FIELD NOTE

Preliminary behaviour observations of the Javan rhinoceros (*Rhinoceros sondaicus*) based on video trap surveys in Ujung Kulon National Park

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Abstract

The behaviours of ten critically endangered Javan rhinoceros (*Rhinoceros sondaicus*) were observed using video camera traps on the peninsula of Ujung Kulon National Park (06° 38'30'–06° 52'30' south and 105° 12'00'–105° 37'30' east), and were organized as descriptive lists of activities (ethogram). Behavioural data were analyzed by examining the length of time each individual rhino displayed a specific activity (duration). Duration of each activity was calculated as a proportion within a total observation time (length of rhino observation in video recording). In addition to duration, the frequency of each activity was recorded. A quantitative analysis summarizing duration and frequency of activities will be used as baseline information about Javan rhino behaviours that can enrich our knowledge of this reclusive species. The results from this study suggest that the use of video trap equipment for quantifying the behaviour of Javan rhinoceros is promising.

Résumé

On a observé les comportements de dix rhinocéros de Java (Rhinoceros sondaicus), espèce gravement menacée, en utilisant des pièges d'appareil vidéo sur la péninsule du Parc National d'Ujung Kulon (06o 38'30'-06o 52'30' sud et 105o 12'00'-105o 37'30' est) et on a les répertoriés en listes descriptives d'activités (éthogramme). On a analysé les données behavioristes en examinant la durée dans laquelle chaque rhinocéros individuel affichait une activité spécifique (durée). On a calculé la durée de chaque activité comme une proportion du temps total d'observation (longueur d'observation du rhinocéros dans l'enregistrement vidéo). En plus de la durée, on a enregistré la fréquence de chaque activité. Une analyse quantitative qui résume la durée et la fréquence des activités sera utilisée comme informations de référence sur le comportement du rhinocéros de Java qui peuvent enrichir nos connaissances de cette espèce recluse. Les résultats de cette étude suggèrent que l'utilisation de matériel de piège vidéo pour mesurer le comportement du rhinocéros de Java est prometteuse.

Introduction

The cause of the Javan rhino's demise throughout their historical range has been attributed to human activities, although changes in climate and vegetation also played an important role (Cranbrook and Piper 2007). Human intrusion, pollution, environmental changes and habitat degradation can increase the risk of spreading disease in wildlife populations (Indrawan 2007). The death of five rhinos in Ujung Kulon in 1982 was tentatively attributed to infection (WWF-IUCN 1982). However, no conclusive evidence has been obtained to determine the cause of these deaths.

There is a strong correlation between disease and behavioural changes in wildlife and other animals, as observed with encephalopathy in cows (Bovine Spongiform Encephalopathy) and chronic wasting disease in elk and deer (Doster 2002). Changes in behaviour have also been observed in animals under stress (Möstl and Palme 2002), intoxication due to consumption of certain type of plants (Mandial 2006; Sharma 2006), and digestive abnormalities such as colic in horses. Therefore, behavioural observation for critically endangered species such as the Javan rhino is crucial, as it can provide an opportunity to detect early signs of stress and health problems before they possibly lead to mortality, and ultimately drive the Javan rhino into extinction. One of the early visual studies of Javan rhinos in Ujung Kulon National Park was made by de Vos and Hoogerwerf (1950), who observed Javan rhino behaviour in wallowing holes. The same concept is applied in this study, but instead of relying on human observers, video cameras (video traps) were used. The use of video traps in studying the Javan rhinos in Ujung Kulon may provide the basis for setting up monitoring protocols based on the behaviour of how rhinos interact with the surroundings, as well as setting up diagnostic tools for detecting health problems as early as possible. All of this information is relevant and is useful for future translocation projects, where adaptation to the new surroundings and health risks need to be closely monitored to ensure the survival of the new population of Javan rhinos outside their existing habitat in Ujung Kulon National Park.

