Observations on the 24-hour clock, reproduction and gestation periods of the white rhinoceros at Ziwa Rhino Sanctuary, Uganda

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Introduction

Based on continuous monitoring of the 21 white rhinos, data are presented on their daily activities and reproduction. On average, the main periods for feeding were 7–10 am and 4–10 pm; the main period for resting was 11–3 pm; the main period for moving was (between) 1–5 am. Calving occurred throughout the year. The gestation periods calculated from actual observations give a range from 488-504 days. This paper presents an overview of six years of data collection (2011-2017) relating to the 24-hour clock of the animal and to their reproductive behaviour, updating the one-year information given in Patton et al. (2011).

Ziwa Rhino Sanctuary (ZRS) covers an area of 64.2 km^2 in the Nagasongola district of central Uganda. Prior to becoming a wildlife sanctuary in 2004, the area was part of a cattle ranching operation. ZRS holds the only wild (re-introduced) southern white rhinos (*Ceratotherium simum*) in Uganda. At the end of 2017 there were 21 individuals including six breeding females and two breeding males, as follows:

Multi-calving females: *Nandi, Kori, Bella*
First calving females: *Malaika, Laloyo, Donna*
Breeding Males: *Taleo*, *Moja*

The rhinos at Ziwa are held under heavy security, 24 hours a day, by armed guards and monitoring rangers (Patton et al. 2012). The monitoring teams keep the rhinos in view but remain at a discrete distance to avoid disturbance to their normal behaviour. All activities are recorded on an hourly basis on a daily sighting form, even throughout the hours of darkness. Ziwa is almost unique for a rhino sanctuary, with no predators such as lions or dangerous wildlife such as elephants and buffaloes, this allows the rangers to follow the rhinos day and night. However, there are situations where an individual rhino might be 'out of view' for several hours or even a couple of days. The causes of this are varied but may include being frightened by lightening or the unwelcome physical attention of a male.

The 24-hour clock of rhinos in Ziwa

The rangers completed a daily sighting form for each hour of the day between June 2011 and May 2017. The analysis includes data on 5 adult females and 6 sub-adults. Calves are excluded as their actions are dependent on their mothers, while adult males move long distances and often cannot be continuously monitored hourly over a full 24-hour period.

For each rhino, the rangers recorded one of three main activities: feeding, resting or moving, as well as the secondary activity of drinking.

The level of the main activit1es for each hour of a 24 hour period were calculated as a percentage (mean of the six years of the study period) of the total spent (100%) on each activity in the day (Table 1). The data combined in Table 1 suggest a 'typical' day, which is presented as a 24-hour clock in figure 1.TThe time spent by the rhinos on each of the three main activities as a percentage of the total time for each year of the study period is presented in Table 2.

The proportion of time spent on the main activities—feeding 61%, resting 37% and moving 2%—is very similar to the figures reported previously for the single year (2010/2011) of feeding 60%, resting 34% and moving 4% (Patton et al. 2011). The ranges of the six years of data are all within the given standard deviations showing a high degree of consistency.

The mean percentages of each activity applied to a period of 24 hours suggests a white rhino feeds on average for 14.6 hours a day, rests for 8.9 hours a day and moves for 0.5 hours. However, the rhinos often move while feeding especially after their main period of rest when they actively move to water for drinking and wallowing. The monitoring rangers would record

Table 1. Main activities of white rhinos in Ziwa Rhino Sanctuary for each hour of the day as a percentage of total hours spent for each activity. Note: significant figures are shown in italics when negative, or in bold when positive.

Time	Moving	Resting	Feeding	Drinking
0100-0200	**6**	7	2	1
0200-0300	7	7	2	0
0300-0400	**6**	6	2	1
0400-0500	**6**	6	2	1
0500-0600	5	5	3	1
0600-0700	4	4	4	1
0700-0800	*2*	*0*	7	1
0800-0900	*2*	1	7	2
0900-1000	3	1	6	4
1000-1100	3	4	5	4
1100-1200	3	**8**	2	2
1200-1300	*2*	**10**	*1*	2
1300-1400	3	**10**	*1*	2
1400-1500	3	**9**	2	6
1500-1600	5	6	3	**12**
1600-1700	7	2	6	**21**
1700-1800	3	1	7	**17**
1800-1900	3	*0*	7	7
1900-2000	4	*0*	7	6
2000-2100	4	*0*	7	4
2100-2200	4	1	6	2
2200-2300	5	2	5	2
2400-0100	5	6	3	1
mean	**4**	**4**	**4**	**4**

the main activity as feeding and not moving. This can be seen in Table 1 where moving is recorded in all the hourly periods, though sometimes at a low level.

