PRESENTATIONS
SESSION XI
EX SITU REPRODUCTION AND MANAGEMENT
“Relationships Among Birth Presentation, Amniotic Sac Rupture and Stillbirths in Rhinoceros.”

Once spread across the entire northern part of the Indian subcontinent, the greater one-horned rhinoceros is currently considered vulnerable (Talukdar et al, 2008). Given this species is conservation dependent, it is vital to have sustainable populations within zoological facilities. This requires putting significant time and resources into the greater one-horned rhino population and determining factors leading to high reproductive success. In spring 2012 the San Diego Zoo Safari Park experienced a difference between two greater one-horned rhinoceros births. One was a successful live birth, anterior presentation, and the other was a dystocia stillbirth, posterior presentation. Initially the stillbirth was suspected to be due to the posterior presentation at birth. However, years of anecdotal evidence suggested otherwise and a formal investigation was initiated.

Data were gathered by reviewing animal records including behavioral and breeding records for all three species of the San Diego Zoo Safari Park’s rhinoceros. Data on 173 rhino births between 1970 and 2013 were analyzed for species of rhino, and whether or not the birth was recorded as a live birth or stillbirth. Breeding records indicated that 5.3% (n = 93 total births) of the southern white rhinos born at the park were stillborn compared to 0.6% for black rhinos (n = 15 total births) and 24.5% for greater one-horned rhinos (n = 65 total births). Compared to the studbooks for each of these species through to 2010, records indicate southern white rhinos have a captive born stillborn rate of 7%, black rhinos at 11.0%, and greater one-horned rhinos at 19.7%. This information led to further investigation as to why greater one-horned rhinos have such a high rate of stillbirths.

The North American Studbook for greater one-horned rhinos lists 126 births at 35 institutions of which 29 were stillbirths. The San Diego Zoo Safari Park alone represents approximately 51.6% of births for greater one-horned rhinos within zoological institutions. Similarly, 16 of the 29 stillbirths have occurred at the park representing 55.2% suggesting the park is quite representative of the greater one-horned rhino population within zoological institutions and this high percentage of still births is not an abnormal occurrence for just one institution. Thus, determining the cause behind the higher percentage of stillbirths could substantially help this population increase sustainability.

While data are limited, 12 births have been video recorded at the San Diego Zoo Safari Park including 8 greater one-horned, 2 southern white and 2 black rhinos. The vast majority of births at the park happen when no one is around and/or no data relevant to this study could be recorded.
Information from these videos was gathered on delivery presentation and presences of sac rupture. Seven additional births had written documentation for presentation and are included but are not considered for sac rupture analysis. Three of these were also recorded, but the video is either lost or misplaced and is not available to confirm sac rupture. Delivery presentation was analyzed as follows. If a calf was born with its front feet and head presenting first it was considered an anterior presentation. If a calf presented with its rear feet first it was considered a posterior presentation. Additionally feet positioning is crucial for presentation and normal delivery. The feet need to be hoof pad “down” for an anterior delivery, as opposed to hoof pad “up” for a posterior delivery.

Of the 19 births 11 calves were delivered in posterior presentation and 7 were delivered in anterior presentation, and one is unknown. Eight of the 12 births that were recorded were live births, 4 were stillborns. In all four cases of a stillbirth delivery, the amniotic sac ruptured prior to delivery of the stillborn. Three were posterior presentation, and one is unconfirmed. Additionally all greater one-horned live births recorded did not have the sac rupture prior to delivery. However, one black rhino birth had the sac rupture prior to birth but still resulted in a live birth, so the number of minutes between sac rupture and delivery may be significant.

Looking at position, one stillborn in this study presented initially with a posterior presentation, but the pads of the feet were facing downward. Since the calf was delivering back feet first, this was an “upside down” position in the birth canal. This female over the course of several hours had the calf rotate to the proper position before delivery but resulted in a stillborn. While anterior versus posterior delivery may not be significant, the position of the calf with pads up or down may be significant, further information is still needed.

With the limited results and surrounding questions, rhino births published on Youtube were then incorporated into the data. The caveat for addition of these recordings is that all births are live births, as no facility would be expected to post video of a stillbirth. Thus these recordings do not necessarily add to the evidence for premature sac rupture as evidence for a stillborn. Nine Youtube videos of rhinos giving birth were evaluated including 4 southern white rhinos, 2 black rhino and 3 greater one-horned rhinos. Data from the southern white rhinos shows that 3 delivered in anterior presentation, 1 was in the posterior presentation. Both black rhino deliveries were anterior presentation and the 3 greater one-horned rhinos included 1 anterior and 2 posterior. All nine rhinos had the amniotic sac intact at time of delivery.

During conversations at the San Diego Rhino Keeper Workshop in May of 2013, additional video data was offered by the Chester Zoo, England. In 2012 they had 2 black rhino give birth; one was a dystocia, posterior presentation with amniotic sac rupture that resulted in the assisted delivery of a dead calf. This calf was delivered over 24 hours after the initial presentation of a single back foot. The other was a normal anterior birth, sac intact at time of delivery.
Additional data was also submitted by the Buffalo Zoo and Cincinnati Zoo and Botanical Gardens. All of the submitted data was recorded.

Preliminary data suggests that presentation at delivery must not be discounted as a factor in stillbirths in rhinoceros considering all 4 stillbirths were posterior presentation. The single live birth with premature sac rupture (a black rhino) indicates that even if the sac ruptures, a live birth is possible. The link may be the time between sac rupture and delivery of the calf. One theory is that the amniotic sac needs fluid in it to help protect the umbilical cord from compression during delivery. If the sac is ruptured and the cushioning effect of the fluid is lost, pressure on the umbilicus may result in loss of oxygen to the calf. Therefore premature sac rupture must be considered as a possible link to stillborn.

Rhinoceros birthing has been observed dozens of times in zoos with a general consensus on what constitutes a “normal” birth. A more comprehensive evaluation of what constitutes a “normal” birth in rhinoceros is needed, but as of this time has not been published. Thus some of the data analysis in this paper is limited to generalizations for rhinoceros approved by the AZA Rhino TAG. Therefore the following is considered a “normal” delivery.

