high-risk areas under climate change.

T. Kalam, T.A. Puttaveeraswamy, R.K. Srivastava, J.-P. Puyravaud & P. Davidar

Spatial aggregation and specificity of incidents with wildlife make tea plantations in southern India potential buffers with protected areas

Journal of Threatened Taxa 12 (2020) 16478-93

Abstract. Many wildlife species survive in human-modified landscapes and understanding the opinions of those who share space with wildlife will aid conservation efforts. Using a questionnaire, we assessed the presence of 12 mammal species in 78 tea plantations in the Nilgiris, southern India. We obtained data on (i) plantation size, location, and elevation, (ii) species presence over a year, (iii) type and number of wildlife incidents caused, (iv) financial cost of wildlife damage, and (v) support for wildlife conservation. We used a generalized linear model to assess whether the distance to protected areas, elevation, and plantation size influenced species presence and the effect of these variables and wildlife incidents on support for conservation. Among all species reported, Bonnet Macaque, Wild Boar, and Porcupine were the most widespread, and the former two and the Gaur reportedly caused >50% of damages. Crop damage was the most frequent (74%, n = 244), whereas livestock predation, attacks on people, and infrastructure damage constituted <10% of incidents reported. The cost of wildlife damage was negligible for 72 estates and significant for six. The number of species increased with proximity to protected areas, with increasing elevation and plantation area. Plantation management (62%) supported wildlife conservation, and support increased with decreasing plantation size, increasing distance to protected areas, and with a higher number of species reported, but decreased with increasing incidents of wildlife damage. Mitigating impacts of a few widely distributed species that cause disproportionate damage and compensating those that incur disproportionately high costs could increase support for conservation. Education and awareness programs for the plantation community can further help increase support and participation in wildlife conservation activities. Plantations can thus serve as supplementary habitats for wildlife in regions where hard boundaries between protected areas and human settlements prevail.

T. Kanazawa, N. Nishimura, S. Hanzawa, M. Andou, Y. Shoji, M. Senzaki & K. Murata

Changes in the activity budget of captive Asian elephants (*Elephas maximus*) after introducing an automatic feeder

Animal Behaviour and Management 56 (2020) 63-70

Abstract. [Main text in Japanese] Introduction of feeding enrichment for captive elephants is necessary during the time zone (17:00 to 8:00 the next morning) when there are no staff working. The effects of an unmanned feeding device (automatic feeder) were verified for individuals housed and managed at the Kanazawa Zoological Gardens at Yokohama. The automatic feeder was designed such that, when activated, the branches and leaves that were hung from chains were fed in front of the indoor enclosure. The feeder was activated twice, once each in the night (18:00-20:00) and the early morning (5:00-7:00). Treatment 1 was performed at a fixed time and Treatment 2 was performed at varying times every day. In both treatments, no effect was observed at night. In the early morning, an increase in feeding and decrease in stereotypical behavior were

observed, confirming the effectiveness of the automatic feeder. In addition, at night, the later the activation time of the automatic feeder, the less effective it was. Therefore, it was considered necessary to improve the timing of operation and the frequency of use for better efficiency of the automatic feeder.

P. Keerthipriya, S. Nandini, H. Gautam, T. Revathe & T.N.C. Vidya

Musth and its effects on male-male and male-female associations in Asian elephants

Journal of Mammalogy 101 (2020) 259-270

Abstract. Musth is an annual, asynchronous, rut-like phenomenon observed in male elephants. We examined whether musth is a roving strategy, and whether musth provides a temporary advantage to young males through increased access to female groups. We collected long-term data on the musth status, associations, and locations of male elephants in the Kabini population in southern India. We sighted older males more frequently in musth than younger males. We found a greater turnover of musth than non-musth males in the study area, suggesting that musth is a roving strategy, enabling males to travel widely and away from their non-musth range. Contrary to our expectation, young (15–30 years old) males spent a smaller proportion of their musth time than their non-musth time associating with females, and associated with similarly sized female groups irrespective of musth status. Old (> 30 years old) males spent only a slightly higher proportion of their musth time than non-musth time with female groups, but associated with larger female groups during musth. Although old males in musth associated with young non-musth males more often in the presence, than in the absence, of females, young males in musth were never sighted with old non-musth males in the presence of females. Therefore, the payoff from musth, as a strategy to gain access to females, was age-specific; musth in old males allowed for increased association with females, while musth in young males restricted their access to females. There was no spatial avoidance between musth and non-musth adult males at scales larger than immediate associations. Our results suggest that musth seems to be primarily a roving strategy for old males to find and associate with females and not a strategy for young males to gain a temporary advantage over old males, within the broad age-classes that we examined.

D. Naha, S.K. Dash, A. Chettri, A. Roy & S. Sathyakumar

Elephants in the neighborhood: Patterns of crop-raiding by Asian elephants within a fragmented landscape of Eastern India

PeerJ 8 (2020) e9399

Abstract. Loss of forest cover, rise in human populations and fragmentation of habitats leads to decline in biodiversity and extinction of large mammals globally. Elephants, being the largest of terrestrial mammals, symbolize global conservation programs and co-occur with humans within multiple-use landscapes of Asia and Africa. Within such shared landscapes, poaching, habitat loss and extent of human-elephant conflicts (HEC) affect survival and conservation of elephants. HEC are severe in South Asia with increasing attacks on humans, crop depredation and property damage. Such incidents reduce societal tolerance towards elephants and increase the risk of retaliation by local communities. We analyzed a 2-year dataset on crop depredation by Asian elephants (N = 380) events in North Bengal (eastern India). We also explored the effect of landscape, anthropogenic factors (area of forest, agriculture, distance to protected area, area of human settlements, riverine patches and human density) on the spatial occurrence of such incidents. Crop depredation showed a distinct nocturnal pattern (22.00–06:00) and majority of the incidents were recorded in the monsoon and post-monsoon seasons. Results of our spatial analysis suggest that crop depredation increased with an increase in the area of forest patches, agriculture, presence of riverine patches and human density. Probability of crop depredation further increased with decreasing distance from protected areas. Villages within 1.5 km of a forest patch were most affected. Crop raiding incidents suggest a deviation from the "high-risk high-gain male biased" foraging behavior and involved proportionately more mixed groups (57%) than lone bulls (43%). Demographic data suggest that mixed groups comprised an average of 23 individuals with adult and sub adult females, bulls

and calves. Crop depredation and fatal elephant attacks on humans were spatially clustered with eastern, central and western parts of North Bengal identified as hotspots of HEC. Our results will help to prioritize mitigation measures such as prohibition of alcohol production within villages, improving condition of riverine patches, changing crop composition, fencing agriculture fields, implement early warning systems around protected areas and training local people on how to prevent conflicts. © 2020 The Authors.

Alireza Nasoori

Tusks, the extra-oral teeth

Archives of Oral Biology 117 (2020) e104835

Abstract. The present review aims to: a) describe the features that support tusks in extra-oral position, and b) represent distinctive features of tusks, which provide insights into tusks adaptation to ambient conditions. A comprehensive review of scientific literature relevant to tusks and comparable dental tissues was conducted. The oral cavity provides a desirable condition which is conducive to tooth health. Therefore, it remains questionable how the bare (exposed) tusks resist the extra-oral conditions. The common features among tusked mammals indicate that the structural (e.g. the peculiar dentinal alignment), cellular (e.g. low or lack of cell populations in the tusk), hormonal (e.g. androgens), and behavioral traits have impact on a tusk's preservation and occurrence. Understanding of bare mineralized structures, such as tusks and antlers, and their compatibility with different environments, can provide important insight into oral biology. © 2020 Reprinted with permission from Elsevier.

D. Neupane, Y. Kwon, T.S. Risch & R.L. Johnson

Changes in habitat suitability over a two decade period before and after Asian elephant recolonization

Global Ecology and Conservation 22 (2020) e01023

Abstract. Habitat degradation has caused a significant threat to wildlife, particularly to megafauna including the Asian elephant that has a large home range. Recolonization of Asian elephants in 1994 in and around Bardia National Park (BNP) has provided a unique study setting to address habitat change over two decades (1990–2013). Elephant presence data in 2013 was modeled using Ecological Niche Factor Analysis (ENFA), which identified the influential ecogeographical variables for elephant habitat. These variables were further used in a regression model to determine habitat suitability for 1990. We found that elephant suitable habitat has been lost between pre-recolonization (1990) and the year 2013 in and around BNP. Unsuitable elephant habitat increased overall by 22% in Bardia District and 20% inside BNP. Central to elephant habitat loss has been a large human population growth, re-forestation efforts with an increase in sal forests, and elephant alteration of vegetation by grazing. Available suitable habitat for elephants in and around BNP should be conserved and managed to prevent further degradation for the maintenance of the elephant population, which will help mitigate human-elephant conflict in the region. © 2020 The Authors.

