Applied Animal Behaviour Science 168 (2015) 10–17

Contents lists available at ScienceDirect

Applied Animal Behaviour Science

journal homepage: www.elsevier.com/locate/applanim

Pregnant cattle associations and links to maternal reciprocity

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ARTICLE INFO

Article history:
Received 19 December 2014
Received in revised form 17 April 2015
Accepted 19 April 2015
Available online 30 April 2015

Keywords:
Cattle
Behavior
Maternal
Pregnant
Post-partum
Social

ABSTRACT

Cattle are a highly gregarious species that form strong social connections. Social support following calving serves to increase offspring survival and conception rates for the following breeding season. It has been shown that cattle change their association preferences following calving, but the correlation between social association and postpartum age class has not been explored. This study investigated the effect of postpartum age on association strength based on the amount of time pairs of individuals spent within close proximity as recorded by proximity logging collars. The associations of 58 mixed breed cattle were recorded over an 11 week period and associations analyzed within and between three maternal classes: maternal (calved prior to the beginning of the trial), pregnant and calved during the trial. There was a clear distinction in the association preferences between the maternal and pregnant cows: both cow classes associated more within their own maternal status than between statuses (maternal 181.47s, pregnant 141.48s, between groups 91.62s, $P < 0.001$). Network analyzes showed both between and within group preferences for the two groups, with some individuals playing a prominent social role in connecting the groups together. The cows that calved during the study showed an immediate change in association preference from the pregnant to the maternal group following parturition. The effect of this was correlated with age of calf; newly maternal cows preferentially associated with cows that had calves of a similar age. This study demonstrates that maternal status is an important determinant of association preference. The change in association patterns once a pregnant cow calves and the strong dyadic relationships between newly calved cows supports the notion that an offspring at foot might provide a motivation for reciprocity.

1. Introduction

The preferential associations between cattle reflect herding responses and influence grazing distribution, protection from predators, and reproductive performance (Sowell et al., 2000). At each stage of the reproductive cycle there are a series of events that are dependent on interactions between individual cattle. These events result in dynamic preferential associations, for example during an oestrus event cows will form sexually active groups (Orihuela, 2000). Observational studies have shown that cows during pregnancy preferentially associate with other pregnant cows but overall they have lower association levels compared to cows that have calves (maternal cows) (Finger et al., 2014).

Although cows are naturally gregarious, most cows show a strong tendency to isolate themselves from the rest of the herd in the hours leading up to parturition to choose a nesting site, and in so doing maintain higher than usual inter-individual distances (Lidfors and Jensen, 1988; Nowak et al., 2000; von Keyserlingk and Weary, 2007). The isolation at calving facilitates the development of a stronger mother-young bond with the calf without interruption by other herd members before re-joining the group (Veissier et al., 1998). It is unclear the extent that cows maintain established associations or develop new associations when they return to the herd after calving. This study quantified social associations in a herd containing both pregnant and maternal cows using continuously collected social association data. During the study some of the pregnant cows calved and this provided the opportunity to observe whether maternal status created a change in social preferences. The null model assumes association patterns between individual members of a herd remain consistent regardless of maternal status, thus the first null hypothesis states that there is no difference in association preferences of maternal and pregnant cows. Therefore cows returning to the herd after isolating themselves at calving would reconnect with previously established preferred associations.

The dynamic nature of maternal and pregnant cow associations may reflect reciprocal behaviors. Reciprocity has been studied in the context of human social interactions and is described as a

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http://dx.doi.org/10.1016/j.applanim.2015.04.008
0168-1591/

Table 1
The number of cows in each age class for all experimental cows.

Year born	Age during trial	Animals per age category
2009	2	9
2008	3	11
2007	4	15
2006	5	9
2005	6	1
2004	7	6
2003	8	4
2002	9	2
2001	10	1

positive response to kind actions (Trivers, 1971). Reciprocity in animal communities is more difficult to determine, as the quality of an interaction and the response of that action are difficult to measure. Rather than determining a specific association it is possible to compare association patterns that are linked to a state of dependency. In this study we compare the interactions based on measures of close association between cows that have calves of varying ages. The second null hypothesis is that there are no association differences between maternal cows with calves of different ages. We predict that cows with younger and potentially weaker calves will have more to gain from cooperative reciprocal associations than cows with older, stronger and less dependent calves and this will be reflected in the association patterns of the cows. Thus, we propose that the association patterns between cows with younger calves will be stronger than associations between cows with older calves. Proximity loggers are used in this study to continuously measure the total duration and frequency of all close proximity encounters between cows and enable us to determine differences in association patterns based on maternal status.