Though rhinos may be in labor for extended periods of time, once the feet are showing the calf comes quickly, usually in less than one hour. If a calf’s feet are presented and the dam takes more than one hour to deliver, it often results in a compromised, stillborn or dead calf. A normal delivery is one that results in the birth of a calf within 60 minutes of feet presentation, with no additional factors. A dystocia birth is any birth that does not follow the normal parameters.

For many species amniotic sac rupture prior to delivery is not an issue. Horses often deliver after the amniotic sac has ruptured delivering a healthy live foal. The difference may be that an anterior delivery is considered normal as opposed to posterior. If the front feet and head are already out of the birth canal, the foal has the ability to breathe on its own during delivery. Since rhinoceros are able to deliver normally both anterior and posterior, premature amniotic sac rupture may contribute to the delivery of a stillborn calf. For the purposes of this study amniotic sac rupture is considered as a possible reason for stillbirth and thus significant.

More data on not only greater one-horned rhino birthing but all rhino birthing will better answer the questions of the relationships between birth presentation, premature amniotic sac rupture and stillbirths in rhinoceros. Through the International Rhino Keeper Association a request for information was sent to members to send videos of their rhino births adding to the data pool for study. While several institutions have recorded births, few are willing to share footage of the birth in a public format, losing control over who observes such recordings. A compromise is to ask each institution to use set criteria for analysis and provide data as opposed to provide videos. This information is still being gathered and will be added to the data in the future to hopefully gain a better understanding of stillbirths in rhinos.
References


Foaling Guide, Maria S Ferrer, DVM, MS, DACT, Veterinary Medical Teaching Hospital, Kansas State University.

“Relationships Among Birth Presentation, Amniotic Sac Rupture and Stillbirths in Rhinoceros.”

• Jane Kennedy, Lead Keeper, San Diego Zoo Safari Park
• North American Regional Studbook Keeper, Greater One-horned Rhinoceros
• Vice-president International Rhino Keeper Association
Rhino Births

- 41 years-173 Births
- No Northern White Rhino
- 93 Southern White Rhinos, 3 Generations
- 15 Eastern Black Rhinos, 5 Generations
- 65 Greater One-horned Rhinos, 7 Generations
Greater One-horned Rhino

- 1972-1.1 from SDZ
- 1975-1st calf born
- 2013-65th calf, a stillbirth

16 Stillbirths
12 of 27 females in NA Studbook have had a stillbirth

Jakichu and Jontu, our 55th calf
SDZSP GOHR Data

- 5 of 6 Anterior live births
- 1980s UNK live birth
- 13 March 1994-Jumia live birth
- 4-Jan-96 –Jumia live birth
- Dec 2009-Raji live birth
- 15-May-2011-Jatri-dystocia, head first no legs, both die
- 20-Jan-12 –Alta live birth
- 5 of 8 Posterior live births
- 24-Mar-75-Jaypuri live birth that died
- 28-May-87-Jaypuri live birth
- 27-Jan-90-live birth
- 23-Nov-97-Godavari live birth
- 25-Jan-05-Gari live birth
- 20-October-2010-Asha stillbirth
- 15-Mar-12 -Asha stillbirth
- Jan 5 2013-Kaya stillbirth

20-Nov-97 Gainda stillbirth likely posterior, but unconfirmed

**Bolded are videoed**
Youtube Data

• 3 GOHR, 1 anterior, 2 posterior
• 4 SWR, 2 anterior, 2 posterior
• 1 Black, 1 anterior
• 1 Sumatran, 1 posterior

• All Live births, 4 anterior, 5 posterior
Delivered stillborn male calf after 3 hours, 169 lbs
Kaya January 2013
Stillborn, posterior, sac ruptured
Kaya’s stillborn January 6, 2013

Delivered stillborn male calf after at least 50 minutes
Gainda 1997 stillborn
Gainda-excessive fluid release
Gainda 1997
UNK, stillborn, sac ruptured?
Gainda posterior? sac rupture?
Unknown Dam 1980’s anterior, live birth, sac intact
Jumia 13 March 1994
anterior, live birth, sac intact
Jumia 4 Jan 1996
anterio, live birth, sac intact
Alta Jan 20, 2012
anterior, live birth, sac intact
Netherlands GOHR-2008
anterior, live birth, sac intact
Netherlands GOHR 2011
posterior, live birth, sac intact
Netherlands GOHR 2012
posterior, live birth, sac intact
Sumatran Rhino
Cincinnati
SDZSP SWR Ujima
posterior, live birth, sac intact
SDZSP SWR Kacy
anterior, live birth, sac intact
German SWR
anterior, live birth, sac intact
Taipei SWR
posterior, live birth, sac intact
Israeli Rhino
anterior, live birth, sac intact
German Black Rhino anterior, live birth, sac intact
SZDSP Black Rhino Jeri posterior, sac ruptured, live birth
Chester Zoo Kitani’s Births

Asani
Male
Born: 29/10/08

Breech birth
Male
Born: 06/07/12
Chester Zoo Chanua’s Birth (calving pen)
Andatu
Combined Rhino Birthing Video Data

SWR-7
4 anterior, 2 posterior,
1-UNK
All live births, sac intact

Black rhinos-5
2 anterior, 3 posterior
4 live births
1 Posterior had sac rupture
1 posterior dystocia
stillbirth

Sumatran-3
1 anterior, 2 posterior
All live births

• GOHR births-14
• 5 anterior, 8 posterior, 1-unconfirmed posterior
• 5 anterior, 4 posterior-live births, sac intact
• 4 posterior-stillbirths
• 1 suspected posterior stillbirth

TOTAL-29 births
13 anterior, 13 live birth
15 posterior, 10 live birth, 5 stillbirth
1 suspected posterior stillbirth
Combined Rhino Birthing Data

**SWR-7**
4 anterior, 2 posterior, 1 unk
All live births

**Black rhinos-5**
2 anterior, 3 posterior
4 live births
1 Posterior had sac rupture ~15 minutes
1 posterior dystocia stillbirth

**GOHR births-21**
8 anterior, 7 live birth
1 dystocia stillbirth
12 posterior, 8 live birth, 4 stillbirths
1 suspected posterior stillbirth

**Sumatran-3**
1 anterior, 2 posterior
All live births
Combined Rhino Birthing Data

TOTAL-36 births

15 anterior
- 14 live births, all sac intact
- 1 stillbirth, dystocia, fetotomy-SDZSP

19 posterior
- 12 live births
- 11 sac intact, 1 amniotic sac ruptured
- 6 stillbirths, all amniotic sac ruptured
- 1 born dead, dystocia, fetotomy-Chester

1 suspected posterior stillbirth
1 unk live birth (SWR video-Dublin)
Relationships Among Birth Presentation, Amniotic Sac Rupture and Stillbirths in Rhinoceros

Birth presentation may be significant
All 5 videoed stillbirths posterior presentation

Amniotic sac rupture may be significant
All 7 stillbirths had sac rupture
(All but 1 live birth had sac intact)

More research is needed
What I need help with

• Collect more data on other rhino births

• Expand the collaborative team

• Further develop an accurate assessment plan of data

• When the members of an organization work together, important questions are answered

• We can answer this question!
Special Thanks to all of you and...