S. Ngamkala, T. Angkawanish, W. Nokkaew & N. Thongtip

Serological study on brucellosis in captive elephants (*Elephas maximus*) and stray dogs in North Thailand

Veterinary World 13 (2020) 1992-1997

Abstract. Brucellosis is considered as an important zoonotic disease caused by various strains of *Brucella* in numerous host species. Although brucellosis has been reported in almost animal species, the relevance of brucellosis infection and diagnostic technique in Asian elephant (*Elephas maximus*) has been limited. The present serological investigation aimed to investigate the antibody response to *Brucella abortus* in captive Asian elephants in North Thailand. Moreover, further serological survey was also conducted to detect the antibody response to *Brucella canis* in stray dogs cohabiting the same area as the elephant herd. Serum samples were collected from 40 captive Asian elephants and submitted for serological analysis based on *B. abortus* antigen using Rose Bengal plate test (RBPT) in combination with ethylenediaminetetraacetic acid-tube agglutination test (EDTA-TAT) as a supplementary test and by commercial indirect enzyme-linked immunosorbent assay (iELISA). In addition, serum samples were also obtained

from 16 stray dogs that live nearby the elephant-raising area and were tested using commercial Dot-ELISA based on *B. canis* antigen. Serological analysis in captive Asian elephants showed 100% seronegative (40/40) from all serological tests response to *B. abortus*. For stray dogs, 12.5% (2/16) had a low positive reaction response to *B. canis*. The serological survey for brucellosis in Asian elephant was adapted and applied using RBPT, EDTA-TAT, and iELISA in the present study. For future evaluation, we recommended the use of a combination of serological tests with validation together with comparing by direct detection such as bacterial isolation to provide an appropriate brucellosis surveillance program in Asian elephants. In addition, the surveillance of stray dogs or multispecies habitation should be kept into considerations. © 2020 The Authors.

I.M. Permata & E. Wahyuni
Behind the Ivory Trade Shutdown in China
Journal of International Wildlife Law & Policy 23 (2020) 151-165
Abstract. Despite being a party to CITES, China remains active in the ivory trade. A Chinese norm identifies ivory as "white gold," resulting in China becoming a main destination market for illegal ivory. Not only is ivory a form of investment in China, but it is also a part of cultural heritage. As a result, the government continues to support preservation of ivory in the country. This activity will trigger the high rate of elephant ivory hunting in the world, which frustrates the goal of CITES regulations. Finally, in December 2017, China claimed to have officially closed the ivory market. This article discusses what conditions drove China to close its ivory trade. This article applies a data-driven, qualitative approach. This article argues that China decided to close its ivory market to convince the world that China respects and complies with international norms, especially regarding animal protection. © 2020 Taylor & Francis Group, LLC.

K.L. Perrin, A.T. Kristensen, C. Gray, S.S. Nielsen, M.F. Bertelsen & M. Kjelgaard-Hansen
Biological variation of hematology and biochemistry parameters for the Asian elephant (*Elephas maximus*), and applicability of population-derived reference intervals
Journal of Zoo and Wildlife Medicine 51 (2020) 643-651
Abstract. The aim of this study was to objectively evaluate the biological variation of healthy Asian elephant (*Elephas maximus*) hematology and biochemistry parameters, therefore enabling evidence-based clinical decision-making to improve patient management. Ten clinically healthy elephants had blood samples collected weekly for 5 wk under standardized conditions. The analytical, between- and within-individual variation, index of individuality, and reference change values were calculated using previously reported methods. Large between-individual variation and small within-individual variation for almost all parameters indicated that individual normal values should be used for interpreting blood results from Asian elephants. © 2020 American Association of Zoo Veterinarians.

A. Pinto, M. Stelvig, C. Costa, J. Colaço & B. Colaço
Influence of male presence on female Asian elephants (*Elephas maximus*) behaviour in captivity
Journal of Zoo and Aquarium Research 8 (2020) 45-49
Abstract. The maintenance of natural behaviour in captivity is relevant for optimizing animal welfare and reproductive efficiency. In captivity, few studies have evaluated the male's influence on the behaviour of Asian females' elephants (*Elephas maximus*). Therefore, we investigated foraging, standing, elimination, vocalization, courtship, mating and stereotypic behaviours in four female Asian elephants after the recent introduction of a dominant male. Elephant activity was video recorded and behavioural data were collected through observing video footage. In male's presence, females spent less time foraging and more time standing ($p<0.05$). Although differences were not statistically significative, an increased elimination behaviour frequency was also observed when the male was present. Females also performed more vocalisations ($p<0.05$) in male's presence. Behaviours, such as courtship and mating, were highly correlated ($r=0.793$ and $p<0.05$), demonstrating that both sexes were performing sexual behaviours. The females also exhibited less frequently stereotypic

behaviours when the male was present (5.6% of the time) than when he was absent (26.8% of the time) ($p<0.05$). Therefore, we have shown that in captivity female elephants behave in a male's presence as their wild conspecifics, which is beneficial for their conservation and well-being. It can be concluded that temporary integration of a male elephant in a female group in captivity has a positive influence on females, leading them to perform less stereotypies and to promote their reproductive behaviours. Further studies should be performed to enhance the knowledge on male's influence in female welfare in captivity.

T.G.S.L. Prakash, W.A.A.D.U. Indrajith, A.M. C.P. Aththanayaka, S. Karunarathna, M. Botejue, V. Nijman & S. Henkanaththegedara

llegal capture and internal trade of wild Asian elephants (*Elephas maximus*) in Sri Lanka

Nature Conservation 42 (2020) 51-69

Abstract. The illegal wildlife trade is considered one of the major threats to global biodiversity. Asian elephants (*Elephas maximus*) have been highly valued by various cultures for use in religious and spiritual contexts, as a draft animal, and more recently, as a tourist attraction. Thus, the demand for captive elephants is high. Wild Asian elephants are taken from the wild, often illegally, to maintain these captive populations due to the unviability of captive breeding programs. For the first time, we documented the extent to which wild elephants are being illegally captured and traded in Sri Lanka between January 2008 and December 2018. We collected data from case records maintained by the Sri Lanka court system where the suspects of illegal elephant trade were prosecuted in addition to information gathered by archives and interviews with various stakeholders. We documented 55 cases where elephants were illegally traded. This is probably an underestimate due to the mortality rate of elephants during capture operations, and challenges in collecting data on this highly organized illicit trade. Nearly equal numbers of male and female elephants were traded and more than 50% of them were juveniles, aged ≤5 years. Significantly more elephants were found to be seized in 2014–2015 than in the other time periods combined. We found evidence of the illegal capture of wild elephants from wildlife protected areas and state forests. More importantly, we identified evidence of corruption of wildlife officers, involvement of politicians and other high-ranking personnel in the illegal wildlife trade, and lack of active enforcement of wildlife law as major challenges to overcome if the illegal capture and domestic trade of wild elephants in Sri Lanka are to be halted. Based on our study, we make a series of recommendations that should result in implementing policy to reduce the trafficking of Asian elephants in Sri Lanka and improve the conservation management of the species.

K. Puri, R. Joshi & V. Singh

Open garbage dumps near protected areas in Uttarakhand: An emerging threat to Asian Elephants in the Shivalik Elephant Reserve

Journal of Threatened Taxa 12 (2020) 16571-75

Abstract. Waste dumping sites near protected areas are a growing issue, which may affect the activities and behaviour of wildlife, more than what we notice. Here, we present two of our case studies, where Asian elephants were found feeding at garbage dumps in Haridwar and Ramnagar forest divisions in the Shivalik Elephant Reserve in Uttarakhand State. Since garbage dumps may spread bacterial infection and induce adverse changes in the health conditions of the elephant population, we draw the attention of planners to develop a plan of action for proper disposal of the garbage through these preliminary observations, without affecting protected areas and wildlife species, including elephants. Moreover, collection of data on the presence of garbage dumps across the reserve and a study on the behavioural responses of scavenging and non-scavenging animals visiting the dumps would give us a better understanding of the level of impact of garbage dumps for disposal planning. It is to emphasize that garbage does not constitute a part of natural food for elephants. There are restrictions and guidelines in the Indian Wildlife (Protection) Act 1972, Solid Waste Management Rules, 2016 and Guidelines for Declaration of Eco-Sensitive Zones around National Parks and Wildlife Sanctuaries.

S. Reichert, V. Berger, J. Jackson, S.N. Chapman, W. Htut, K.U. Mar & V. Lummaa

Maternal age at birth shapes offspring life-history trajectory across generations in long-lived Asian elephants

Journal of Animal Ecology 89 (2020) 996-1007

Abstract. Advanced maternal age at birth can have pronounced consequences for offspring health, survival and reproduction. If carried over to the next generation, such fitness effects could have important implications for population dynamics and the evolution of ageing, but these remain poorly understood. While many laboratory studies have investigated maternal age effects, relatively few studies have been conducted in natural populations, and they usually only present a "snapshot" of an offspring's lifetime. In the present study, we focus on how maternal age influences offspring life - history trajectories and performance in a long - lived mammal. We use a multigenerational demographic dataset of semi - captive Asian elephants to investigate maternal age effects on several offspring life - history traits: condition, reproductive success, and overall survival. We show that offspring born to older mothers display reduced overall survival but higher reproductive success, and reduced survival of their own progeny. Our results show evidence of a persistent effect of maternal age on fitness across generations in a long - lived mammal. By highlighting transgenerational effects on the fitness of the next generation associated with maternal age, the present study helps increase our understanding of factors contributing to individual variation in ageing rates and fitness. © 2019 The Authors & British Ecological Society.

