

Research Article

Activity patterns and social network of banteng (*Bos javanicus*) at Chester Zoo

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Abstract

Many species of wild cattle are now listed as endangered on the IUCN red list. These species are commonly kept in zoological collections, aiding their conservation through viable *ex situ* populations and increasing the understanding of effective species management. However, wild cattle are often underrepresented in zoo animal behaviour research. The aim of this study is to add to this research area using banteng (*Bos javanicus*) as a focal species. Behavioural data was collected using focal and group instantaneous sampling of a herd of thirteen banteng at Chester Zoo. Results revealed that banteng spent the most time resting and eating, with juvenile animals spending more time conducting exploratory and locomotive behaviours than adult and sub-adult animals, which corresponds to patterns in wild populations. To fully explore how similar the patterns are further research is needed into nocturnal behaviour as wild banteng are thought to be more active during the night. A social network analysis of the positive social interactions within the herd revealed that the bull received the most positive interactions, which is typical in a wild herd. Other positive interactions were observed with mothers preferentially associating with their offspring. Very few negative interactions were observed within the herd revealing that competition for resources is low. This study adds to the limited knowledge of banteng behaviour but a greater sample using data from other collections could be used to provide a more thorough basis for their behaviours in captivity.

Introduction

Asia is the richest region in terms of wild cattle species; 9 of the 12 extant species are found on this continent, but there is little tradition of effectively managed protected areas, demanding a need for appropriate conservation and management measures (Melletti & Burton, 2014). Increasing human populations have encroached upon wild cattle habitat and all species are threatened by human activities; hunting and urban development being two of the most common and potentially severe threats (Pedrono & Clausen, 2009). Many species of wild cattle are now listed as endangered on the IUCN red list of threatened species (IUCN, 2010). Steps can be taken to prevent the loss of these species; including increasing the effectiveness of protected-area management, and involving

local people in conservation activities (Melletti & Burton, 2014). Conservation breeding of these species is also a key part of their conservation; by ensuring viable *ex-situ* populations and increasing the understanding of effective species management provides a framework for *in-situ* efforts to protect wild cattle species (McGowan *et al.*, 2017).

Role of zoos in wild cattle conservation

The conservation of wild cattle species is often a challenge due to limited knowledge as a consequence of their behaviour; being naturally wide-ranging, nocturnal, shy, solitary or occurring in low densities (Gray, 2012). There is immense potential value of zoo-derived data for helping to understand how taxon, ecological niche, breeding success, and captive environments together affect animals' responses to captivity

(Mason *et al.*, 2007). Empirical measures of animal behaviour and space use within the captive environment can provide important information about animals' requirements, preferences and internal states, which can then be implemented in ex-situ conservation projects (Ross *et al.*, 2009). Ungulates are often underrepresented in zoo animal behaviour and welfare research, yet they comprise some of the most widely-kept captive species and as such, their lives within the zoo are worthy of closer investigation (Rose & Robert, 2013). The aim of this study is to add to the understudied research area of wild cattle behaviour ex-situ, using banteng (*Bos javanicus*) as a focal species.

Behaviour of cattle

Although little behavioural research exists for wild cattle species, other species of cattle, including domestic cattle have been studied more intensively (Melletti & Burton, 2014). The behaviours observed in other cattle species can potentially provide a basis for wild cattle behaviour. As ruminants, grazing occupies a large amount of time in cattle species, approximately 8-9 hours per day, and the pattern of grazing behaviour is relatively similar for each herd member (Sato, 1982). Rumination most often occurs during resting and is roughly three-quarters of the time spent grazing (5-6 hours per day) (Sato, 1982; Clauss & Hoffman, 2014). As many cattle species typically exist in large, mixed herds, social behaviours are an important aspect of their lives (Bouissou *et al.*, 2001). Social interactions can be divided into negative (such as aggressive and avoidance reactions) and positive social behaviour (including social grooming, olfactory communication and minimal social distance) (Bouissou *et al.*, 2001). Recognising the difference between normal, healthy and aggressive or stereotypical cattle behaviour and applying this knowledge to wild cattle species can be used to develop better husbandry practices and contribute to improving the standard of ex-situ conservation programmes with Asian wild cattle.

Banteng ecology and behaviour

Banteng naturally inhabit open dry deciduous, mixed deciduous or evergreen forest, preferably in low elevation zones.