- My Husband, Big Eddie
- East Crew, Best Crew Ever!
- San Diego Zoo Global Employees
- Collections, Husbandry and Sciences Department SDZSP
- Institute for Conservation Research
- Dr. Lance Miller
- Randy Rieches-Henshaw Curator, SDZSP
- Lance Aubery, SDZSP
- Andy Blue, SDZSP
- Chester Zoo-Mark Cleave, Tim Hamilton
- Cincinnati Zoo
- Dr. Terri Roth, Dr. Monica Stoop,
- Leah Winstead-Intern video observer
- Buffalo Zoo-Joe Hauser

Ask the animals, they will teach you...JOB 12:7
Why we do this
Thermoregulation in the African Elephant (Loxodonta africana) and possible effects on fertility.

R.L. Ball¹, M.W. James¹, M.J. Schotsman², Brandon Laforest², J.L. Atkinson², E.J. Finegan² and S.P. Miller²
Tampa’s Lowry Park Zoo¹ and Department of Animal and Poultry Science University of Guelph
Elephants

• Largest living land animal
  – 5,000 - 6,000 kg
• Habitat
  – African savanna
  – Heat gained from solar radiation, landscape, metabolic processes
  – Captive habitats
• relatively low metabolic rate (/kg body weight) and low surface area:body mass
• heat which is absorbed becomes harder to lose because of the elephant’s low surface area
  – Need a way to shed excess heat
Temperature’s Effect on Fertility

• Heat Stress
  – Caused by rise in core body temperature
  – Contributing climatic factors (Gwazdauskas, 1985):
    • Temp
    • Humidity
    • Radiation
    • Wind
  – Studies in dairy cattle have shown (Jordan, 2003):
    • Increase in body temperature of ~0.9°F can cause a decline in conception rate of 12.8%
    • Negative effects can be identified from 42 d prior to and 40 d after insemination
    • Heat stress does not have to last for months to have profound negative impacts, but can occur in days, even in temperate climates
Heat Stress in Males

- oxidative stress and decrease in fertility

MINI REVIEW

Do heat stress and deficits in DNA repair pathways have a negative impact on male fertility?

Catriona Paul\textsuperscript{1}, David W. Melton\textsuperscript{2} and Philippa T.K. Saunders\textsuperscript{1,3}

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\textsuperscript{2}Sir Alastair Currie Cancer Research UK Laboratories, Molecular Medicine Centre, University of Edinburgh, Western General Hospital, Edinburgh EH4 2XU, UK
Heat Stress in Females (citations?)

- alter the duration of estrus
- colostrum quality
- conception rate
- uterine function
- endocrine status
- follicular growth and development
- luteolytic mechanisms
- early embryonic development
- fetal growth

- the only known method for increasing fertility in heat-stressed cows is to cool the cow
- hormonal treatments have been tested for increasing fertility of heat-stressed cows but none of them have been shown to consistently cause an increase in fertility of heat-stressed cows
Possible Strategies to Avoid Heat Stress

• Behavioral
  – Seek shade under trees (Kinahan et al., 2007a)
  – Mudding/wallowing
  – Ear-flapping (Phillips and Heath, 1992)
  • two to three degrees Celsius (°C) between the temperature of the blood entering the ear in the arteries and the blood leaving in the veins.

- Evaporation through the skin (Wright and Luck, 1984)
Possible Strategies to Avoid Heat Stress

– Adaptive Heterothermy
  • Some mammals in hot, arid areas are capable of allowing their core body temperature to rise
    – instead of jeopardizing their water balance and energy reserves to cool off
    – They then lose this excess heat during the night, using the cool sky and landscape as heat sinks
  • Elephant core body temperatures may vary as much as 5°C (9°F) (Elder and Rodgers, 1975)
  • Use a countercurrent blood vessel arrangement known as a rete to cool blood flow to the brain
Thermoregulation by the African Elephant, *Loxodonta africana*

M.J. Schotsman, J.L. Atkinson, E.J. Finegan and S.P. Miller  
*Department of Animal and Poultry Science, University of Guelph, Guelph, Ontario*  
EMA 2008

Abstract

As large mammals in hot, arid environments, African elephants face difficulties losing excess heat gained during the day. They may store heat gained during the day, and release it at night through vasodilation in their ears and sides. Three African elephants were observed over six nights and their core body, side, and ear temperatures were measured. Side and ear temperatures decreased faster on cold nights (slopes of -0.11 to -0.21) than warm nights (slopes of -0.03 to -0.21). Both side and ear temperatures were more variable on warm nights. Core body temperatures varied by as much as 4 degrees Celsius. These findings indicate heat storage during daylight hours and heat loss overnight.
Hypothesis

• Elephants store heat during the day instead of using energy and water to keep body temperature stable
• Skin temperatures will stay high early in the night
• Ear temperatures will be high for some part of the night
• Core body temperatures will go down over the course of the night
Methods

• Study animals
  – 3 female African elephants at the Toronto Zoo
  – 2 acre paddock
  – Three observation sites used
Methods

• Procedure:
  – Every 15 minutes weather data taken
    • Solar radiation, background longwave radiation, cloud cover, relative humidity, windspeed, and air temperature
  – Infrared images taken every 15 minutes
    • Side-on, ears visible
  – **Images also taken whenever urinations occurred as a measure of core body temperature**
    • Benedict and Lee (1936)
  – Observations made on 10 nights through June and July from sunset to sunrise
Thermal Imaging

- Infrared/longwave radiation
  - Emitted by anything with a temperature over absolute zero (-273 °C)
- Thermal imaging camera (FLIR Thermacam)
  - Uses infrared radiation emitted by a surface to determine the temperature of the surface
Methods

• Outlined sides and ears, took average temperature of both areas
Results

• Huge number of pictures
  – More than 2400 images to analyze!