M. Ruetten, H.W. Steinmetz, M. Thiersch, M. Kik, L. Vaughan, S. Altamura, M.U. Muckenthaler & M. Gassmann

Iron regulation in elderly Asian elephants (*Elephas maximus*) chronically infected with *Mycobacterium tuberculosis*

Frontiers in Veterinary Science 7 (2020) e596379

Abstract. Restriction of nutrients to pathogens (nutritional immunity) is a critical innate immune response mechanism that operates when pathogens such as *Mycobacterium tuberculosis* have the potential to evade humoral immunity. Tuberculosis is of growing concern for zoological collections worldwide and is well-illustrated by infections of Asian and African elephants, where tuberculosis is difficult to diagnose. Here, we investigated hematological parameters and iron deposition in liver, lung, and spleen of three Asian elephants (*Elephas maximus*) infected with *Mycobacterium tuberculosis*. For reference purposes, we analyzed tissue samples from control *M. tuberculosis*-negative elephants with and without evidence of inflammation and/or chronic disease. Molecular analyses of bacterial lesions of post mortally collected tissues confirmed *M. tuberculosis* infection in three elephants. DNA sequencing of the bacterial cultures demonstrated a single source of infection, most likely of human origin. In these elephants, we observed moderate microcytic anemia as well as liver (mild), lung (moderate) and spleen (severe) iron accumulation, the latter mainly occurring in macrophages. Macrophage iron sequestration in response to infection and inflammation is caused by inhibition of iron export via hepcidin-dependent and independent mechanisms. The hepatic mRNA levels of the iron-regulating hormone hepcidin were increased in only one control elephant suffering from chronic inflammation without mycobacterial infection. By contrast, all three tuberculosis-infected elephants showed low hepcidin mRNA levels in the liver and low serum hepcidin concentrations. In addition, hepatic ferroportin mRNA expression was high. This suggests that the hepcidin/ferroportin regulatory system aims to counteract iron restriction in splenic macrophages in *M. tuberculosis* infected elephants to provide iron for erythropoiesis and to limit iron availability for a pathogen that predominantly proliferates in macrophages. Tuberculosis infections appear to have lingered for more than 30 years in the three infected elephants, and decreased iron availability for mycobacterial proliferation may have forced the bacteria into a persistent, non-proliferative state. As a result, therapeutic iron substitution may not have been beneficial in these elephants, as this therapy may have enhanced progression of the infection. © 2020 The Authors.

Sanjit Kumar Saha

Innovative way of human-elephant com-

petition mitigation
Journal of Threatened Taxa 12 (2020) 16494-501
Abstract. The negative interaction between humans and elephants is often referred to as conflict, however it is also seen as competition. Human-elephant competition (HEC) is a major protection threat in the fringe villages of the Jaldapara National Park (JPNP) of West Bengal, India. JPNP is facing challenges from the highly populated fringe villages, which exist in elephant corridors. Between 2015 and 2018 there were 12 elephant deaths. During the same period elephants caused 34 human deaths. As per data, most of the elephant interactions occurred in the fringe villages of Madarihat and Jaldapara North Range. Per reports of human deaths, Chekamari and Khairbari villages of Madarihat Range are in the most vulnerable list. Most of the human deaths occurred in the early morning (05.00–06.00 h) and in the evening, when people are going outside for open defecation (OD). On a pilot basis Chekamari and Khairbari villages of Madarihat Range were selected for a door to door household survey with the objective to develop an innovative strategy as a mitigation measure of HEC. The results of the survey show that both villages are tribal and minority population, the socio-economic condition of the people is very poor, on an average 5–6 members are in each household, the source of drinking water is a community well for most of the households, and 50 households are devoid of toilet facilities so automatically the members of those households go outside for OD. Out of the total human deaths, 16 occurred in the Madarihat area; out of these 16 cases, six were from the Chekamari and Khairbari villages. For this reason, between April 2019 to September 2019, with available funds 20 toilets with tube-well were built in the 20 neediest households of these two villages. Due to the communication with the community, behavioural changes were made and their participation for 100% usage of those toilets was assured. After the construction of the toilets until now, no human death cases have been reported.

O. Saif, R. Kansky, A. Palash, M. Kidd & A.T. Knight
Costs of coexistence: Understanding the drivers of tolerance towards Asian elephants *Elephas maximus* in rural Bangladesh
Oryx 54 (2020) 603-611
Abstract. Habitat degradation and fragmentation have heightened the importance of understanding human tolerance towards wildlife, as the fate of wildlife in multi-use landscapes depends on people's capacity for coexistence. We applied the wildlife tolerance model to examine drivers of tolerance towards Asian elephants *Elephas maximus* in rural Bangladesh, interviewing local people in 17 villages. We used structural equation modelling to identify causal pathways in which elephant-related exposure, positive and negative interactions, costs and benefits (tangible and intangible) contributed to tolerance. Contrary to expectations, monetary costs were non-significant in shaping tolerance despite major impacts on livelihoods. Instead, intangible costs and intangible benefits were significant factors determining tolerance. Furthermore, reducing people's exposure to elephants would not necessarily affect tolerance, nor would increasing positive interactions. We discuss how the socio-economic and bio-cultural dynamics of local communities can explain these results, and demonstrate how our model can be used to incorporate such complexities into conservation decision-making. For instance, compensation schemes aim to recompense monetary losses and direct damages, to improve tolerance, whereas our results suggest a more effective approach would be to enhance resilience to non-monetary costs and improve perceived benefits. We conclude that future studies should pay increased attention to intangible costs and consider the less direct drivers of tolerance. Through repeated testing of universal models such as that presented here, broad trends may emerge that will facilitate the application of policies across contexts and landscapes.

D.J.F. dos Santos, V. Berger, R. Cristofari, W. Htut, UK.N., H.H. Aung, S. Reichert & V. Lummaa
Seasonal variation of health in Asian elephants
Conservation Physiology 8 (2020) coaa119
Abstract. Long-lived species are often predicted to be buffered against seasonal variation: longevity means low annual mortality

and reproductive rates and annual variability in climate may therefore have a smaller impact on population growth rates of long-lived species in comparison to short-lived ones. However, little is known of the physiological mechanisms underlying such patterns in long-lived species. In this study, we investigated seasonal variation in the health of Asian elephants living in a seasonal monsoon climate. We used two complementary methods: (i) global and (ii) trait-by-trait analyses of seasonal effects on 23 health parameters of 225 individually marked elephants with known age and reproductive and health history, with repeated measures per individual over a 26-month period. The global analysis highlighted the biggest differences in health between the hot and monsoon seasons. Our trait-specific analyses identified the physiological functions underlying such health variation in different ecological settings, including haematological, immunological, muscular, kidney and liver functions, as well as protein balance and electrolytes. Overall, the results suggest that even long-lived, large mammals may experience physiological changes in response to seasonal variation that in extreme circumstances can pose a significant health risk.

D.J.F. dos Santos, J. Jackson, H.H. Aung, U.K. Nyein, W. Htut & V. Lummaa

Sex differences in the reference intervals of health parameters in semicaptive Asian elephants (*Elephas maximus*) from Myanmar

J. of Zoo and Wildlife Medicine 51 (2020) 25-38

Abstract. The reference intervals of health parameters are valuable tools for veterinarians and conservationists to monitor the health status and viability of endangered species. Natural variation in the health of the long-lived Asian elephant (*Elephas maximus*) is poorly understood, particularly in relation to differences between males and females. Longitudinal health data were collected from clinical examination, hematology, and serum chemistry analyses over 3 yr from 227 healthy individually marked Asian elephants varying in age and sex. The study population was semicaptive and used in Myanmar's timber industry, but maintained natural feeding and breeding behavior. Body condition score (BCS) and blood pressure were investigated in clinical examinations. Hematological parameters included hematocrit, hemoglobin, total white blood cell count, and differential blood cell counts. Serum chemistry parameters included blood urea nitrogen, creatinine, total protein, albumin, globulins, aspartate aminotransferase, alkaline phosphatase, triglycerides, creatine kinase, glucose, calcium, potassium, sodium, and chloride. To the knowledge of the authors, this is the first description of BCS in an elephant population outside of zoos, and of blood pressure in this species using a novel adaptation of the Intelli Wrap Cuff pressure monitor. Several differences between the sexes were observed, with females generally having higher BCS and triglycerides, and males displaying higher alkaline phosphatase and glucose levels. This study provides important clinical tools that can be used to assess the health status and improve management in this endangered species. © 2020 American Association of Zoo Veterinarians.

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

Weigh and see – Body mass recordings versus body condition scoring in European zoo elephants (*Loxodonta africana* and *Elephas maximus*)

Zoo Biology 39 (2020) 97-108

Abstract. Regular body mass (BM) monitoring plays a key role in preventative health care of zoo animals. In some species, including African (*Loxodonta africana*) and Asian elephants (*Elephas maximus*), the process of weighing can be challenging, and alternative methods such as visual body condition scoring (BCS) have been developed. We investigated the temporal development of both parameters regarding correlation patterns between them, and their suitability as monitoring measures in dependence of an elephant's life stage. While BM is more suitable in calves and juveniles under the age of 8 years, both BM and BCS are considered equally reliable in adult elephants. In elephants over the age of 40 years, BCS might be more suitable for assessing the physical status. Independent of species and sex, juvenile zoo elephants grow in BM nearly linearly with age, and reach a higher BM at an earlier age compared with conspecifics of free-ranging and semi-captive populations in the countries of origin.

The BCS typically remains constant during this life stage, seemingly unaffected by growth. In adult animals, breeding females have a lower BM and BCS than nonbreeders, and BM and BCS typically indicate fluctuations in the same direction. In geriatric elephants (>40 years) a drop in BCS occurs commonly, while BM may even increase in this life stage. We recommend regular body mass recording in zoo elephants to enhance our knowledge of body mass development and allow the formulation of objective practical recommendations. BCS presents a valuable and simple tool for complementary monitoring of an elephant's condition, especially in adult and geriatric individuals.