2. Methods

2.1. Animals

The cattle used in the study were selected from a larger commercial beef herd of 120 cows based on their expected calving date. A sub-group of 58 pregnant cows expected to calve between 1 May and 30 August 2011 were selected for the trial and separated from the main herd into the experimental paddock 11 weeks prior to the beginning of the trial. The sub herd was expected to be socially stable at the commencement of observations based on a previous report suggesting that relationships are stable 45 days following regrouping (Sato et al., 1990). The trial herd were of mixed breed, predominately Droughtmaster and Brahman Cross, with a mean weight of 579 ± 70 kg. Their ages ranged from 2 to 10 year old (see Table 1).

Trial animals were classified according to one of three maternal statuses; maternal, pregnant or calved during. At the beginning of the trial 23 cows had already calved, forming the maternal group, and at the completion of the trial 12 cows had not calved, forming the pregnant group. The remaining 23 cows calved during the trial and were classified as 'calved during'. Analyzes were conducted based on these classifications.

The cattle were grazed under standard industry conditions in a 202 ha paddock on a commercial property in Central Queensland, Australia. All procedures used in the study were approved by the CQUniversity Animal Ethics Committee (approval number A11/03-270).

2.2. Data collection

The cattle were observed each day over an 11-week observation period (5 May–20 July 2011). The detailed observation data has previously been reported (Finger et al., 2014) and included detailed measures of association patterns. Over a series of three 4-week deployments, all adult cattle were fitted with a Sirtrack proximity logger to record the frequency and duration of close proximity encounters (Patison et al., 2010). At the end of each 4 week deployment, the collars were removed and downloaded before being re-fitted to the animals. The first collar deployment began 7 days after the observations began and the third collar deployment concluded 6 days prior to the completion of the observations.

The Sirtrack devices (Sirtrack Ltd., Havelock North, New Zealand) use ultra-high frequency (UHF) transceivers to transmit and receive unique identification codes. When two animals come within a pre-defined range (set to 4 m in this study) the proximity loggers record the date, time and duration of the contact (Prange et al., 2006). A distance of 4 m was chosen as it represents close social association within two body lengths of an animal. Cattle are known to space themselves within 2–3 m during resting and between 4 and 10 m during grazing (Broom and Fraser, 2007). However, various factors are known to influence the spatial behavior of grazing herbivores, such as individual sociability (Sibbald et al., 1998), group size (Green, 1992b; Michelena et al., 2008) and area available (Kondo et al., 1989). The animal's body will also absorb a portion of the signal, thus selecting a range slightly longer than one body length ensures that contacts initiated from the rear of the animal would be detected.

2.3. Data processing and statistical analysis

The proximity logger data were aligned for contacts between pairs based on the method of Patison et al. (2010) and Hamede et al. (2009) to create a single file of pair-wise contacts. The contact data were summarized on a daily basis to provide the total time that individual pairs of cows spent in close proximity. The pairs were grouped based on maternal status and analyzed for within- and between-group effects.

To investigate the differences in contacts between pregnant and maternal cows, the total number of contacts per day between groups and within groups were analyzed using a one way analysis of variance (ANOVA) (Rowell and Walters, 1976). Distributions were checked for normality prior to the statistical analysis. The data were negatively skewed; a logarithmic transformation provided the closest fit to normality and was used to compute the statistical analysis. Tukeys HSD test was then used to compare differences within and between groups. Post hoc analyzes using Levene's statistic indicated unequal variances between groups ($P < 0.05$), however as the group sizes were different, there were more than five individuals per group and the variance ratio between groups was less than 4:1 it was concluded the difference in variance between groups had minor implications on the results (Keppel and Wickens, 2004).

The average contact of cows that calved during the trial with pregnant and maternal cows were analyzed based on the day of calving. The pre- and post-calving periods were divided into daily periods and assessed 50 days either side of calving to include cows that calved either early or late in the observation period. Thus, cows that calved early had a longer post-calving period whereas those that calved late had a greater pre-calving period. Additional analyzes were computed to investigate the effect of calf age on association. Average daily contact between cows that calved during the study was assessed within cows that had calves of a similar age and between all other cows, which included cows with calves of other ages and the maternal and pregnant groups of cows. Cows that calved during the study were further classified into 2 weekly intervals post-calving and comparisons between groups were statistically assessed using a *t*-test at the 0.05 significance level.

All differences were considered significant at the 5% probability level. Statistical analyzes and graphical representations of the