• Complications...
  – Animals not always in view, may be lying down or leaning against walls
Focus on three elephants

• Why these three?
  – Most visible
  – Little time spent lying down or behind obstructions
  – Frequent visible urinations

• Data from 6 nights, 3 “warm” and 3 “cold”
Discussion

- Decrease in side, ear, and urine temperatures over the course of the night
  - Ear temperatures were more variable on warm nights than cold nights (Warm nights $R^2 = 0.15 - 0.87$, Cold nights $R^2 = 0.40 - 0.91$)
  - Side temperatures were more variable on warm nights than cold nights (Warm nights $R^2 = 0.14 - 0.84$, Cold nights $R^2 = 0.61 - 0.94$)
  - Urine temperatures indicate that core body temperature can decrease as much as $4.9^\circ C (8.8^\circ F)$ over the course of the night
  - Surface temperature tends to decrease more rapidly on cold nights
Conclusions

• Managed elephants do have a highly variable core body temperature.
• This fluctuation may be more than wild elephants (Kinahan 2007)
• Initial support for adaptive heterothermy in African elephants
• **Elephants may require opportunities to thermoregulate**
• actively retain heat the longest in their trunk
• The body to a lesser degree to dissipate heat
• The ears, smaller compared to body size than African ears, cool most quickly
Is heat stress present in managed elephants and how?

Indoor housing  Obesity
Reproductive Capabilities of the Managed Population

• Asian Elephants ♀’s (ages 10-40)
  • 21/56 (37.5%) are considered non or post-reproductive

• African Elephants ♀’s (ages 10-40)
  • 71/102 (69%) are considered non or post-reproductive

• Why such a high rate of infertility?
  – Could be several contributing/intertwining environmental factors
    • Heat Stress
    • Obesity
    • Diet

(AZA SSP Population Analysis, 2011)
How can we reduce heat stress in managed elephants?

• Exhibit Design
  – Shade
  – Access to water features/wallows
  – Reflective features
How can we reduce heat stress in managed elephants?

- Create circumstances that allow for adaptive heterothermy
  - Access to outdoor space overnight
- Diet
- the only known method for increasing fertility in heat-stressed cows is to **cool the cow**
Further Investigations

- Verify that elephants exhibit adaptive heterothermy
  - Urine temps as core validation in progress

**TABLE 1**

**TEMPERATURES OF THE URINES OF A 4000-KG. ELEPHANT**

(April 9, 1935)

<table>
<thead>
<tr>
<th>TIME OF DAY</th>
<th>BARN TEMPERATURE, ºC.</th>
<th>WEIGHT OF URINE COLLECTED, KG.</th>
<th>URINE TEMPERATURE, ºC.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:33 A. M.</td>
<td>11</td>
<td>3.35</td>
<td>35.8</td>
</tr>
<tr>
<td>2:50 A. M.</td>
<td>10</td>
<td>3.15</td>
<td>36.0</td>
</tr>
<tr>
<td>6:27 A. M.</td>
<td>10</td>
<td>8.74</td>
<td>36.0</td>
</tr>
<tr>
<td>9:26 A. M.</td>
<td>9</td>
<td>5.10</td>
<td>35.8</td>
</tr>
<tr>
<td>11:36 A. M.</td>
<td>9</td>
<td>3.29</td>
<td>36.0</td>
</tr>
<tr>
<td>4:55 P. M.</td>
<td>13</td>
<td>5.65</td>
<td>35.6</td>
</tr>
<tr>
<td>6:32 P. M.</td>
<td>11</td>
<td>4.81</td>
<td>35.5</td>
</tr>
<tr>
<td>8:54 P. M.</td>
<td>9</td>
<td>10.72</td>
<td>36.1</td>
</tr>
<tr>
<td>11:02 P. M.</td>
<td>9</td>
<td>3.40</td>
<td>35.9</td>
</tr>
</tbody>
</table>
Further Investigations

• Association between infertility and obesity
  – Endocrine or heat or both??

• Temperature management and semen collection
  – Indoor bulls??

• Study heat loss indoor overnight
White rhinoceros

• Adaptive thermoregulatory behaviors, which limit heat gain during the hottest hours

• Large diurnal temperature variation
  – (Allbrook et al., 1958)

• Local blood flow to the body surface
  – Thermal windows
  – Epidermis 1mm, well-developed subjacent vascular bed
White rhinoceroses

• Do white rhinos exhibit adaptive heterothermy?
  – life history as an arid-zone megavertebrate
• If not, are they still given opportunity to thermoregulate (dissipate heat)?
• Do they acquire more heat in captive situations?
• If no, then is heat stress contributing to infertility?
White rhinoceros

- Preliminary observations suggest no adaptive heterothermy
- Shade a predominant behavioral cooling mechanism
White rhinoceros reproduction success

- San Diego Safari Park
- Busch Gardens Tampa
- Western Plains Dubbo
- Lowry Park Zoo
- Space
- Housing  
  - Indoors vs outdoors

- Expand thermal research with white rhinos  
  - Associations with repro success
Acknowledgments

- University of Guelph
- Busch Gardens Tampa Elephant Team
- TLPZ Elephant and Rhino Staff

Katie L. Edwards, Susanne Shultz, Mark Pilgrim and Susan L. Walker
Ex situ conservation
EEP population of black rhino

[Bar chart showing the number of males and females from 1985 to 2005]

[Map showing the distribution of black rhinos in Europe]
EEP population of black rhino
<table>
<thead>
<tr>
<th></th>
<th>Ex situ</th>
<th>In situ</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Last 10 year period</strong></td>
<td>11.3% females breeding per annum</td>
<td>23.7 % females breeding per annum</td>
</tr>
<tr>
<td><strong>Previous 10 year period</strong></td>
<td>40.7% females aged 5-32 produced offspring</td>
<td>52.9% females aged 5-32 produced offspring</td>
</tr>
<tr>
<td></td>
<td>1.54 calves per breeding female</td>
<td>2.11 calves per breeding female</td>
</tr>
</tbody>
</table>
What could be limiting growth?