N.P. Singh, A.M. Jukar, R. Patnaik, K.M. Sharma, N.A. Singh & Y.P. Singh

The first specimen of *Deinotherium indicum* (Mammalia, Proboscidea, Deinotheriidae) from the late Miocene of Kutch, India

Journal of Paleontology 94 (2020) 788-795

Abstract. Deinotheriidae Bonaparte, 1845 is a family of browsing proboscideans that were widespread in the Old World during the Neogene. From Miocene deposits in the Indian subcontinent, deinotheres are known largely from dental remains. Both large and small species have been described from the region. Previously, only small deinothere species have been identified from Kutch in western India. In the fossiliferous Tapar beds in Kutch, dental remains have been referred to the small species *Deinotherium sindiense* Lydekker, 1880, but the specimens are too fragmentary to be systematically diagnostic. Here, we describe a large p4 of a deinothere from the Tapar beds and demonstrate that it is morphologically most similar to *Deinotherium indicum* Falconer, 1845, a large species of deinothere, thereby confirming the identity of deinotheres at Tapar. *Deinotherium indicum* from Tapar is larger than other deinotheres identified from Kutch and is the first occurrence of the species in the region. This new specimen helps constrain the age of the Tapar beds to the Tortonian and increases the biogeographic range of this species—hitherto only known from two localities on the subcontinent. This specimen also highlights the morphological diversity of South Asian deinothere p4s and allows us to reassess dental apomorphies used to delimit Indian deinothere species. Lastly, we argue that by the late Miocene, small deinotheres in Kutch were replaced by the large *Deinotherium indicum*. © 2020 Paleontological Society.

K.D. Snyder & D. Rentsch

Rethinking assessment of success of mitigation strategies for elephant-induced crop damage

Conservation Biology 34 (2020) 829-842

Abstract. Crop damage is the most common impact of negative interactions between people and elephants and poses a significant threat to rural livelihoods and conservation efforts. Numerous approaches to mitigate and prevent crop damage have been implemented throughout Africa and Asia. Despite the documented high efficacy of many approaches, losses remain common, and in many areas, damage is intensifying. We examined the literature on effectiveness of crop-damage-mitigation strategies and identified key gaps in evaluations. We determined there is a need to better understand existing solutions within affected communities and to extend evaluations of effectiveness beyond measurement of efficacy to include rates of and barriers to adoption. We devised a conceptual framework for evaluating effectiveness that incorporates the need for increased emphasis on adoption and can be used to inform the design of future crop-damage mitigation assessments for elephants and conflict species more widely. The ability to prevent crop loss in practice is affected by both the efficacy of a given approach and rates of uptake among target users. We identified the primary factors that influence uptake as local attitudes, sustainability, and scalability and examined each of these factors in detail. We argue that even moderately efficacious interventions may make significant progress in preventing damage if widely employed and recommend that wherever possible scientists and practitioners engage with communities to build on and strengthen existing solutions and expertise. When new approaches are required, they should align with local attitudes and fit within limitations on labor, financial requirements, and technical capacity. © 2019 Society for Conservation Biology.

S. Songthammanuphap, S. Puthong, C. Pongma, A. Buakeaw, T. Prammananan, S. Warit, W. Tipkantha, E. Kaewkhunjob, W. Yindeeyoungyeon & T. Palaga

Detection of *Mycobacterium tuberculosis* complex infection in Asian elephants (*Elephas maximus*) using an interferon gamma release assay in a captive elephant herd

Scientific Reports 10 (2020) e14551

Abstract. Tuberculosis is highly contagious disease that can be transmitted between humans and animals. Asian elephants (*Elephas maximus*) in captivity live in close contact with humans in many Asian countries. In this study, we developed an interferon gamma release assay (IGRA) for elephant TB detection using antigens from the MTB complex (MTBC) and nontuberculous mycobacteria (NTM) as stimulating antigens (PPD, ESAT6, CFP10) to elicit a cell-mediated immune response (CMIR). The developed assay was applied to an elephant herd of more than 60 animals in Thailand, and the results were compared with those obtained through serological detection. IGRA has sufficient sensitivity for detecting elephant interferon gamma (eIFNγ) from specific antigen-stimulated PBMCs. Among 60 animals tested, 20 samples (33.3%) showed negative results for both MTBC and NTM infection. Eighteen samples (30%) showed positive responses against PPD from M. bovis and/or ESAT6 and CFP10, indicating MTBC infection. In contrast, only 15.6% showed seropositivity in a commercial serological test kit for elephant TB. The discrepancies between serological and CMIR highlight that the two methods may detect different stages of elephant TB. Therefore, employing both tests may enable them to complement each other in correctly identifying elephants that have been exposed to MTBC.

Foteini Spagopoulou

Transgenerational maternal age effects in nature: Lessons learnt from Asian elephants

Journal of Animal Ecology 89 (2020) 936-939

Abstract. In Focus: Reichert, S., Berger, V., Jackson, J., Chapman, S. N., Htut, W., Mar, K. U., & Lummaa, V. (2019). Maternal age at birth shapes offspring life-history trajectory across generations in long-lived Asian elephants. Journal of Animal Ecology, 89, 996-1007. Parental age can have strong effects on offspring life history, but the prevalence and magnitude of such effects in natural populations remain poorly understood. Using a multigenerational dataset of semi-captive Asian elephants, Reichert *et al*. (2019) studied the effects of maternal and grandmaternal age on offspring performance and found that offspring from old mothers have lower survival, but higher body condition and reproductive success than offspring from younger mothers. Importantly the observed consequences on survival are long-lasting and span more than one generation, with grand-offspring of old grandmothers also showing reduced survival. These findings suggest that persistent transgenerational effects of maternal age on fitness can shape the individual variation in ageing patterns in nature and ultimately the evolution of life histories.

R.B. Suba, N.G.P. Beveridge, W. Kustiawan, G.R. de Snoo, H.H. de Iongh, S.E. van Wieren, Y.H. Choi & H.K. Kim

Food preference of the Bornean elephant (*Elephas maximus borneensis*) in North Kalimantan Province, Indonesia, and its conservation implications

Raffles Bulletin of Zoology 68 (2020) 791-802

Abstract. The preference to feed on particular plant species may reflect the most desirable components that an animal perceives, in relation to what is available. The food preference of the Bornean elephant (*Elephas maximus borneensis* Deraniyagala, 1950) in the Sebuku area of North Kalimantan was studied by chemical analysis on the metabolites of several known food plant species. We analysed the chemical properties of the Bornean elephant diet from thirteen food-plant species which represented the level of food-plant categories utilised by the Bornean elephant in the study area. All samples were analysed for nutritional value, and their metabolic pro les were obtained using 1H nuclear magnetic resonance spectroscopy. These data were subjected to multivariate data analyses to identify the common components. This study confirmed that Bornean elephants tend to follow a strategy to maximise their energy intake by selecting food items rich in sugar and crude protein and minimise fibrous

elements. The fact that they also prefer food items with high glutamate suggests that taste plays a role and this element may be a cue for the Bornean elephant to assist in foraging and searching for palatable food. © 2020 National University of Singapore.

N.R. Talukdar & P. Choudhury

Attitudes and perceptions of the local people on human-elephant conflict in the Patharia Hills Reserve Forest of Assam, India

Proceedings of the Zoological Society 73 (2020) 380-391

Abstract. No permission to print abstract.

N.R. Talukdar, P. Choudhury, F. Ahmad, H. Al-Razi & R. Ahmed

Mapping and assessing the transboundary elephant corridor in the Patharia Hills Reserve Forest of Assam, India

Rangeland Ecology & Management 73 (2020) 694-702

Abstract. Asiatic elephants are facing numerous direct and indirect anthropogenic threats throughout their geographical distributional range. Consequent to the land use and land cover change, habitat loss, fragmentation, and deterioration of the corridor status are the prime threats for the species. The current study aimed to delineate the routes and migratory corridors of elephants in the Indo-Bangla forest along the Patharia Hills Reserve Forest and characterizing existing threats on the corridor for long-term conservation of the elephants using field survey and geospatial techniques. The study identified and mapped the elephant corridor for the first time in the area and named it the "Juri-Patharia-Tilbhum elephant corridor." Land use and land cover changes in the corridor were markedly observed for over 4 decades (between 1972 and 2018). Forest-covered areas in the corridor were 32.06% in 1972, which has been reduced to only 2.98% in 2018, whereas human development types have all increased, grasslands by 127.18%, plantations by 146.56%, agriculture by 279.63%, and settlements by 147.17% between 1972 and 2018. The study concluded that the corridor area is at risk because of the lack of sustainable development in the area, which deliberately undermines conservation. Human settlement, road construction, and electrification in and around habitats and the corridor are vital threats faced by elephants in the Patharia Hills Reserve Forest. Conservation of habitat and corridor through both adoption of legal measures and community participation might be a better proposition for their long-term conservation in the habitat. The study appeals to the government to take conservation initiative in the area and suggest legal protection of the corridor and provide subsidies to the local private landowner to restrict the land-use change on the corridor. © 2020 The Society for Range Management. Reprinted with permission from Elsevier

A.S.L. Tan, J.A. de la Torre, E.P. Wong, V. Thuppil & A. Campos-Arceiz

Factors affecting urban and rural tolerance towards conflict-prone endangered megafauna in Peninsular Malaysia

Global Ecology and Conserv. 23 (2020) e01179

Abstract. The long-term survival of conflict-prone megafauna such as tigers *Panthera tigris* and Asian elephants *Elephas maximus* requires people's tolerance and willingness to coexist with them. Understanding people's attitudes can help design conservation interventions that are more effective and supported by various stakeholders. We studied Malaysian citizens attitudes towards local megafauna and the influence of urbanization, conservation awareness, local context, taxonomic bias, and conflict severity on people's attitudes and tolerance towards endangered megafauna. We conducted 733 interviews in three locations with different degrees of urbanization (capital city, small town, and rural area). Interviews in the city and small town were conducted in zoos and shopping malls to investigate the role of local context. Our respondents showed relatively good knowledge of local wildlife and wildlife conservation issues and thought that wildlife conservation was predominantly the government's responsibility. People in all groups showed a taxonomic bias, expressing more tolerance towards less conflict-prone tapirs than towards potentially more dangerous elephants, and even less towards tigers. Urbanization and awareness had consistently positive effects on people's attitudes, while the local context (zoos vs shopping malls) had very minor effects.