Materials and methods

The research team used 34 DVREye video cameras, manufactured by Pix Controller, Inc. USA. These units use heat and motion sensors to trigger an MPEG 4 digital video recording to a 4 GB compact flash (CF) memory card installed in the digital recorder. A 12V sealed lead acid battery powered each DVREye camera in the field. These camera units were distributed systematically in 34 grids (2 x 2 km^2) representing a rhino home range as described in Griffith (1993), in known rhino tracks throughout the Ujung Kulon Peninsula (06° 38'30'– 06° 52'30' south and 105° 12'00'–105° 37'30' east). Therefore, one 2 x 2 km^2 grid was monitored by one DVREye automatic camera. In order to reduce disturbance to the rhinos and other animals, the cameras were placed high above rhino eye level with a downward angle that enabled capture of details of rhino behaviou`r, but were high enough to avoid detection by the rhinos. The focus of this survey was to use the cameras to study rhino behaviour in wallow sites, so camera placements (a total of 30 cameras in 30 locations) were selected primarily around known wallow sites. The four remaining cameras were placed around rhino tracks to record locomotor behaviour. Three teams installed the cameras simultaneously in the rhino habitat to ensure that these cameras operated over a period of 13 months (March 2008 through March 2009).

In order to differentiate clips taken from each camera, information containing camera code and date was recorded as a marker at the beginning and the end of each camera placement. After the cameras had been operational for one month, the team visited each camera unit to download the video clips onto a Digimate portable hard disk. The sealed lead acid batteries were replaced and recharged as necessary. The data in the portable hard disk was then analyzed in the WWF Project office in Carita, Banten Province, Indonesia. All video clips were transferred to a computer, and vetted for those containing Javan rhino footage. The individual rhinos were identified and differentiated using key parameters (morphological features) used by Griffith (1993). The rhino footage was viewed with a timer using Microsoft Media Player to observe activities in detail, as well as measuring the respiratory rate, as indicated by expansion of thorax and/or sound of exhalation recorded in the video clips. Data was organized using a Microsoft Excel worksheet containing columns for time period and behaviour classification.

The total duration of specific activities (in seconds) was divided by the total sampling time (length of video clips in seconds) to quantify be-

havioural data. Due to differences in observation times (length of video clips), frequency was reported by summing the number of times an activity was performed by an individual rhino per total time of observation (length of clips in seconds).

Results

Record of the Javan rhinos

Throughout the survey period, 10 rhinos—two mothers, two calves, four adult males and two adult females—were recorded. Information about each rhino used in the behavioural analysis is summarized in Table 1. Based on criteria for categorizing behaviours developed by Colgan (1978), activities were classified into three main categories: locomotor, feeding and social behaviour (Nagendran 2007). In addition, wallowing and aggressive behaviours were added in order to accommodate the wide variety of rhino activities in wallow holes.

Locomotor behaviours and general body movements

Locomotor behaviour consists of: walking where the animal is moving in a forward direction with legs on the ground at all times; walking with legs on the ground at all times and moving backwards; running where the animal moves forward exhibiting a short period of 'floating' during which legs do not touch the ground. In addition to locomotor actions, general body movements (such as head movements) are included in this section. Head movements included: nodding up and down, shaking, swaying sideways, ear movements and horn rubbing, which is similar to head movement with an object such as a tree rubbed against the horn.

Social behaviours (limited to mother and calf)

The following activities were categorized as social behaviour between two or more individual rhinos: guarding where the mother stands between the calf and suspected threats (i.e. the camera); physical contact between mother and calf, (usually the rhinos touch with mouth or head); and walking in line where the mother walks directly in front of the calf, although sometimes the calf is separated behind (for 11 seconds/approximately 10 metres away on one occasion).

Wallowing behaviours

The activities recorded in rhino wallows consist of: standing/sitting where the rhino is motionless in the mud; rolling in which the rhino is moving from side to side; sleeping, which is similar to sitting, but differentiated by a slower respiratory rate and fewer head movements; and neck rubbing whereby the rhino rubs its neck in the mud.

Aggressive behaviours

Our observations include activities that we categorized as aggressive behaviours and consist of: attacking/charging where the rhino is attacking a suspected threat (i.e. the camera); standing ground with the rhino's attention focused toward the suspected threat (i.e. a wild boar); and chasing where the rhino runs or charges towards a suspected threat (i.e. a wild boar).