42.1%  
Non-proven

48.6%
Differences in reproductive success
Hormones and reproductive success

Glucocorticoids
- Proven males had higher testosterone than non-proven males
- No relationship between testosterone and glucocorticoids
4 types of cyclicity pattern observed
No evidence of seasonality
Long cycle types more commonly observed in non-proven females
Glucocorticoids were higher during long cycle types
Especially in non-proven females
What other factors could be involved?
Non-proven females scored higher BCS than proven females
Non-proven females were less likely to express regular behavioural signs of oestrus.
<table>
<thead>
<tr>
<th>Temperament Description</th>
<th>Gender</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘Almost always behaves the same’</td>
<td>♂</td>
<td>PROVEN</td>
</tr>
<tr>
<td>‘Sometimes can be unpredictable’</td>
<td>♂</td>
<td>GC</td>
</tr>
<tr>
<td>‘Very unpredictable’</td>
<td>♂</td>
<td>NON-PROVEN</td>
</tr>
<tr>
<td>‘Almost always behaves the same’</td>
<td>♀</td>
<td>PROVEN</td>
</tr>
<tr>
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<tr>
<td>‘Very unpredictable’</td>
<td>♀</td>
<td>NON-PROVEN</td>
</tr>
</tbody>
</table>
Extrinsic factors
Summary

- Sub-optimal reproduction limiting population growth
- Hormone differences between breeding and non-breeding rhinos
- In males, testosterone differences unrelated to extrinsic factors
- In females, erratic cyclicity is relatively common
- Long cycle types may be indicative of a problem – glucocorticoids
- Body condition related to reproductive success
- Expression of oestrus can be unreliable, especially in non-proven females
- Temperament related to glucocorticoids and reproductive success
Acknowledgements
Improving the welfare of captive Asian elephants in Kerala, India

T.P. Sethumadhavan, K.C. Panicker, R. Radhika

Abstract

Improving the welfare of captive Asian elephants in India is emerging as an important conservation issue. Improving elephant welfare is one of the research priorities of scientists, policy makers and researchers. This study was done in Kerala state, the southern state of India where elephants are used widely for festivals. Tuskers are used for processions and festivals in Temples and churches. Recent findings revealed that due to poor elephant management, 400 human lives have been lost during the last three and a half decades in India, of which more than 90 per cent of the victims were mahouts. It is clear that poor elephant management practices cause elephant aggression toward mahouts.

This study was conducted in the southern state of India, Kerala, which occupies only 1.13 percent of the geographic area of the country. The state has 600 captive Asian elephants. As part of the study 100 captive Asian elephants were selected to determine the cause of elephant aggression and to formulate measures to improve captive elephant welfare. Variables like breeding, feeding, management, season, age, musth, behavior, transportation and diseases were identified. Major interventions affecting the above variables were also identified and a SWOT analysis was done. Major indicators of poor elephant welfare included reduced chances for breeding, unscientific feeding and management methods, prolonged standing during festivals, unscientific musth management, poor musth forecasting system, heat stress, poor transportation and disease management.

Based on the above findings, a system was formulated to improve elephant management after taking in to account the major variables identified including best feeding and management practices, musth forecasting system, scientific disease control system and best management practices during transport and festivals.

The formulated scientific management system was administered on 100 captive Asian elephants during the festival season of 2012-2013. During the festival season, when the elephants are compelled to stand more than 6 hours, measures were taken to frequently give watery vegetables like cucumber and water melon. In order to reduce heat stress the elephants were allowed to walk in shady places. Wet gunny bags were placed underneath their feet. Shamianas were made over their standing space to protect them from scorching sunlight. A twelve hour rest period was made compulsory for elephants before moving to the next festival. Mahouts were given training in scientific management practices. As part of transportation norms, elephants were allowed to walk only 20 kms per day during the morning and evening hours. For distances to be traveled beyond 20
Km, travel by trucks was made mandatory as per the State’s captive elephant management rule.

The study findings revealed that best captive elephant management practices could reduce 90 percent of the elephant aggression toward humans. In order to reduce stress, a scientific feeding & management program and disease control during musth also needs proper attention. There is a positive correlation between season and incidence of musth. A musth forecasting system will help to reduce elephant aggression toward humans and maintain appropriate elephant welfare.

**Introduction**

Among range countries, measures to improve welfare of captive Asian elephants is an important conservation issue. Improving the welfare of captive Asian elephants in India is emerging as an important conservation issue. Improving elephant welfare is one of the research priorities of scientists, policy makers and researchers. This study was done in Kerala state, the southern state of the country where elephants are used widely for festivals. Tuskers are used for processions and festivals in Temples and churches. Recent findings revealed that due to poor elephant management, 400 human lives have been lost during the last three and a half decades in India, of which more than 90 percent of the victims were mahouts. It is clear that poor elephant management practices cause elephant aggression toward mahouts.

**Materials and methods**

This study was conducted in the southernmost state of India; Thrissur in Kerala which occupies only 1.13 percent geographic area of India. Human-captive elephant interaction is primarily observed in regions of the state where tuskers are used for festivals and processions. There are certain festivals where up to 70 animals at a time will be used for a procession. Kerala has more than 600 captive Asian elephants. As part of the study, 100 captive Asian elephants were randomly selected to analyse the animal welfare issues and to find suitable measures to improve the situation.

Different variables like feeding, management, season, age, musth incidence, behavior, transportation, breeding and diseases were identified. Data was collected from different stakeholders such as veterinarians, mahouts, elephant owners, festival organizers, policy makers and elephant lovers with the help of standardized interview forms. Focus group discussions were also conducted. Major interventions affecting the above variables were identified and a SWOT analysis was conducted. The societal drivers of attitudes to elephant issues can be analysed in terms of a ‘V-STEEP’ (Values, Social, Technological, Economic, Environmental and Politico-legal) framework of Rogers (2005), an extension of the SEEP framework of Campbell & Olson, 1991. Appropriate management protocols were developed to improve the welfare of captive Asian elephants.
Results and discussion

Major elephant welfare issues identified were stress due to overwork during festival season, poor chances of breeding, unscientific feeding and management, prolonged standing in festivals, improper musth management, poor musth forecasting system, heat stress & climatic variations, poor transportation and disease management.