The "suggested clock" in Figure 1 shows that the main periods for feeding were 7–10 am and 4–10pm; the main period for resting was 11–3pm; the main period for moving was 1–5am. The remaining periods of 5–7am, 10–11am, 3–4pm and 10–1am show no preference for a particular main activity. Water was taken (mostly between) 3–6pm.

The data collected, presented here, are the most comprehensive for a full 24 hours of white rhino activity in the wild, especially the activity of rhinos at night.

Table 2. Percentage of time spent on each main activity of the white rhinos at Ziwa Rhino Sanctuary for the years 2011/2-2016/7.

Time	Moving	Resting	Feeding
2016/7	1	38	61
2015/6	1	38	60
2014/5	2	37	62
2013/4	2	38	60
2012/3	3	37	60
2011/2	2	36	62
mean	2	37	61
SD	1	1	1
range	1-3	36-38	60-62
hrs/24hrs	0.5	8.9	14.6

Gestation period of white rhino in Ziwa

For each rhino, the rangers recorded activities, which include mating, births and related associations. This paper reports an analysis of some aspects of reproduction, which have rarely been recorded in wild white rhinos.

There have been 12 births in ZRS with known or estimated gestation periods.

The 12 births were distributed across the year as follows:

3 births in month of low rainfall (February)
7 births in months of high rainfall (April, August and September)
2 births in months of moderate rainfall (March and November).

The data indicate it is unlikely that rainfall has had an effect on the time of conception.

The gestation periods are known or can be estimated in 12 instances (Table 3). Schwarzenberger (2017), reporting on an analysis of nearly 20 years of gestation period data from zoos, gives a variation between 490 and 510 days. This is similar to the range of 480-548 days found by Rookmaaker (1989), where some of the highest figures were taken to be excessive. Observations are complicated, because it has been noted that mating can occur after conception, especially around 35 days (Schwarzenberger, pers. comm.). This information has been used to guide our data analysis particularly where there may be missing sighting data.

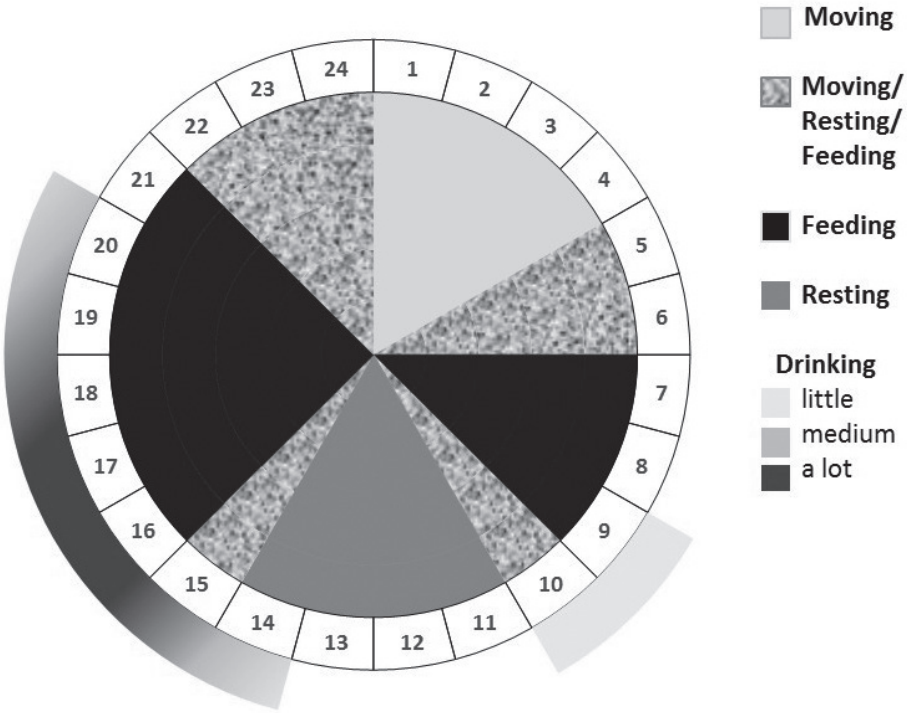


Figure 1. Diagram of the 'suggested' 24 hour clock of the main activities of the white rhinos at Ziwa Rhino Sanctuary, 2011-2017.