Table 1. Individual Javan rhinos recorded through video trap survey for behavioural analysis

Object Code	Clip No.	Sex	Age class
Mother 1	MP400011a	Female	Adult
Calf 1	MP400011a	Male	Young (approx. 2 yrs)
Female 1	MP400108	Female	Adult
Female 2	M4V00001	Female	Adult
Mother 2	MP400010	Female	Adult
Calf 2	MP400010	Male	Young (approx. 2 yrs)
Male 1	MP400014	Male	Adult
Male 2	MP400002	Male	Sub-adult
Male 3	MP400003b	Male	Adult
Male 4	MP4V00009	Male	Adult

N.B. The identified rhinos consisted of 4 adult females, 4 adult males, and 2 male calves; thus yielding an approximate sex ratio of 3:2 males to females.

Table 2. Duration of rhino behaviours (proportion of time rhinos performed each activity)

Activities	Objects										Average
	Mother 1*	Calf 1*	Mother 2	Calf 2	Female 1*	Female 2*	Male 3 *	Male 4	Male 1	Male 2*	
Locomotor											
Walk forward	0.14	0.23	0.28	0.28	0.07	0.15	0.27		0.27	0.13	0.20
Walk backward	0.02	0.08	0.02				0.05		0.05		0.05
Slow running (gallop)		0.06									0.06
Head movements	0.40	0.35	0.57	0.59	0.82	0.40	0.70	0.16	0.55	0.82	0.54
Horn rubbing									0.22		0.22
Social											
Guarding	0.29										0.29
Physical contact			0.12	0.13							0.12
Walk in line	0.12										0.12
Wallowing											
Stand/sit still	0.56	0.36	0.60	0.59				0.74	0.89	0.53	0.61
Rolling	0.18							0.23	0.22	0.05	0.17
Sleeping										0.54	0.54
Neck rubbing	0.21	0.32							0.43	0.13	0.27
Aggression											
Attack/charge	0.08		0.02		0.02						0.04
Stand ground										0.49	0.49
Chasing/running										0.05	0.05

N.B. Asterisk (*) indicates individuals recorded during the night (night time activities). Duration was calculated by dividing the total duration of specific activities (in seconds) by the total sampling time (length of video clips in seconds). It is shown that—based on the average duration—these rhinos spent their time standing or sitting still while in the wallow holes (0.61 average duration), and head movement was a dominant part of their general body movements (0.54 average duration).

Table 3. Frequency of rhino behaviours (times per minute of each observation)

Activities	Objects										Average
	Mother 1*	Calf 1*	Mother 2	Calf 2	Female 1*	Female2*	Male 3*	Male 4	Male 1	Male 2*	
Locomotor											
Walk forwards	0.018	0.023	0.045	0.027	0.009	0.024	0.027		0.042	0.025	0.027
Walk backwards	0.012	0.031	0.023				0.024		0.017		0.021
Slow running (gallop)		0.019									0.019
Head movements	0.024	0.026	0.028	0.028	0.013	0.064	0.035	0.014	0.037	0.061	0.033
Horn rubbing									0.043		0.043
Social											
Guarding	0.020										0.020
Physical contact			0.039	0.039							0.039
Walk in line	0.020										0.020
Wallowing											
Stand/sit still	0.020	0.027	0.046	0.046				0.035	0.038	0.026	0.034
Rolling	0.045							0.028	0.043	0.017	0.033
Sleeping										0.017	0.017
Neck rubbing	0.061	0.045							0.042	0.021	0.042
Aggression											
Attack/charge	0.042		0.023		0.004						0.023
Stand ground										0.013	0.013
Chasing/running										0.013	0.013

N.B. Asterisk (*) indicates individuals recorded during the night (night time activities). The data shows that head movement was the most common activity for each rhino, as it was performed by all rhinos in this observation (average frequency 0.033).

Quantification of Javan rhino behaviour

Duration of each activity is summarized in Table 2, while the frequency is summarized in Table 3. In addition to observed behaviours, average and standard deviation of respiratory rate was calculated. Thirty-seven out of 40 clips of the Javan rhino (92.5% of the clips) were used for respiratory rate analysis, while the other three clips did not provide reliable audio and visual information for determining the respiratory rate. The respiratory rate averaged 21.275 breaths per minute, standard deviation 9.418 with a minimum of 10.8 breaths per minute and a maximum of 42.60 breaths per minute; the normal distribution as shown in Fig. 1.