SWOT analysis

<table>
<thead>
<tr>
<th>Strength</th>
<th>Weakness</th>
<th>Opportunities</th>
<th>Threat</th>
</tr>
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<tr>
<td>2. 600 Captive Asian Elephants</td>
<td>2. Major festivals are during December to May</td>
<td>2. Musth forecasting system</td>
<td>2. Increasing musth incidents during winter</td>
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<td>6. Climatic variation</td>
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<td>7. Traditional festival practices</td>
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<td>8. Unpredictable behavior of elephants</td>
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</tbody>
</table>

Based on the above findings and different variables identified, management protocols were formulated to improve the welfare of captive Asian elephants. Major variables include best feeding and management practices, musth forecasting system, scientific disease control system and best management practices during transport and festivals.

The formulated scientific management practices were administered on 100 captive Asian elephants during the festival season of 2012-2013. During the festival season, when the elephants were standing more than 6 hours, measures were taken to frequently give watery vegetables like cucumber and watermelon. They were allowed to walk in shady places during the festivals. Wet gunny bags were placed underneath their feet. Shamianas were made on their standing space to protect them from scorching sunlight. A twelve hour rest period was made compulsory for elephants before proceeding to the next festival. Mahouts, veterinarians and media persons were given training in scientific management practices. Elephants are only allowed to walk 20 kms per day and only during morning and evening hours. For distances beyond 20 km, the
elephant must be transported by trucks and this regulation was made compulsory as per the Captive Elephant Management Rule. The presence of veterinarians and forest officials was made compulsory during festivals to monitor the situation.

Management protocols

1. Elephants require adlibitum fodder/ green leaves and water just prior to festival procession/parade.
2. Elephants require a rest period of 12 hours before the next festival procession.
3. During festivals, elephants were compelled to stand under scorching sunlight and on overheated floors causing stress and foot lesions. Sufficient shade should be provided at the procession venue. Frequent sprinkling of water on the floor and foot was suggested.
4. During transportation, elephants cannot be allowed to walk more than 20 Km at a time. It should be done during morning and evening hours. Trucks should be used for transportation for a distance of more than 20 Km. Sufficient care should be taken while transporting elephants in trucks.
5. During festivals where elephants are compelled to stand more than 6 hours at a time, succulent fruits like watermelon, banana and pineapple should be given.
6. A registered veterinary practitioner should examine elephants before they are put to use in festivals.
7. Animals showing pre-musth, musth and post musth symptoms should not be allowed to participate in the festivals.
8. Based on age, season and previous musth incidents, a musth forecasting system was developed. This can be used as a screening process.
10. Awareness programmes for public, festival organizers, students and elephant lovers are suggested.
11. Registered veterinary practitioners and forest officials should monitor the welfare of animals during festivals where elephants are put to use for procession.

The study findings revealed that best captive elephant management practices could reduce by 90 percent the elephant aggression toward humans. In order to reduce stress, scientific feeding & management, disease control and management during musth needs proper attention. There is a positive correlation between season and incidence of musth. Musth forecasting system based on previous incidences of musth, age and season will help to reduce elephant aggression toward humans and maintain a sustainable elephant welfare system. Social attitudes and constructs among stakeholders should be influenced in ways that allow greater sharing of information and values on elephant management.

Literature cited-

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   Pretoria.


Authors are thankful to the Elephant welfare association, Thrissur, Kerala and Kerala Veterinary and Animal Sciences University, Kerala, India for providing facilities for conducting the study.
Improving welfare of captive Asian elephants in Kerala, India

T.P.Sethumadhavan, K.C.Panicker & R.Radhika
Kerala Veterinary & Animal Sciences University, India
www.kvasu.ac.in
Asian elephants occur in isolated populations in 13 range States, with an approximate total range area of almost 880,000 square kilometers equivalent to only one-tenth of the historical range as defined by the IUCN. Today Asian elephants occur in Bangladesh, Bhutan, India, Nepal, Sri Lanka, Cambodia, China, Indonesia, Lao People’s Democratic Republic, Malaysia, Myanmar, Thailand, and Viet Nam. Feral populations occur on some of the Andaman Islands in India. Recent reports from across the 13 Asian elephant range States suggest that there are between 39,500 and 43,500 wild Asian elephants. In addition, there are approximately 13,000 domesticated (working or former working) elephants in Asia.
Asian elephants occur in isolated populations in 13 range States, with an approximate total range area of almost 880,000 square kilometers equivalent to only one-tenth of the historical range as defined by the IUCN.
Geographic distribution

- Asian elephants occur in Bangladesh, Bhutan, India, Nepal, Sri Lanka, Cambodia, China, Indonesia, Lao People’s Democratic Republic, Malaysia, Myanmar, Thailand, and Viet Nam. Feral populations occur on some of the Andaman Islands in India. Recent reports from across the 13 Asian elephant range States suggest that there are between 39,500 and 43,500 wild Asian elephants. In addition, there are approximately 13,000 domesticated (working or former working) elephants in Asia.
Indian Elephant Population Figures

- Elephant Range: 110,000 km²
- Country Ranking: 2\textsuperscript{nd} of 13
- Wild elephants: 23,900
- Total Captive Population: 3,500
- Country Ranking: 3\textsuperscript{rd}
Domesticated Asian Elephants in India-Current status

3300 domesticated Asian Elephants
75% owned by individuals
6 Percent by temples
2 percent by zoos
3 percent by circuses
14 percent by state forest departments
Purpose of rearing

39 % are used for logging
10 % for transportation
16 % for Tourism
3 % for entertainment (Circus & Zoos)
20 % for ceremonial purposes
2 % for agriculture
7% for begging
Kerala Scenario

A tiny state with 1.13% geographic area of the country
600 captive Asian elephant population
Mostly Tuskers are used for festivals, processions and work
Human-Elephant contact during festivals
Mahouts and the elephant
Tuskers are used during festivals
Festival procession through the crowd
Elephant lovers as Friends of Elephants
Young Mahout
Traditional Custom of worship-anayoothu
Feeding of Elephants
Friends of Elephants
Elephant aggression towards Mahouts
Elephant beyond control
Recent findings revealed that 400 human lives were lost due to elephant aggression during the last three and a half decades in Kerala, India. Of which more than 90 Percent victims are mahouts.
Objectives of the study