Our results suggest that awareness campaigns can have a positive effect to promote positive attitudes towards wildlife in Malaysia and the need for stratified approaches when it comes to conservation campaigns. In urban settings, efforts should be made to enhance people's sense of ownership and responsibility in conservation, while in rural areas efforts should focus on reducing the cost of conflict on people while promoting tolerance and willingness to coexist with conflict-prone megafauna. © 2020 The Authors.

R. Tang, W. Li, Di Zhu, X. Shang, X. Guo & Li Zhang

Raging elephants: Effects of human disturbance on physiological stress and reproductive potential in wild Asian elephants

Conservation Physiology 8 (2020) e106

Abstract. Human disturbance has become a widespread threat to wildlife viability. The Asian elephant (*Elephas maximus*), an endangered and disturbance-prone species, is under severe threat from habitat loss and fragmentation, human–elephant conflict and poaching. Establishing connections between human disturbance, stress responses and reproduction is crucial for assessing the long-term survivability of a species and will provide critical information for conservation management. The current study investigated the effects of human disturbance on population-level stress responses and stress-related effects on reproductive potential of wild Asian elephants in Xishuangbanna Dai Autonomous Prefecture, China. We used a radioimmunoassay to measure the concentration of fecal cortisol and estradiol in 257 samples collected from five local populations at 15 sites over 4 years. Human disturbance in Xishuangbanna was quantified based on the Ecological-Niche Factor Analysis model. We found that fecal cortisol concentrations were strongly positively correlated with the degree of human disturbance and increased markedly with the expansion of tea plantations. Percentage of non-stressed individuals in a population was higher depending on the extend of undisturbed area in their home ranges. Fecal estradiol concentrations decreased significantly with increasing stress levels. Our results suggest that human disturbance poses environmental challenges to wild Asian elephant populations, and chronic exposure to human disturbance could lead to population decline. The study demonstrates the efficacy of non-invasive endocrine monitoring for further informing management decisions and developing conservation strategies. © 2020 The Authors.

L.D. Thewarage, D.S.B. Dissanayake, U.S. Perera, A.T. Bandara, B.V.P. Perera, S. Wickramasinghe & R.P.V.J. Rajapakse

Morphology and molecular characterization of *Parabronema smithii* (Cobbold, 1882) (Nematoda: Habronematidae) from wild Asian elephant (*Elephas maximus maximus*) of Sri Lanka

Acta Parasitologica 65 (2020) 504-517

Abstract. No permission to print abstract.

P. Toin, J.L. Brown, V. Punyapornwithay, P. Bansiddhi, C. Somgird & C. Thitaram

Reproductive performance of captive Asian elephants (*Elephas maximus*) in large tourist camps in Thailand

Animal Reproduction Science 222 (2020) e106606

Abstract. In Thailand, many elephants are used in tourism, with populations sustained by breeding of animals that are in captive habitats. Even though there are programs to promote breeding, there is not success in all camps. In this study, there was summarization of reproductive performance data of 407 elephants (150 males, 257 females) at seven tourist camps based on 4 to 21 years of breeding records. Age pyramid structures for elephants varied among camps. Reproductive rates averaged 21.6±6.17% and varied among camps (2.8%–45.0%). Based on parity, 77.4% of elephants were nulliparous, 8.2% produced one calf, and 14.3% were multiparous, with there being camp differences. There were 1.10±0.46 (range, 0.03-3.55) births per year, with a total of 19.6±9.3 (1-71) calves per camp. Age at first calving was 19.2±1.1 years (range, 8 – 40 years), mean inter-birth interval was 4.4±0.2 years (range, 1.8 – 7.9 years), and average gestation length was 653.9 ± 6.9 days (range, 578 – 743 days). Rates of abortions/stillbirths averaged 12.4% and ranged from 3.5% to 66.7%. There were no obvious differences in management (e.g., number of males, estrous

detection methods, work activities) that when evaluated explained the range in breeding success, although lack of male interest in females was a common problem. While informative and useful for designing future studies, results of this study indicate there is a lack of precise breeding records that makes it difficult to evaluate effects of management practices on reproductive performance of captive elephants in Thailand. © 2020 Reprinted with permission from Elsevier.

A. van de Water, L.E. King, R. Arkajak, J. Arkajak, N. van Doormaal, V. Ceccarelli, L. Sluiter, S.M. Doornwaard, V. Praet, D. Owen & K. Matteson

Beehive fences as a sustainable local solution to human-elephant conflict in Thailand

Conserv. Science and Practice 2 (2020) e260

Abstract. As human-elephant conflict (HEC) increases, a better understanding of the human dimensions of these conflicts and non-violent mitigation methods are needed to foster long-term coexistence. In this study, we conducted household questionnaires (n = 296) to assess the prevalence of HEC and attitudes towards elephants in four rural villages in Thailand. In addition, we evaluated a pilot beehive fence as a sustainable solution for HEC. The majority of the households reported seeing or hearing elephants near their property at least once a week (84.9%) and experienced negative impacts from elephants in the last 5 years, (81.0%). The beehive fence deterred 88.4% of individual elephants (n = 155) and 64.3% of elephant groups (n = 28) that approached the fence. Most elephants (70.7%) exhibited behaviors suggesting heightened attentiveness or alarm. The farm owner reported economic and social benefits of the beehive fence. By contributing to farmer income and reducing crop damage caused by wild elephants, beehive fencing may provide an important locally-managed complement to regional HEC mitigation methods. © 2020 The Authors.

D. Vasudev & V.R. Goswami

A Bayesian hierarchical approach to quantifying stakeholder attitudes toward conservation in the presence of reporting error

Conservation Biology 34 (2020) 515-526

Abstract. Stakeholder support is vital for achieving conservation success, yet there are few reliable mechanisms to monitor stakeholder attitudes towards conservation. Importantly, few approaches account for bias arising from reporting errors; that is, reporting a positive attitude towards conservation when the respondent actually does not have one (a false positive error), or not reporting a positive attitude when the respondent is positive towards conservation (a false negative error). We borrow from developments in applied conservation science to use a Bayesian hierarchical model to quantify stakeholder attitudes as the probability of having a positive attitude towards wildlife, notionally (or in abstract terms) and at localized scales. The model allows us to assess stakeholder attitudes, and factors influencing these attitudes, while accounting for false negative and false positive reporting errors. We show through simulations that this method has lower bias than naïve estimates of the proportion of respondents who are positive towards wildlife, or Likert-scores. We demonstrate the utility of the model by applying it to questionnaire surveys on Asian elephants *Elephas maximus* in the Kaziranga–Karbi Anglong landscape, Northeast India. After accounting for reporting errors, we estimated the probability of being positive towards elephants notionally as 0.85; at a localized scale, however, the proportion of respondents that were positive towards elephants was 50%. In comparison, without accounting for reporting errors, the proportion of respondents professing positive attitudes towards elephants in at least one of the certain questions, was 0.69 and 0.23, notionally and at local scales, respectively. False (positive and negative) reporting probabilities were consistently non-zero (0.22–0.68). We submit that regular and reliable assessment of stakeholder attitudes—combined with an understanding of factors contributing to variation in attitudes—can feed into participatory conservation monitoring programs, help assess the success of initiatives aimed at facilitating human behavioral change, and inform conservation decision-making. © 2019 Society for Conservation Biology.

P. Wendler, N. Ertl, M. Flügger, E. Sós, P. Torgerson, P.P. Heym, C. Schiffmann, M. Clauss & J.-M. Hatt

Influencing factors on the foot health of captive Asian elephants (*Elephas maximus*) in European zoos

Zoo Biology 39 (2020) 109-120

Abstract. Pathological lesions of feet occur frequently in captive elephant populations. To improve foot health, it is important to identify risk factors associated with such pathologies. Several previous studies have analyzed potentially influencing factors but were limited, for example, by small sample sizes. This study analyzed the relationship between 87 independent variables and the foot health score of 204 Asian elephants (*Elephas maximus*) in European zoos using bivariate correlation, multivariable regression models, and principal component analysis (PCA). Correlation and regression tests revealed significant results for 30 different variables, mainly with small effect sizes. Only three variables were significant in more than one test: sex, time spent indoors, and time spent on hard ground, with lower scores (i.e. less or less severe pathological lesions) in females, and when less time is spent indoors or on hard ground. Due to small effect sizes and differing results of the statistical tests, it is difficult to determine which risk factors are most important. Instead, a holistic consideration appears more appropriate. A biplot of the PCA shows that factors representing more advanced husbandry conditions (e.g. large areas, high proportions of sand flooring) were associated with each other and with decreased foot scores, whereas indicators of more limited conditions (e.g. high proportions of hard ground, much time spent indoors) were also associated with each other but increased the foot score. In conclusion, instead of resulting from just one or two factors, reduced foot health might be an indicator of a generally poorer husbandry system.

G. Wilson, R.J. Gray & H. Sofyan

Identifying the variation in utilization density estimators and home ranges of elephant clans in Aceh, Sumatra, Indonesia

E. Journal of Wildlife Research 66 (2020) e88

Abstract. No permission to print abstract.

J. Witteveen & S. Müller-Wille

Of elephants and errors: Naming and identity in Linnaean taxonomy

History and Philosophy of the Life Sciences 42 (2020) e43

Abstract. No permission to print abstract.