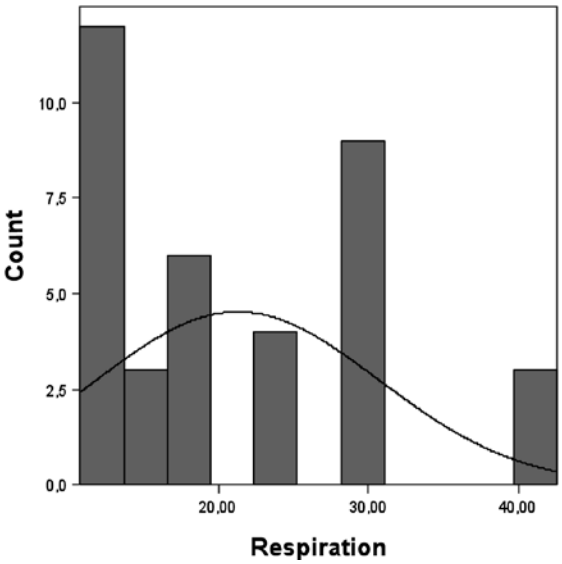

Figure 1. The normal distribution curve of Javan rhino respiration rate, which is expressed in breaths per minute with average 21.275 breaths per minute is based on measurements from 37 video clips (N=37).

Discussion

Based on duration and frequency of each activity, it was noted that these rhinos exhibit head movements (nodding, swaying and ear-moving) as distinctive components of locomotory behaviour. It is also supported by the agreement between the duration and frequency showing that head movement was the most common activity. In addition, rhinos in wallows tend to stand or sit while exhibiting head movements. Although we recognize that our data set is limited, neck rubbing was observed frequently for short periods. This activity may be a mechanism to relieve itching around the neck folds. These data show frequent physical contact (head touching) between mothers and calves, which possibly serve to reinforce the mother-offspring bond. Aggressive behaviour was exhibited in the presence of a disturbance (consisting of camera and wild boar in this sample). In the event of a disturbance, Javan rhinos stand with eyes focused on the intruder. Aggression behaviours such as charges or attacks were repeated as shown by the high frequency, but are generally short in duration. Rhinos' aggression towards the camera suggests that the camera is still detectable at such angle of placement; therefore, higher placement with a more acute angle is still needed to avoid detection. Improper placement of cameras may result in detection of cameras by the rhinos, which may eventually influence the behaviour.

The observed respiratory rate from video trap observation was similar to that reported for the standing, unsedated white rhinoceros,16–23 breaths per minute (Citino and Bush 2007). Activity level (e.g. aggression and resting) appeared to be correlated with respiration; two rhinos from our video survey had high respiration rates (42.60 breaths per minute) while one rhino had a low rate (10.8 breaths per minute), which was possibly associated with low respiration during sleeping/resting. Therefore, respiratory rate is a potential indicator to measure levels of activity, as well as to study microclimate-related stress, as tested with small ruminants (Suprayogi 2006).

Due to the limited numbers of individuals observed and period of observation, mating and feeding behaviours were not recorded; however, basic behaviours such as movements, wallowing and even aggression were documented. Similarly, respiratory rate as a physiological parameter of the Javan rhino can be measured using a video trap set-up, as 92.5% of the clips prove to be suitable for such measurements. A long-term observation period of at least two years is planned to record more comprehensive behavioural activities of Javan rhinoceros individuals, thus increasing the sample size as well as the observation period, allowing stronger correlation analysis between respiratory rates and activity levels exhibited by the rhinos. Although still in an early stage, these preliminary observations using video trap equipment result in behaviour quantifications that can be used as a primer to construct more robust parameters suitable to monitor the behaviour and the physiology of Javan rhinos in wallows.

Acknowledgements

The research was made possible thanks to co-operation with Ujung Kulon National Park Authority, Indonesian Ministry of Forestry, WWF, International Rhino Foundation, Asian Rhino Project and WWF-AREAS (Asian Rhino and Elephant Action Strategy). Thanks aslo go to Susie Ellis for the editorial review of this article.

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