1. To find out the cause and to formulate the required measures to reduce Elephant aggression.
2. To formulate management protocols and musth forecasting system to reduce increasing incidence of aggressive behavior in elephants.
Materials and methods

As part of the study 100 domesticated/captive Asian elephants were randomly selected to find out the cause and to formulate measures to reduce the aggressive behavior among elephants.
Different variables studied

- Different variables like feeding, management, season, age, musth incidence, behavior, transportation, breeding and diseases were identified.
- Data were collected from stakeholders involved in elephant welfare like veterinarians, mahouts, elephant owners, festival organizers, policy makers and elephant lovers with the help of interview schedule.
- Focus group discussions were also conducted. Major interventions affecting above variables were identified.
- SWOT analysis was done.
- Based on the findings management protocols were developed to reduce the increasing incidence of aggressive behavior among elephants.
Results and discussion

Major elephant welfare issues are stress due to over work during festival season, poor chances of breeding, unscientific feeding and management, prolonged standing in festivals, improper musth management, poor musth forecasting system, heat stress & climatic variations, poor transportation and disease management.
Strength & Weakness

- Literacy
- 600 Captive Asian Elephants
- Captive Elephant management rule 2003
- Network of veterinary institutions
- Media awareness
- Friends of Elephant culture

- Over work during festive season
- major festivals are during December to May
- Poor chances of breeding
- Improper feeding and watering
- Poor musth management
- Transportation stress
- Climatic variation
Opportunities & Threat

- Captive elephant management rule
- Musth forecasting system
- Awareness programmes at the institutional level
- Good mahout practices
- Management protocols
- Positive attitude towards elephant welfare

- Frequent climatic variation
- Increasing musth incidents during winter
- Poor management practices
- Unscientific mahout practices
- Improper implementation of captive elephant management rule
- Cruelty on elephants
- Over work during a particular season
- Traditional festival practices
- Unpredictable behavior of elephants
Management protocols

Best feeding and management practices, musth forecasting system, scientific disease control system and best management practices during transport and festivals were developed.
Existing management protocols were modified and applied new scientific management protocols on 100 captive Asian elephants during the festival season January to May 2013.
Based on the SWOT analysis remedial measures were identified in breeding, feeding, management, season, age, musth incidence, musth forecasting, Mahout training, behavior, over work, cruelty, transportation and disease control in tune with captive elephant management rule 2003.
• Elephants require adlibitum fodder/ green leaves and water just prior to festival procession/parade.
• Elephants require a rest period of 12 hours before the next festival procession.
• During festivals elephants were compelled to stand under scorching sunlight and on overheated floor. This causes stress and foot lesions. Sufficient shade should be provided at the procession venue. Frequent sprinkling of water on the floor and foot were suggested.
• During transportation, elephants cannot be allowed to walk more than 20 Km at a time. It should be done during morning and evening hours. Trucks should be used for transportation for a distance of more than 20 Km. Sufficient care should be taken while transporting elephants in trucks.
• During festivals where elephants are compelled to stand more than 6 hours at a time, succulent fruits like watermelon, banana and pineapple should be given.
A registered veterinary practitioner should examine elephants before they are put to use in festivals.

Animals showing pre-musth, musth and post musth symptoms should not be allowed to participate in the festivals.

Based on age, season and previous musth incidents, a musth forecasting system is developed. This can be used as a ready reckoner for screening process.

Mahouts must be trained as per captive elephant management rule 2003.

Awareness programmes for public, festival organizers, students and elephant lovers are suggested.

Registered Veterinary practitioners and forest officials should monitor the welfare of animals during festivals where elephants are put to use for procession.
Musth forecasting

Based on

- Season
- Behavior
- History

Swelling of the temporal gland
Oedema around the perineal region

Behavior towards mahouts

Symptoms

Hormonal assay
5. During festivals where elephants were compelled to stand more than 8 hours at a time, succulent fruits like watermelon, banana and pineapple should be given.

6. A registered veterinary practitioner should examine elephants before they are put to use in festivals.

7. Animals showing pre-musth, musth and post musth symptoms should not be allowed to participate in the festivals.

8. Based on age, season and previous musth incidents, a musth forecasting system was developed. This can be used as a ready reckoner for screening process.

9. Mahouts must be trained as per captive elephant management rule 2003.

10. Awareness programmes for public, festival organizers, students and elephant lovers were suggested.
The management protocols were applied to elephants during the peak festival season from January to May 2013. As a result, the incidence of aggressive behavior of elephants could be reduced up to 90 percent in the state.

Study revealed that there exists a positive correlation between Elephant’s aggressive behavior and poor feeding and management practices.
Conservation issue

- A future for Asian elephants ensures a future for other species and wild spaces
Initiatives for elephant welfare

- Animal welfare clubs at school level
- Capacity building for Veterinarians, and Forest officials
- Skill development programmes for Mahouts
- Awareness programmes for School children and public
- Knowledge dissemination on elephant welfare through print, electronic and web media
- Research elephant welfare issues
Authors are thankful to the Kerala Veterinary and Animal Sciences University, Thrissur, Kerala, India for providing facilities for conducting the study.
Thank You
Relationship between management, adrenal activity and reproduction in a captive group of female Asian elephants (Elephas maximus)

Jess Trotter, Katie Edwards, Martin Jones, Hanspeter Steinmetz, Susan Walker
In Captivity Welfare and Sustainability is Key
Introducing the Herd

MATRIARCH

Sheba

ADULTS

Jangoli

Thi

Birma

SUB ADULT

Sithami

JUVENILE

Sundara

CHESTER ZOO
Chester’s Breeding Programme

-20
0
20
40
60
80
100
120
140
Nov-07
Dec-07
Jan-08
Feb-08
Mar-08
Apr-08
May-08
Jun-08
Jul-08
Aug-08
Sep-08
Oct-08
Nov-08
Dec-08
Jan-09
Feb-09
Mar-09
Apr-09
May-09
Jun-09

Jangoli
Sithami
Thi
Sundara
Birma

Period 1
Period 2
Period 3
Period 4
Data Collection

- Study Period: March 2008 to June 2009
- Faecal samples analysed for progesterone and corticosterone metabolites
- Management factors: Animal Records Keeping System (ARKS) and the elephant keepers’ daily diaries
Data Collection

• Study Period: March 2008 to June 2009

• Faecal samples analysed for progesterone and corticosterone metabolites

• Management factors: Animal Records Keeping System (ARKS) and the elephant keepers’ daily diaries
Questions

1) Were management factors related to adrenal activity?