Optimal banteng habitat includes open grassy areas with access to water and mineral licks (AWCSG, 2015). Banteng play a key role in circulating nutrients through ecosystems, dispersing seeds and maintaining food chains as they are also a critical food source for many carnivore species, including tigers and leopards (AWCSG, 2015). It is estimated that there could be as few as 5,000 banteng left in the wild, with their numbers in decline due to reduction of habitat, hunting, hybridisation with domesticated cattle, and infections with cattle diseases (Timmins *et al.*, 2008). Attempts to conserve this species include translocation and captive breeding programmes (Bradshaw *et al.*, 2006). Despite their elevated conservation status, and an increasing global captive population, zoos do not yet have information on optimal husbandry (Rowden & Rose, 2016). Banteng are an example of a species of conservation concern without current "best practice" guidelines, as they have been the focus of little applied husbandry research (Rowden & Rose, 2016). This study, therefore aims to increase our understanding of Banteng behaviour in captivity using a herd at Chester Zoo, UK. Chester Zoo has been a leader in the conservation and breeding of endangered Asian wild cattle. The opening of the *Islands* exhibit in 2015 aimed to provide even greater capacity to achieve the highest standards in breeding and education, as well as profile the Zoo's in-situ activities with these species (Chester Zoo, 2017).



Figure 1. Female banteng (*Bos javanicus*) with two calves at Chester Zoo (image: © Chester Zoo).

In 2017, Chester Zoo was home to a herd of 13 banteng, herd sizes in captivity tend to be smaller than those observed in the wild, where they can live in groups of up to 30 (Rowden & Rose, 2016). Since arriving at the zoo in 2013, the herd at Chester Zoo has had a number of calves born, demonstrating the success of the breeding programme and helping to raise the profile of this species in captivity. Despite these successes, overall cattle species are still generally overlooked in zoo settings as they are not deemed an 'exciting' species by visitors (Hediger, 2013).

The aim of this study is to add to the body of knowledge on captive banteng behaviour, investigating the animals' activity patterns with a particular focus on social behaviour within the herd.

Materials and Methods

Data was collected over 50 hours (5 hours per individual) over a period of 14 weeks from mid-March 2017 until the end of June 2017. The observations were carried out for hour-long periods and were conducted between 10am and 5.30pm.

Study species

The group of banteng consisted of 13 individuals (fig. 1), one adult bull male (11 years), five adult female cows (ranging between 3-7 years), two sub-adults (one male, one female, both aged two), two juveniles (one male, one female both aged one) and three calves. All banteng were individually identifiable from ear tags, excluding the three youngest calves. Focal data was not collected for the three youngest calves, as they were unable to be individually identified. However, any social behaviour towards a calf initiated by another herd member was recorded.

Sampling methods

There is little published literature on banteng behaviour, particularly in captivity, so an ethogram of 30 defined behaviours was developed based on previous studies carried out on similar species e.g. Kilgour (2012) and Fell & Clarke (1993) (Table

1). A mixture of instantaneous group sampling and instantaneous focal sampling were used to gather behavioural data at both an individual and group level for the banteng. Instantaneous group samples were recorded for the banteng at 5-minute intervals whereas instantaneous focal samples were collected at a 30 second interval rate, where each individual was observed in turn following an order that was generated randomly. The observations were carried out from the same location for every session (the visitor viewing area) which provided a good view of the entire enclosure. The only area of the enclosures not visible from these viewing platforms was the indoor area so when the focal individuals were indoors at the point of observation, they were recorded as out of sight. The frequency of social behaviours was also recorded. For any social interactions that were observed, the focal individual and the recipient of the social behaviour were recorded based on the behaviours defined in the ethogram.

Data Analysis

The 'Type of Behaviour' category from the ethogram was used for descriptive analysis. Behaviours under 'Positive Social' and 'Negative Social' were combined to 'Social' as very few negative interactions were observed. No procreative behaviours were observed during the study. Instantaneous behavioural data was converted into proportion per observation session for analysis. Social network analysis was conducted using R-Studio 1.0.136 using the number of positive social interactions observed between individuals.