S. Yasui & G. Idani

The effect of proximity relations to mahouts on social behaviors among captive Asian elephants (*Elephas maximus*)

Animal Behav. and Management 56 (2020) 1-7

Abstract. Asian elephants (*Elephas maximus*) have worked with people for a long time in several Asian countries. Additionally, there are many elephants in zoos and sanctuaries all over the world. In captivity, accidents sometimes occur involving elephants and zoo keepers (mahouts). Although human-elephant relationships are very important to the management of elephants in captivity, there have not been many studies done on these to date. The objective of this study was to clarify how mahout- elephant proximity relations influence elephant behavior. Our subjects were 17 captive Asian elephants at the Elephant Study Centre in Surin Province, Thailand. We recorded all social behaviors performed by each focal animal and the distances between her and her mahout every minute. We compared the frequency with which the elephants and mahouts stayed in close proximity to one another and the frequencies of different social behaviors involving the elephants. We found that elephants that maintained close proximity to their mahouts for longer periods underwent fewer interactions with other elephants. This study may represent the first report to demonstrate the influence of mahouts on the social behavior of captive elephants.

News Briefs

Compiled by Jayantha Jayewardene

Biodiversity and Elephant Conservation Trust, Rajagiriya, Sri Lanka
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1. Vietnam acts to protect last remaining wild elephants

VN Express - 2.7.2020

After rampant habitat destruction and poaching have pushed Vietnam's elephants to the brink, rangers are working hard to protect a small pachyderm herd. Now 30 rangers take turns to patrol a forest sanctuary in Quang Nam Province once a week or more to check on the elephants living there. One day last month, a team of six rangers got on their motorbikes and set out on a trail that runs through Quang Nam and Quang Ngai Provinces in the central region as well as several other provinces in the Central Highlands.

Along their trek, the rangers saw elephant footprints of many sizes on the soil, aside from the animal's excrement along a stream. They also found tree barks peeled, a sign that the elephants could have been there for a meal.

On the way, they removed several animal traps, set up camera traps, and as the sun went down, set up camps to stay for the night. Every month, 30 rangers of the Elephant Habitat and Species Conservation Area take turns to patrol the elephant sanctuary four to six times. In all, a ranger spends an average of 15 days in the forest each month.

2. Planting right crops may prevent elephant-human conflicts (Indonesia)

The Jakarta Post - 4.7.2020

As elephant-human conflicts continue to be reported in Sumatra amid massive deforestation that prompts the critically endangered species to go to plantations and human settlements to find food, an expert has suggested that planting the right crops may prevent such conflicts. Wahdi Azmi, director of the Aceh Conservation Response Unit, which aims to care for the elephant population, said Sumatran elephants were not familiar with oil palm fruit in the past. "But ever since the loss of their habitat to plantations, the fruit is what is available to them and they find it palatable.

Aceh is home to the largest population of the critically endangered Sumatran elephants. More than 500 individuals of a population of around 2500 of the elephants native to Sumatra Island live in the province. Therefore, the animals need a vast natural habitat as their home range. Wahdi said people should learn from the history of the Aceh Sultanate, which gained wealth from the export of pepper and nutmeg and at the same time, nurtured coexistence with elephants because the animal did not eat the crops. "We can serve both animal conservation and economic interests hand in hand by growing the right commodity crops," he said.

3. Plastic waste kills a Thai elephant in another wake-up call

Sustainability Times - 14.7. 2020

It is not as if any more proof was needed that plastic waste is a clear and present danger to wild animals large and small, but here it comes: a wild elephant has died in Thailand after ingesting large amounts of plastic litter. A male elephant weighing about 3.5 tons and aged around 20, was found dead in the Khao Khitchakut National Park in central Thailand and a subsequent autopsy revealed the cause of death to have been plastic bags and other items that caused a blockage and infection in the pachyderm's intestines.

Likely the jumbo unwittingly swallowed plastic trash left behind by visitors to the protected nature reserve. "People are still being deaf to our campaign," the minister said. "We have found the loss of other animals caused by the plastic bags, with the latest case of the poor wild jumbo." Until recently Thailand's nearly 70 million citizens produced some 3.75 billion plastic bags a month as waste since plastic bags were handed out liberally in shops and stores with every purchase. A campaign launched this past January to reduce that colossal sum has led to some positive results, yet the Southeast Asian nation is still a leading producer of plastic waste in the world.

4. Electric wire traps set up for wild elephants turn into death traps for locals

Kathmandu Post - 18.7.2020

On July 13, Badri Thapaliya, 60, a resident of Magurmadi in Mechinagar Municipality Ward No. 9, Jhapa, came across a naked wire hanging by the electric wire trap set for wild elephants. Unaware that the wire still had active electricity flowing through it, Thapathaliya grabbed a hold of it and died of electrocution. The trap was set by Thapaliya himself to ward off wild elephants. But he had forgotten to cut off the power supply to the trap the night before. Although it's illegal to construct electric fences in the fields, the residents of northern and southern belts of Jhapa fence their properties with electric wires to ward off wild elephants. In 2019, Thapaliya had lost his older brother, Ganga Thapaliya, to a similar accident; he had fallen into an electric trap set up for elephants.

The same year, two people from Magurmadi also died after being electrocuted in a similar wire trap setting. In Ward No. 4 of Buddhashanti Rural Municipality, two other people lost their lives in a similar accident, according to the District Police Office in Jhapa. Two similar deaths were reported in 2018 and in 2017, three people had lost their lives after being electrocuted by elephant traps in Jhapa, according to the Office. The Division Forest Office in Jhapa, said accidents caused by electrocution has become a major problem in the northern and southern belt of the district.

5. Elephant deaths in Cambodia leads to extinction concerns

The Star - 23.7.2020

A local Elephant conservation organisation in Mondulkiri province has expressed concern about the declining domestic elephant population after a 53-year-old male pachyderm named Kham Khen died on Sunday from chronic abscess disease on his back. "Since 2017, the number of domestic elephants in Mondulkiri decreased subsequently and so far the breeding of domestic elephants in Cambodia has not been successful," said Khun Dlyon, director of the elephant conservation organisation Elephant Livelihood Initiative Environment.

Five domestic elephants died in 2017. Three died of illness, another was shot by authorities when it charged villagers and another from Mondulkiri province died after falling into a pit in Snuol district in Kratie province. Two more elephants died in 2018. One was sick and the other died as its owner didn't provide food when it was in rut (displaying behaviour associated with the urge to breed). There were 70 domestic elephants in Mondulkiri province 20 years ago, according to Dlyon. But indigenous peoples do not allow domestic elephants to breed. Ageing and disease have resulted in a series of deaths and only 38 elephants remain. "After the death of Kham Khen, the number of domestic elephants in Mondulkiri has dropped to 37 and could lead to the extinction of elephants in that area.

6. Problem pachyderms? 'Geofencing' helps reduce Sri Lanka's human-elephant conflict

Mongabay – 26.7.2020

As the chief veterinary surgeon at the Department of Wildlife Conservation (DWC), Tharaka Prasad is probably the only Sri Lankan to receive messages from an elephant. Known as Panu Kota, a male elephant roams the Sinharaja Forest Reserve in southern Sri Lanka, and each time he draws close to a nearby village, his collar emits a beep that offers locational information to Prasad. Scientists put a radio collar on Panu Kota on

June 1, 2019. Since then, the elephant's current location details are transmitted through the GPS coordinates every four hours via a satellite communication system to wildlife authorities.

Through this mechanism, the department's team was able to mark a virtual boundary known as a geofence around the adjacent villages the elephant was known to enter. "Whenever Panu Kota crosses any of the virtual boundaries, a message transmits itself, enabling us to easily identify its geolocation and the closest village so our teams can intervene swiftly," Prasad, who monitors the elephant's movements from DWC headquarters, told Mongabay. If the elephant remains inside the village, Prasad informs ground staff at DWC's Rakwana office, the station closest to the range of the elephant, so they can act fast before the animal comes into conflict with the villagers.

Prithiviraj Fernando, an Asian elephant conservation and management specialist who leads the Centre for Conservation and Research (CCR), pioneered Sri Lanka's first effort in radio tracking the elephants. The CCR team, in collaboration with the DWC, started their mission using VHS collars to check migration patterns of Sri Lankan elephants in 1995. They found that the animals have home ranges of around 200 km^2 and do not migrate long distances through elephant corridors as previously believed.

7. Trunk calls get jumbos food (India)

The Telegraph Online - 29.7.2020

A flood-hit Assam village along the Brahmaputra is in the limelight for reasons other than the deluge and Covid-19: its residents have played benefactor to a herd of elephants stuck on a chapori (sandbar) over the past four days.

Since Saturday, the villagers of Salmara in Upper Assam's Majuli district, have been supplying whatever they can to feed the elephants following their "incessant trumpeting" over the past fortnight. "We couldn't turn a deaf ear to their call from the chapori, about 8km away. They seemed to be in distress, having run out of food. We then raised funds to supply to this herd of over 100 elephants with whatever was available and could be carried on boats," Saitainya Hazarika, 30, a small-time trader, told The Telegraph.

They have till now supplied over 300 banana plants, 10 bags of salt, besides bananas, elephant apples, pumpkins, sugarcane and jackfruit for the elephants. The trumpeting has decreased since Saturday. Other villages are now following in Salmara's footsteps. On Tuesday, residents of two nearby villages — Jogigaon and Dhakinpat Kumargaon — visited the chapori with a boat laden with banana trees, fruits and salt. "We are having a tough time since May 24 due to floods. Then came Covid. It is difficult to reach the nearest hospital because of the floods. After overcoming these odds, it is an indescribable feeling that we are doing something good. Elephants are like God to us," Hazarika said.

8. More than 500 people, 100 elephants die every year due to conflict with each other (India)

Hindustan Times - 10.8.2020

Addressing the event, Union Environment Minister Prakash Javadekar said elephant conservation is vital as it balances the ecosystem. More than 500 people and 100 elephants die every year due to conflict with each other, officials of the environment ministry said on Monday. Releasing the figures at an event ahead of World Elephant Day on August 12, the officials said interactions between humans and elephants have led to the death of both.