2) Was adrenal activity related to acyclicity?
Training

- In 4 individuals no effect of routine training on adrenal activity
- In 1 individual intensive training was related to higher adrenal activity
Foot Care

- In 4 individuals no effect of routine footcare on adrenal activity
- In 1 individual intensive foot care was related to higher adrenal activity
Presence of Matriarch

MATRIARCH
Sheba

ADULTS
Jangoli
Thi
Birma

SUB ADULT
Sithami

JUVENILE
Sundara
Adrenal Activity and Acyclicity

During acyclicity:

• For 1 female adrenal activity was lower during the acyclic period than during cycling
• For 2 females there was no difference

Prior to acyclicity:

• For all 3 females, adrenal activity was not elevated during the cycle prior to acyclicity
Findings

- What about acyclicity?

- Pregnant females – herd was highly synchronised prior to this study, and we cannot rule out the influence of a behaviourally dominant female conceiving......
Findings

- Management recommendations made after this study:
  - To minimise separation of the family group for training
  - To not separate the matriarch from the group
  - Refurbishing enclosures with sand to benefit foot health
  - Installing natural features to provide a more stimulating environment
Any Questions?
SOCIAL AND REPRODUCTIVE BEHAVIOUR OF CRITICALLY ENDANGERED NORTHERN WHITE RHINOCEROS (*CERATOTHERIUM COTTONI*) IN A ZOOLOGICAL GARDEN

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Group composition may be an important factor for optimal welfare and reproduction of socially living mammals. Northern and southern white rhinos are the most social of all rhinoceros species, and females, sub-adults and juveniles live in groups. However, white rhinos in zoological gardens are often kept in small numbers and they cannot change their companions as often as they do in the wild. White rhinos have low reproductive success in captivity and social interactions between the animals, especially their increased agonistic behaviour, might be one of the reasons. Therefore, appropriate group composition and/or a change of social relationships in white rhino herds might have a positive effect and increase reproduction of the captive rhinos. However, studies experimentally investigating the influence of changes in group structure on the social and reproductive behaviour of captive rhinos are missing. The northern white rhino is currently on the brink of extinction with only seven animals known to survive. We studied the social and reproductive behaviour of a group of northern white rhinos (one male, five females) in zoological garden Dvůr Králové in 2005. The most often observed agonistic activities among the animals were threat, snarl and clash of horns. The agonistic behaviour was most frequently directed from the females towards the male and agonistic activities between the females were rarely recorded. In the middle of our study, one of the females (the oldest one and the only one wild-born) was separated from the herd. Following her separation, the agonistic behaviour between the other rhinos significantly increased. In addition, play behaviour, especially between the male and females also increased. However, play behaviour is observed in adult male-female interactions in the wild only very rarely. We did not register any changes in socio-positive behaviour. Social dominance among the females, which might affect reproduction of subordinate animals, was not found. The presence of an old and experienced wild-born female in the herd during our study might have had a positive influence on the social interactions between other animals. Our results show that the composition of a white rhino group in captivity can have significant influence on the social interactions between the rhinos. Better knowledge of appropriate composition of white rhino groups in zoological gardens in terms of age, sex and wild or zoo origin might therefore improve animals’ well-being and also increase a chance for their reproduction.
Social and reproductive behaviour of critically endangered northern white rhinoceros (Ceratotherium cottoni) in a zoological garden

Ivana Cinková, Vítězslav Bičík

DEPARTMENT OF ZOOLOGY AND LAB OF ORNITHOLOGY, FACULTY OF SCIENCE, PALACKÝ UNIVERSITY, OLOMOUC, CZECH REPUBLIC, E-MAIL: IVANACINKOVA@CENTRUM.CZ
Introduction

- Northern white rhinos in captivity and in the wild
- Northern white rhinoceros – formerly subspecies of the white rhino (taxonomic revision: Groves, Fernando and Robovský, 2010)
- Low reproduction in captivity
- Behaviour:
  - Increased agonistic behaviour in captivity
  - Sociality
  - Dominance hierarchy?
Methods

- Zoological garden Dvůr Králové, 3 000 m² enclosure
- Breeding situation in the zoo
- Jul – Nov 2005
- Before our study started:

  - 3 adult females + 1 subadult female
  - + Adult female NESÁRÍ
  - 1 month later
  - + Adult bull SUNI
  - 1 month later
  - Our study started
Methods

- Agonistic, cohesive (= socio-positive) and play behaviour

In the middle of our study, NESÁRÍ was separated from the group:

- Observations: before NESÁRÍ was separated (99 h 50 min) and after the separation (94 h 10 min)
- Scale scores to assess potential dominance hierarchy (following Jameson et al. 1999)
Results

Behaviour before x after the separation (Wilcoxon paired test)

* P = 0.04

Snarl (P = 0.04)
Snort (P = 0.07)
Clash of horns (P = 0.22)
Grunt (P = 0.27)

After Bonferroni correction non-significant (for P = 0.0125)
Results

- Scale scores to assess potential dominance hierarchy
- 73% of all agonistic activities were directed towards the bull SUNI
Results

- Sociogram of cohesive interactions between the pairs of animals
Results: Reproduction

- Interest of the bull in females: 5x before NESÁRÍ was separated, 2x after her separation
- No mating occurred
Conclusion

- Separation of NESÁRÍ influenced the behaviour of other rhinos
- Increased agonistic behaviour $\Rightarrow$ increased stress (Meister 1997) $\Rightarrow$ lower chance for reproduction?
- Dominance hierarchy was not found
- NESÁRÍ (33 years, wild-born)
- Captive-born females are more likely to reproduce in the presence than in the absence of a wild-born female (Swaisgood et al. 2007)
- More studies on this topic are needed
Acknowledgements

- Zoo Dvůr Králové
- Dr. Kristina Tomášová
- Rhino keepers

The attendance at INTERNATIONAL ELEPHANT & RHINO CONSERVATION & RESEARCH SYMPOSIUM 2013 was supported by a grant from project PROVAZ (CZ.1.07/2.4.00/17.0138).

The results of this study were already published as:
Thank you for your attention