The periods between last observed mating and birth date are shown in Table 3. Taking into account the observation on gestation length made in zoos of between 490 and 510 days, some of the ZRS data were adapted for gestation length based on probable mating that occurred when the female was 'out of view'.

As shown in Table 4, the four means calculated from the gestation periods, uncorrected and corrected, all fall within the range reported by Schwarzenberger, showing the data from the wild herd in Uganda are comparable to that found in zoos, although gestation in ZRS was slightly shorter than those in the captive animals.

Associations and Reproduction

In this analysis, an association was measured by the number of hours in a month when a breeding male was with a female. The two main times when a male would be likely to associate with a female were considered to be when a female was receptive to mating and at the birth of the resulting calf.

Figures 2a to 2f show how often the two breeding

Table 3. Gestation periods observed (days).

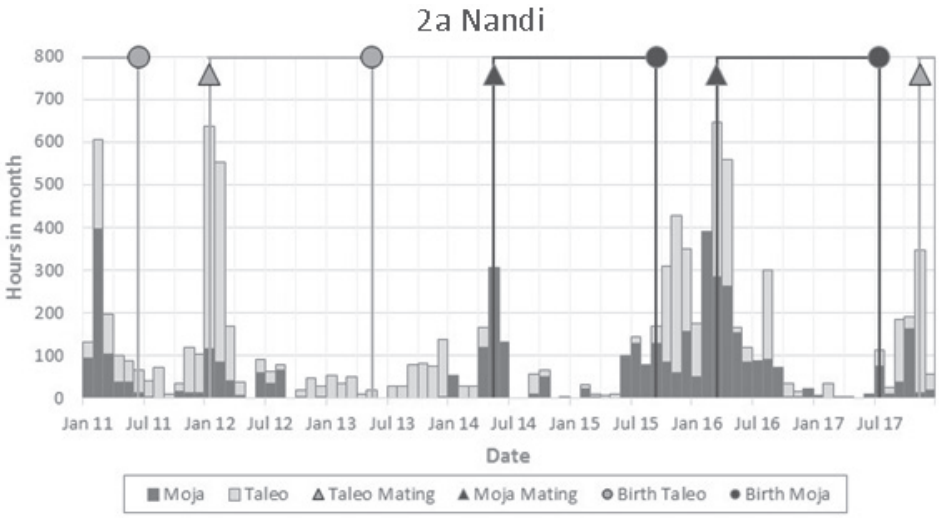
Mother/ female	First period	Second period	Third period
Nandi	473	500	500
Bella	489	507	488
Kori	482	495*	490*
Donna	506*		
Malaika	491		
Laloyo	498		

*Estimated days

Table 4. Mean ± standard deviation for gestation length in days, calculated under different scenarios.

Mean of 12 periods uncorrected	508 ± 33	range 475-541
Mean of 12 periods corrected	493 ± 10	range 483-503
Mean of 12 periods corrected (2)	496 ± 8	range 488-504*
Mean of 9 periods without outliers	492 ± 10	range 482-502

*observations for Nandi: 473 days was adjusted to 503 days.