As per the last census conducted in 2017, India is home to 30,000 elephants. Elephants have to be kept in forests for which fodder and water augmentation program has been initiated, the minister said, adding that by next year results will start showing. "We must protect our elephants. The Kerala incident was inhuman and such criminal acts will be dealt with. Giving out the figures of deaths due to human-elephant conflict, Additional Director General of Forests (Wildlife) Soumitra Dasgupta said hundreds of elephants migrate and come in contact with human beings. "More than 500 human and 100 elephant deaths

take place each year due to the conflict. More elephant corridors have been identified, budget has been increased by 30 per cent and several committees have also been formed,

9. Most of 250 wild elephant deaths in Tamil Nadu caused by poison, allege activists (India)

Mirror Now – 12.8.2020

Over 250 wild elephants have succumbed in the last three years in Tamil Nadu. While forest officials term these deaths as natural, some wildlife activists have alleged that most of the deaths occurred due to poison used by some farmers to prevent wild animals from damaging the crops. According to an activist who conducted a study on elephants in the western region of Tamil Nadu, some farmers leave jackfruit laced with jaggery and poison to prevent crop destruction during the annual migration of elephants through private plantations.

The activist added that many jumbos who consumed these poison-laced fruits died over a period. He further claimed that such poison 'traps' are used by farmers who encroach on forest land to raise crops, said a report in Times of India. According to the activist, such illegal crop plantations were found along the stretch from Anaikatti in Coimbatore to Bhavani Sagar in Erode, and passing through Velliyagadu, Karamadai, Mettupalayam, Sirumugai and Lingapuram.

10. Call to boost efforts to protect pygmy elephants

Sun Daily - 13.8.2020

Malaysians may soon see the last of jumbos unless there is political will to help them survive. The elephant is a protected species, but not enough is being done to ensure they do not go extinct. For instance, the Borneo pygmy elephant is listed as endangered and accorded protection under the Wildlife Conservation Enactment.

The Borneo pygmy elephant is a sub-species of the Asian elephant and the smallest on the continent. The chairman of the Centre for Environment, Technology and Development, Malaysia, said it was still unclear what caused the premature deaths of pygmy elephants. "It could be a question of insufficient wildlife enforcement officers. He said the federal government should fund efforts by the state to protect the pachyderm.

Data from nathab.com shows there are about 1500 pygmy elephants left in the wild. The primary threat to them is loss of habitat mostly through human encroachment such as the clearing of land for agriculture or infrastructure development. They are no longer able to take their traditional migration routes, and in Sabah it is estimated that 20% of elephants have been wounded by traps.

11. Nepal's elephant population trapped between human settlements and mega development projects

Kathmandu Post - 13.8.2020

Ever-expanding human settlements, deforestation and development projects are undermining Nepal's elephant conservation efforts, wildlife conservationists have warned. Speaking during a virtual interaction organised on the occasion of World Elephant Day, the participating experts suggested that the country needs to strike a fine balance between conservation and development to save valuable wildlife species like elephants, which are under threat due to human activities.

The problem arises after 1950 with malaria eradication programmes and new settlements in the Tarai where people did not only migrate from the Hills, They stripped down the forest areas and settled down in the low-lying Tarai plains, which used to be elephant habitats and corridors. Earlier, there used to be one long chain of elephant movement from Assam to northwest India via Nepal. This path was cut off due to massive deforestation."

Now wildlife conservationists worry that the mega projects like East-west railway, Tarai expressway, proposed Nijgadh airport, Postal Highway and upgradation of East-West Highway will further damage what little remains of the

elephant habitats and their corridors. Elephant habitats are already under threat due to deforestation, urbanisation and various human activities. Restricted movement of elephants has become a major cause behind increasing elephant-human conflicts in recent years.

12. China's smart system guards 300 wild Asian elephants

China.org - 15.8.2020

A leading smart system is monitoring about 300 wild Asian elephants in Xishuangbanna, Yunnan province. The Xishuangbanna National Nature Reserve and Inspur Co., Ltd have joined hands to develop a world-leading system for the conservation and ecological protection of Asian elephants. Powered by artificial intelligence (AI), Internet of Things (IoT), big data, and cloud computing, this system enables around-the-clock monitoring of the animals, effectively mitigating human-elephant conflict.

An Inspur spokesperson said that it sets an example of how technology can be leveraged to protect endangered species, promote harmony between humans and nature and drive sustainable development. With the establishment of the Xishuangbanna National Nature Reserve in Yunnan province and effective conservation measures, the number of elephants in China has grown to nearly 300 in 2020. About 95% of the elephant population live in the reserve, China News Service reported. Found only in South Asia, Southeast Asia and the southern border of Yunnan province, Asian elephants play a crucial role in protecting wildlife resources in their habitats and maintaining local biological diversity and ecological integrity in tropical forest ecosystems. This will unveil a new age of harmonious coexistence.

13. Across China: China defuses human-elephant conflicts

XinhuaNet – 19.8.2020

In recent years, conflicts between wild elephants and humans continue to worsen, with the giant animals breaking into residential areas, eating crops, damaging houses and threatening people's lives. In addition, the lives of wild elephants are often in danger. While continuously strengthening the protection of wild Asian elephants, the Chinese government has rolled out measures, such as constructing prevention projects, carrying out monitoring and building food bases for the endangered species, to solve the dilemma of human-elephant conflicts. Asian elephants are under Class-A protection in China and are mainly scattered in Xishuangbanna and Pu'er, southwest China's Yunnan Province. Since 1958, Yunnan has established 11 national or regional-level nature reserves in the tropics, covering a total area of about 510,000 hectares, providing the Asian elephants shelter. The data released by the Yunnan Forestry and Grassland Administration (YFGA) showed that thanks to strengthening ecological conservation, the population of wild Asian elephants in Yunnan increased from 170 to about 300 over the past three decades.

14. The Chitwan National Park starts collecting samples following detection of tuberculosis in dead elephants (Nepal)

Nepal 24 Hours - 24.8.2020

The Chitwan National Park (CNP) has started collecting blood samples from living tuskers following the detection of tuberculosis among dead elephants.

There are 59 elephants at CNP. Samples of 28 elephants (20 at the elephant breeding center at Khorsor and eight at Sauraha) will be collected for a test. Blood samples of the elephants will be taken out through ears and tails of the elephants, he said, adding that it takes four to five days to collect blood samples. The samples will be sent to the Centre for Molecular Diagnosis in Kathmandu. Fifteen elephants witnessed natural death while 25 others breathed their last due to several causes at CNP since 2002. It may be noted that elephants at CNP contracted the disease in 2002 for the first time and the disease continued to affect the mammoths until 2016. The disease resurfaced in 2018.

15. Virus gives Sri Lanka's threatened elephants a reprieve

Brinkwire - 26.8.2020

Sri Lanka's coronavirus lockdown has helped reduce the death toll from clashes between elephants and humans, conservationists have said. A record 405 elephants were killed by humans in the country last year, up from about 360 in 2018. A total of 121 people were killed by elephants, up from 96 the year before, according to government data.

Speaking ahead of World Elephant Day on Wednesday, Jayantha Jayewardene, a leading international expert on elephants, said: "We can say that the human-elephant conflict eased during curfews. "But this is a temporary situation. Farmers will start defending their crops and the killings will resume. Most of the killed elephants are shot dead or poisoned by farmers trying to keep them off their land. The beasts are considered sacred in the majority-Buddhist island and are protected, but prosecutions are rare. Most of the humans are killed by elephants who have seen their habitat drastically reduced, rampaging in villages looking for food.

16. Elephants cross swollen river, destroy crops (India)

Outlook India - 31.8.2020

A herd of 50 wild elephants strayed into the Sankrail area in Jhargram district of West Bengal on Monday, crossing the swollen Subarnarekha river, officials said. The herd, which had several elephant calves, destroyed paddy in Rohini, Rogra and Adhari villages in the area after swimming over to Sankrail, they said. The jumbos also ate vegetables grown on a vast stretch of land and camped in the nearby forested area at dusk, Forest Department officials said. Villagers ensured no harm was done to the elephants despite the loss of crop and cordoned off the area, they said. Efforts were on to drive the herd back to Chandabila forest range by quick response team of the Forest Department and locals, they added.

17. 1600 elephants in Bandipur, finds internal survey (India)

The New Indian Express - 19.9.2020

Over 1600 elephants are wandering in and around Bandipur Tiger Reserve (BTR), as per an internal survey conducted by forest officials of the reserve. The survey was conducted during the lockdown and unlock period for four months, starting April. The officials followed all the protocols used when the all-India elephant census is carried out. This is the first time that an internal survey has been conducted by a team for a particular forest. As per the last all-India survey, there are 8500 jumbos in Karnataka.

The survey was done for two days every month for four months. It was done to understand the species, the forest area and get data on how to improve the habitat. The officials stated that it helped in improving supervision on ground. If the forest staffers know the number of jumbos and congregation points, we can manage them better. We found that there is a need to strengthen the vegetation infrastructure rather than concrete infrastructure. Preliminary information has shown than that there are over 1600 elephants in the reserve. A final assessment report will be ready in another 20 days," he added.

18. Kin of victims killed by elephants to get jobs as Home Guards in Bengal (India)

Hindustan Times - 7.10.2020

The West Bengal government will provide jobs to kin of victims killed by elephants in the state, chief minister Mamata Banerjee announced on Tuesday. "Till date villagers killed by elephants used to get a compenstaion of Rs 2.5 lakhs from the government. We have taken a policy decision that henceforth we will provide a family member of the victim with a job of Home Guard," said Banerjee. At least 433 people have been killed by elephants across West Bengal between April 2014 and September 2019. In Odisha, Jharkhand and Chhattisgarh, the death toll was 447, 391 and 329 respectively during this period. "There are around 200 elephants in south Bengal and around

500 elephants in north Bengal. Man-elephant conflict is common in both south Bengal and north Bengal," said a forest official.