Table 1. Ethogram of behaviours of banteng based on Kilgour (2012) and Fell & Clarke (1993)

Type of Behaviour	Behaviour	Description of Behaviour
Exploratory	Browse	The animal forages around the enclosure, sniffing at the ground often in search of food.
Eating	Graze	The animal browses and eats food from the ground.
	Eat	The animal eats food prepared in food areas of the enclosure.
Ruminating	Ruminate	The animal is re-chewing cud, a common behaviour in cattle species.
Drinking	Drink	The animal drinks water.
Maintenance	Groom	The animal licks its own body.
	Excretion	The animal urinates or defecates.
Resting	Sleep	The animal is asleep and is not alert to environmental changes.
	Rest	The animal is standing but is not making any specific movements in any particular direction.
	Sit	The animal is sitting or lying and not making any particular movement.
Locomotive	Walk	The animal is moving in no particular direction at a slow to moderate pace.
	Run	The animal is moving in no particular direction at a moderate to quick pace.
	Orientation towards stimuli	The animal moves in a specific direction towards a stimulus, such as food.
Self Expression	Vocalise	The animal makes an audible sound.
	Head Roll	The animal rolls its head backwards in a circular motion.
	Paw ground with forefoot	The animal taps or rubs its hoof against the ground.
	Tail Wag	The animal flicks its tail in a deliberate manner, often to swat away insects.
	Perform flehmen	The animal curls back its upper lip exposing its front teeth, inhales with the nostrils usually closed and holds this position for several seconds.
	Startle Reflex	The animal reacts in an erratic manner to a stimulus such as a sudden noise or another individual.
Positive Social	Sniff	The animal sniffs another individual in the herd.
	Approach	The animal moves towards another herd member or members.
	Guard	The animal stands protectively between one individual and another.
	Rub against another animal	The animal rubs its own body against another individual in the herd.
	Social grooming	The animal licks another individual or solicits licking by another animal in the herd.
	Suckling	The animal suckles or the mother stands to allow the young to suckle.
	Mount	The animal mounts another individual in the herd or allows another individual to mount them.
Negative Social	Withdraw	The animal moves away from another herd member or members.
	Agnostic Actions	The animal engages in agnostic or aggressive behaviour, such as head-butting, charging at or locking horns with another herd member.
Procreative	Inseminate	A male in the group attempts to breed with a female in the herd.
	Gives Birth	A female in the herd gives birth to a calf.

Results

The most common behaviour observed by all the banteng in the heard was resting (fig. 2), with all individuals spending approximately 60% of the time exhibiting this behaviour. The second most observed behaviour was eating, with the adult females (21%) and sub adult (23%) animals spending the most time eating, and juveniles spending the least (10%). The largest differences were observed in the more active behaviours with juvenile animals spending more time exploring (13%) and in locomotion (5%) than other heard members. Adult animals spent more time ruminating (7%-10%) than the sub-adults (2%) and juveniles (3%).

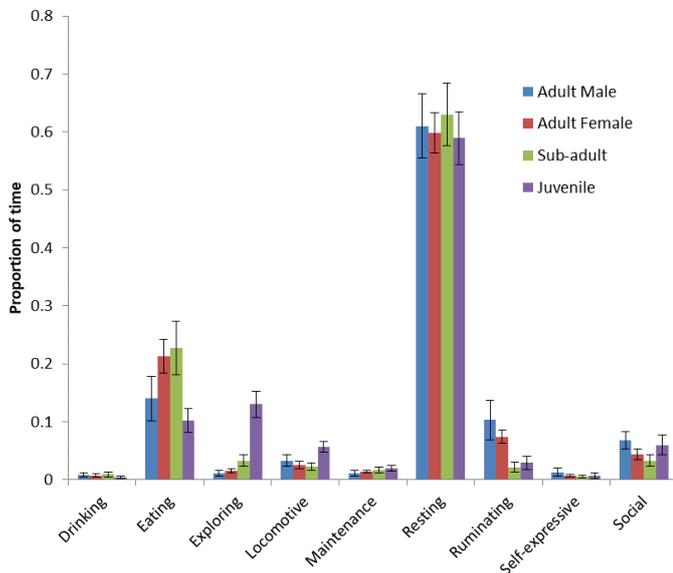


Figure 2. The mean (± standard error) proportion of time banteng (N=10) were observed exhibiting different behaviours according to age group and sex of adult animals.

Banteng spent between 4-6% of their time engaging in social behaviour. Positive interactions were seen regularly between heard members (fig. 3), many of the positive interactions were directed towards the dominant bull (adult 1 male) with his position towards the centre of the network. The dominant bull and many adult females directed positive interactions to adult female 3, suggesting she is one of the higher ranking females in the group. Adult female 5 also received positive interactions from many herd members. The mothers of the three calves (combined values were used for the calves as

they were unable to be individually identified) have strong positive interactions with their offspring (adult females 2, 5 and 6). This bond appears to continue into later life with the two juveniles both having strong positive interactions with their mothers (adult female 3 and juvenile 2, and adult female 4 and juvenile 1). The two sub-adult animals and adult female 6 were the ones who received fewest positive interactions.