2a Nandi
Hours in month
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Jan 11 Jul 11 Jan 12 Jul 12 Jan 13 Jul 13 Jan 14 Jul 14 Jan 15 Jul 15 Jan 16 Jul 16 Jan 17 Jul 17
Date
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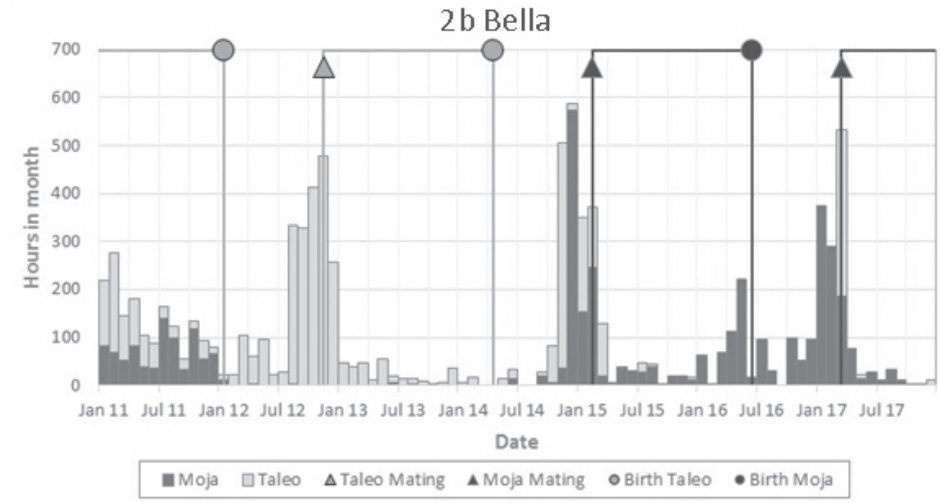
2b Bella
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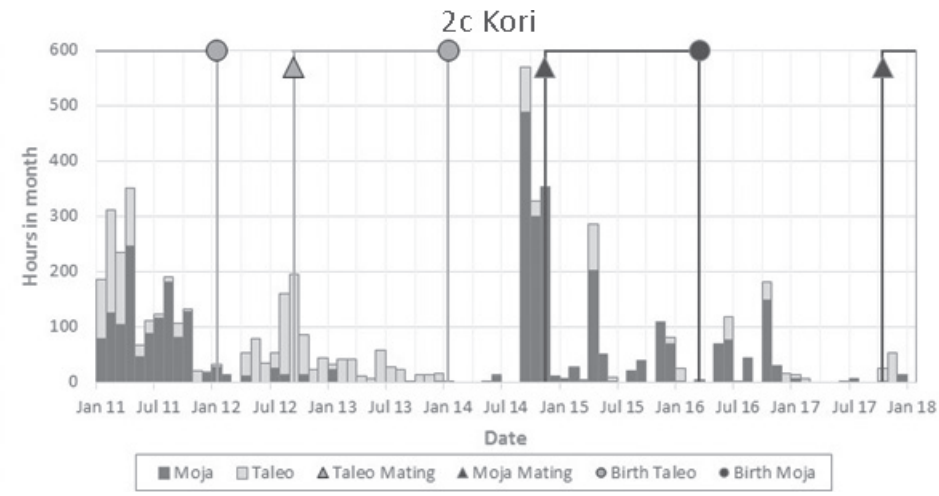
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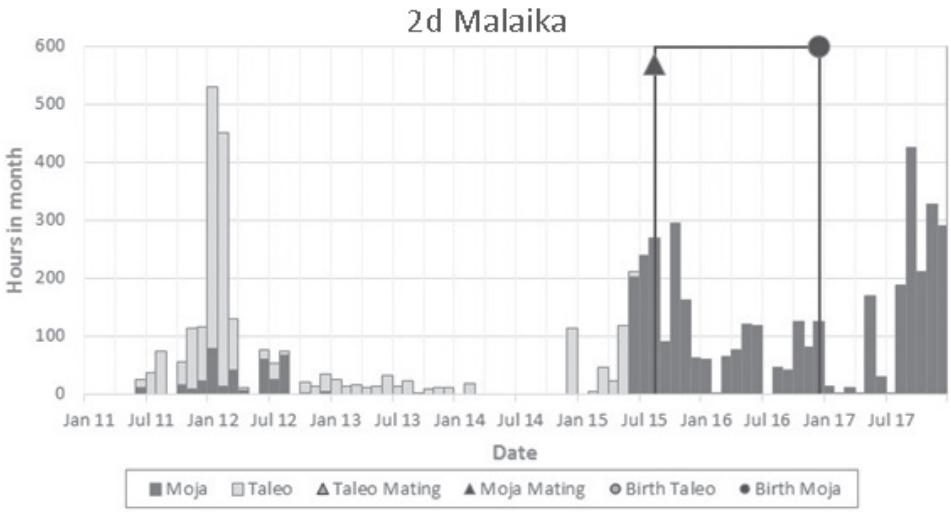
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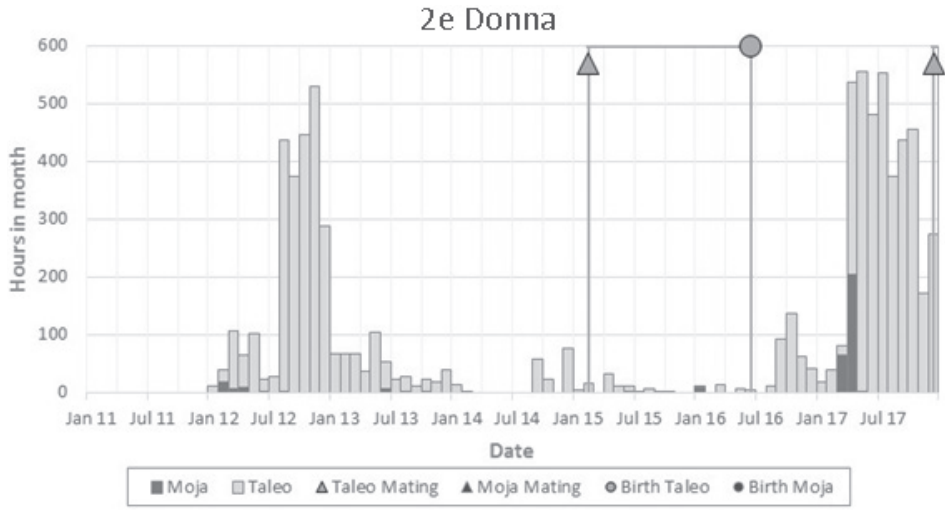
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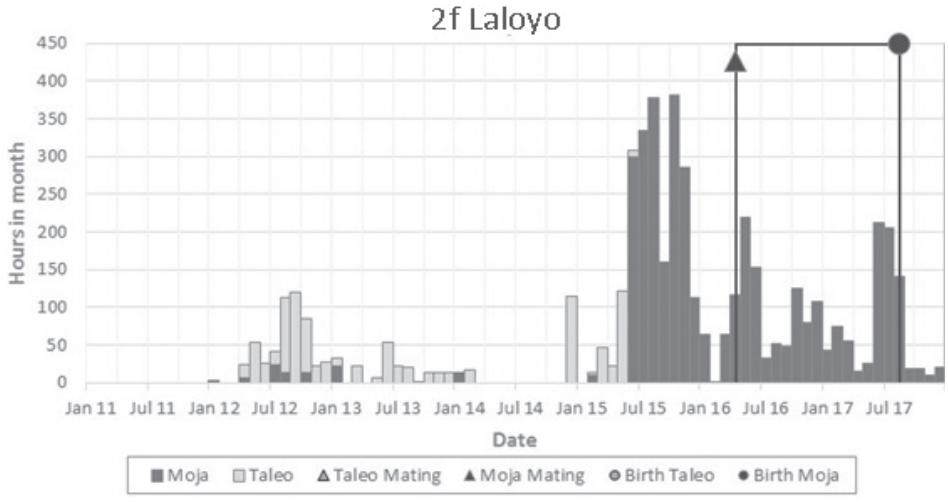
2f Laloyo
Hours in month
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Date
Moja Taleo Taleo Mating Moja Mating Birth Taleo Birth Moja

males (*Taleo* and Moja) were found with each of the six breeding females, with the estimated dates of conception (493 days before birth date) and of calf birth highlighted.

The data consistently show that the level of association between a male and a female ready for mating increases markedly prior to conception and drops off rapidly afterwards. At and around the time of birth of the resulting calf, the breeding male shows little interest in being present. However, as found by Coutts (2009), it is important to check by genetic testing, the true parentage of each calf born as behaviour data alone can be misleading.

Acknowledgements

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