19. Human-elephant conflict escalates in China's Xishuangbanna

Nikkei - 20.10.2020

Xishuangbanna, the southernmost prefecture in China's Yunnan Province, is known as a safe haven for wild Asian elephants where hundreds of the giant animals live in the sprawling tropical rainforests. But balancing modern human activities with protection of wildlife has never been easy. For some people in Xishuangbanna, coexistence with the wild elephants is becoming more and more challenging, and sometimes even fatal.

The Asian elephant is the largest land animal in Asia and was listed in 1986 as an endangered species by IUCN. With an average height of 3.7-4.1 m, adult Asian elephants weigh 3-5 tons. Although most wild elephants try to avoid humans, they will attack if threatened. Over the past couple of decades, the level of threat has increased for both humans and elephants. Deforestation due to expansion of rubber tree plantations and farmland, as well as conservation-driven changes to the rainforests, have dramatically reduced food sources for elephants. At the same time, the size of the elephant population in Yunnan has almost doubled to 300 from 180 in the 1980s. This has forced many of the giant animals out of nature reserves and into close encounters with villages.

20. State Forest Department starts campaign to curb jumbo deaths due to electrocution (India)

The Millennium Post - 18.10.2020

Concerned over the recent trend of elephant deaths through electrocution in different forests of North Bengal, the state Forest Department (FD) started anti-electrocution campaign at strategic locations to curb such deaths. The campaign has been undertaken in the villages and tea gardens around the elephant corridors and in sensitive villages and tea gardens around Buxa Tiger Reserve, Jaldapara National Park, Gorumara National Park, Mahananda Wildlife Sanctuary, Bagdogra and Naxalbari areas.

The FD is using its own vehicles 'Airavat' for the campaign. Five of these vehicles will travel in different parts in and around the forests of North Bengal to sensitise people about the importance of conserving wildlife. They will be asked to inform the FD if they notice electric wires situated at lesser height, wires dangling precariously here and there and electric poles not properly rooted to the ground, or similar issues

According to sources in the FD more than 17 jumbo deaths have been recorded since January out of which seven deaths have been attributed to electrocution. There has been deliberate electrocution in at least three to four cases mostly in North Bengal.

21. Take a hike: Vietnam bans elephant rides

New Straits Times - 23.10.2020

Authorities in Vietnam's Central Highlands region are set to ban the famous elephant riding tours following accidents and animal protection concerns. This was confirmed by Central Highlands province's Department of Culture, Sports and Tourism deputy director, who said they would look at other elephant-related services such as bathing and feeding the animals to offer tourists new experiences. Animal rights activists have long complained that the elephant rides were an exploitation of the animals.

Dak Lak in the Central Highlands is home to many of Vietnam's surviving elephants. Vn Express News reported Dak Lak Elephant Conservation Centre director Huynh Trung Luan as saying that the centre would try out new tourism products using four elephants. He said that in the last 30 years, three captive elephants delivered stillborn calves and the nearly 100 wild elephants gave birth to only four babies. Luan blamed the high mortality and low birth rates among the pachyderms on habitat encroachment, contaminated food and exploitation for tourism.

22. Elephants to be spotted near railway track with sensor system (Bangladesh)

The Financial Express - 27.10.2020

The Chittagong-Cox's Bazar Railway Project will introduce use of sensor system to detect the presence of elephants near rail-tracks to avoid accidents, according to a publication of the Asian Development Bank (ADB). The technology, which comprises thermal imaging cameras or seismic sensors, will help save the lives of both elephants and human beings. Supported by the ADB's High-Level Technology Fund, construction of the proposed 102-km railway line is expected to make significant contribution to Bangladesh's tourism sector.

Accordingly, the railway link will connect Cox's Bazar district to the country's railway network, facilitating transportation to the world's longest sea beach. "The project will not only boost the national economy through further development of Cox's Bazar into a major tourist destination, but also facilitate access to the Trans-Asia Railway network for the local population as well as the entry of local products to sub-regional markets and trade," the article noted.

There are around 40,000 Asian elephants in the world. In Bangladesh, the Forest Department has reported that there are around 300 Asian elephants, and most of them are in Chittagong and Cox's Bazar. These elephants are known to migrate from across the border in Myanmar to Cox's Bazar and Chittagong, and reach the north-east Indian states of Tripura and Mizoram.

23. Elephants chase motorbike driver to Chon Buri home (Thailand)

The Thaiger - 29.10.2020

Wild elephants chased a motorbike driver in Chon Buri, following him to a family's home where he stopped and asked to hide inside. Three elephants ran after him to the house and damaged the front of the home. Luckily, the elephants weren't able to enter inside the home and the family, including a child and a pregnant woman, were not harmed. One resident live streamed the elephant intrusion on Facebook, recording an elephant wandering in their outdoor living space and knocking down laundry that was hanging up to dry. Locals called authorities and 10 officers responded to the call at around 10 pm. They were able to lead the 3 elephants back into the forest.

Elephants in the area have been an issue, and local residents have been asking authorities to help move the elephants deeper into the jungle, away from residential homes and roads. Last month, in the same district, an elephant wandered to a resident's home, knocking down a fence.

24. Elephant trespassers: Angels or beasts? (China)

CGTN - 30.10.2020

Asian elephants living in southwest China's Yunnan Province are an endangered species. But protecting them demands more than a little tolerance from locals. Between 2011 and 2015, about 48,000 incidents were reported of elephants ravaging cropland and injuring people. This is not surprising as the animals' living space, which once covered over half the country, has been squeezed to a small southwest corner where about 300 still roam the rainforest.

The elephants have also developed a fondness for the corn and sugarcane grown by farmers. As a result, locals have had to get used to living alongside these giant animals, who weigh about 3-4 tons and can easily knock over a car. But their presence is not always welcome. For locals, the animal is both angel and beast. Elephants have an excellent memory, remembering things they can be grateful for as well as incidents for which they might want to seek revenge.

Rescuers say they are often unwilling to leave the rescue center where they have been treated for an injury. At the same time, there have been reports of elephants destroying the same cropland every year, belonging to a farmer that once killed a member of their family. Human-elephant relations are complicated. To keep them away from farmland, their favorite crops

and vegetables are grown in separate designated areas. But what is grown still falls short of what the elephants consume, considering that an adult elephant can eat over 150 kg of food on a daily basis.

25. Sri Lanka digs moat around landfill to keep hungry elephants out

Reuters – 25.11.2020

Sri Lanka's government is digging a moat around one of its landfills to keep hungry elephant herds out and reduce conflicts between the animals and villagers. Dozens of elephants lumber out of the forest daily into a rubbish dump near the eastern town of Ampara, rummaging through mounds of garbage for wilted vegetable scraps. This has become a common sight at the country's three largest landfills, which are located next to wildlife protection zones.

The elephants consume plastic along with the food scraps, which slowly kills them, officials have said. In 2019, a record 361 elephants died mainly because of humans, local environmental groups reported. The Ampara landfill was created around a decade ago in the middle of an elephant corridor that is home to 200 to 300 elephants. Electric fences have not worked to keep the determined animals away. There is no proper plan or a system for this, Government institutions have established landfills on the border of wildlife protection zones. Once that is done, the wild elephants and other wild animals who eat the rubbish die.

The government is now trying trenches around the facility to deter the animals. Villagers who have had an uneasy co-existence with the wild herds say the situation is only getting worse.

26. Wild elephants return to Yunnan's reserve after decades (China)

Xinhua - 4.12.2020

Eighteen wild Asian elephants were spotted in a nature reserve in the Dai Autonomous Prefecture of Xishuangbanna in southwest China's Yunnan Province, local authorities said on Thursday. The trumpeting of wild elephants was first heard by a forest ranger in a village near the Menglun subsidiary nature reserve on Nov. 12. Their footprints were later discovered. Two days later, drones and infrared cameras captured the herd, which included 11 adult elephants and seven calves, according to Wang Bo. It has been 41 years since wild Asian elephants were first spotted in the Menglun subsidiary nature reserve, according to the station. The station has carried out real-time monitoring and early warnings of elephant activities in the area. It also timely publicizes safety information to villages and scenic areas within the scope.

27. Anthrax scare in Joypur rainforest in Dibrugarh (India)

The Sentinel - 6.12.2020

The recovery of the bodies of a female elephant and a calf within three days in Joypur rainforest in Dibrugarh district has spread Anthrax scare in the forest area. On December 3, inside the Joypur rainforest of Naharkatia, the body of an elephant calf was recovered. The veterinarians from TinsukiaGuijan and Naharkatia suspected the cause of death of the elephant calf to be infection of Anthrax. The fear of Anthrax has thickened on December 5 after the recovery of the carcass of a female elephant inside the rainforest.

Anthrax is a bacterial disease caused by *Bacillus anthracis*, a type of germ positive and spore-forming bacteria. Anthrax cause bacteria capable of lying dormant in the form of spores in carcasses and burial grounds of infected animals. To prevent the outbreak of Anthrax, the forest officials cremated the elephant calf instead of burying it. After just two days of the incident, the dead female elephant was recovered under a mysterious condition which has increased the risk of Anthrax outbreak. Spread over an area of 108 km^2 at Joypur in Dibrugarh district, several rare animals such as hoolock gibbon, black panther, leopard, wild dog, stump tailored macaque, caped langur and flying squirrel are found inside the rainforest.

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.). *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.

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

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

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

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