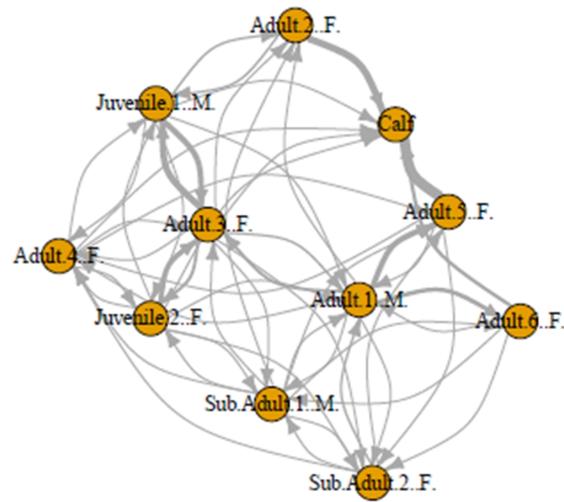


Figure 3. A social network analysis for banteng at Chester Zoo using positive social interactions

Discussion

This study investigated the activity patterns and social interactions of a herd of banteng at Chester Zoo. The most common behaviours observed in all individuals were resting and grazing. This corresponds to activity patterns in wild populations where banteng activity has been found to decrease from mid-morning until early afternoon, when they tend rest and ruminate (Melletti & Burton, 2014). When peaks in activity occur, they often forage and socialise (Gardner 2016). Juvenile animal activity patterns were most different from the adults with more time spent exploring and moving around their enclosure they often forage and socialise (Gardner 2016). Juvenile animal activity patterns were most different from the adults with more time spent exploring and moving around their enclosure and less time eating and ruminating. This is likely due to the difference in age with young animals potentially still feeding on milk, as banteng calves wean around 10 months of age

(Saari, 2004), potentially leaving more time for other activities. This study focused on the diurnal behaviour of banteng during zoo opening hours, a study of banteng in the Cambodian Eastern Plains found that 80% of camera-trap observations took place between 18:00 and 06:00 (Gray *et al.*, 2012), suggesting that banteng are active nocturnally. Future research could investigate nocturnal activity of the banteng to see if their activity in captivity also increases during this time.

Many animals preferentially associate with certain other individuals (Snijders *et al.*, 2017). This study found that females preferentially associate with their calves and older offspring. Grooming is often associated with suckling and is an important activity of cows towards their calves, grooming for long periods of time (Keeling, 2001). The amount of grooming a day remains high for more than 10 months after birth (Keeling, 2001). Banteng tend to gather in herds of two to 30 members, with each herd containing only one adult bull (Saari, 2004). There were many positive interactions, such as sniffing and social grooming displayed by the dominant bull towards the females, which is typical of a dominant male towards females in a herd (Keeling, 2001; Melletti & Burton, 2014). There appeared to be a difference in social ranking amongst females with some receiving many more positive interactions than others. This social structuring can influence how populations respond to changes to their environment, thus making network analysis a promising technique for understanding, predicting and potentially manipulating population dynamics (Snijders *et al.*, 2017).

Negative interactions between cattle usually occur when there is increased competition for food resources or water access, a better suited resting place, for defending their territory, and in bulls, fighting for the right to mate with females (Acatincăi & Gavojdian, 2010). Agnostic behaviour can be recognised by aggression and/or fighting although fights are rarely recorded, and usually their duration is short (Acatincăi & Gavojdian, 2010). Very few negative interactions were observed in the herd at Chester Zoo revealing that levels of competition for resources were low. The patterning of social rela-

tionships between individuals influences how space is utilised and how animals interact with resources provided for them (Rose & Croft, 2015). Social interactions and patterns of association are important to health, welfare and the fitness of individuals (Price & Stoinski, 2007; Silk *et al.*, 2009).

This study adds to the body of knowledge of banteng behaviour. However, this research only focusses on the behaviour of banteng in one zoological collection, a greater sample using data from other collections could be used for comparison and provide a more thorough basis for behaviours of these species in captivity. Data collected from rare, understudied and endangered species not only contributes to the understanding of sociality and behaviours but may also serve as a tool to identify environments that support an adequate activity budget for these species (Cartagena-Matos *et al.*, 2017).

In conclusion, this study has revealed that the herd of banteng at Chester Zoo exhibit similar behaviour patterns to those observed in the wild during the day. The results of the social network analysis demonstrate that animals often exhibit positive social interactions and few negative social interactions which is an indicator that the herd has low levels of competition

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