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ABSTRACT

A study was conducted to determine if social status of heifers within a herd influences estrus activity and subsequent fertility. Thirty cyclic dairy heifers were observed over a 14 d period and ranked by social status, based on a displacement index. The estrous cycles of the heifers were synchronized by treatment with two injections of prostaglandin F2a (PGF2a; Lutalyse, 25 mg) given 14 d apart. At the second PGF2a injection, HeatWatch transmitters were placed on the heifers for continuous monitoring of mounting (estrus) activity over the next 45 d. All heifers were artificially inseminated at estrus, using semen from a single sire. Pregnancy status was determined by ultrasonography post-insemination. For analysis, heifers were placed into three groups based on social status. Subordinate heifers, ranked in the bottom one-third of the herd, exhibited a shorter estrus ($P = 0.001$) than more dominant heifers. The number of mounts recorded during estrus declined with decreasing social status ($P = 0.009$). There was a trend for the number of mounts per h to be greatest for heifers in the top one-third of the social hierarchy ($P = 0.074$). Of those heifers detected in estrus and inseminated, pregnancy rate was similar among the social groups for the first and subsequent inseminations ($P = 0.315$ and 0.608, respectively). Preliminary results indicate that social hierarchy of dairy heifers influences length and expression of estrus. However, social standing within the herd does not influence fertility of heifers detected in estrus.

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MEET THE STUDENT-AUTHOR

As a 2002 graduate from Valley View High School in Jonesboro, Ark., I left in search of great knowledge and found the University of Arkansas was going to be the place where I would begin my college career. I never grew up around livestock and only started studying animal science in hopes of becoming a veterinarian. I soon found out that was not the path I wanted to pursue, so I became more involved in different aspects of the animal science field. I took a job under Dr. Elizabeth Kegley, who allowed me to work in the Animal Science Nutrition Lab. I really enjoyed this aspect of animal science and soon asked Dr. Kegley who in the department might be interested in taking on an undergraduate for a research project that I could use as my honors research project. She introduced me to Dr. Rick Rorie, who became my mentor. Upon graduating in 2006, I plan to enroll in graduate school and study more about reproductive physiology.

Dawn A. Elkins

INTRODUCTION

A successful artificial insemination program in cattle is dependent on accurate and efficient estrus detection. Visual observation for estrus, which is based on mounting activity, is accurate but not very efficient without continuous observation of the animals. During any given estrous cycle, 30-50% of cows or heifers within a herd are not detected as in estrus by visual observation (Rorie et al., 2002). A reproductive examination of animals failing to exhibit estrus usually does not reveal any physiological abnormalities. Failure to detect estrus has been attributed to infrequent mounting activity and/or short estrus periods (Dransfield et al., 1998). It is possible that failure to express estrus activity could be correlated to an individual animal's social status within the herd.

When a group of cows or heifers are placed together, they will establish a "pecking order" or social hierarchy. The social hierarchy can be dependent upon age, breed, temperament, weight, and presence or absence of horns (Ewing et al., 1999). The number of animals in the group can affect the amount of stress in a particular herd. Individuals at the lower end of the social hierarchy can be subjected to considerable levels of stress which in turn can result in adverse effects on all production traits, including reproduction (Dobson et al., 2001). Social stresses might explain why some animals within a group fail to express sexual receptivity (estrus) and thus have poor fertility. While studies have been conducted to determine how social status in bulls affects reproductive efficiency within a herd (Garcia et al., 1986), very limited research has been conducted to determine the effects of social status in cows on expression of estrus and fertility. Therefore, the objective of this study was to determine if the social status of dairy heifers within a herd influences their expression of estrus and subsequent fertility.

MATERIALS AND METHODS

A group of 30 crossbred dairy heifers, predominantly of Holstein or Jersey breeding, ranging from 14 to 16 months of age and weighing between 287 and 376 kg, were used for this study. The heifers were maintained on pasture and fed supplemental grain and hay to achieve a gain of ~ 0.77 kg/d. Prior to the start of the study, the heifers were examined via rectal palpation and ultrasonography to confirm that they were cyclic (based on the presence of a corpus luteum on one ovary) and free of any obvious reproductive tract abnormalities.

The heifers were observed over a 14 d period for expression of dominant or submissive behaviors in individual confrontations. Dominant behavior included

butting, charges, and pushing, whereas submissive behavior included avoidance either of an individual or of a situation, and submission to or displacement by the aggressor (Galindo and Broom, 2000; Phillips and Rind, 2002). Data collected were used to determine the social status of individual heifers based on a displacement index (Galindo and Broom, 2000).

The displacement index was calculated based on the number of times a heifer displaced another individual divided by the number of times a heifer displaced another individual plus the number of times the heifer herself was displaced. This formula gave a continuous range of numbers between 0 and 1, with the higher the number the more dominant the individual animal (Galindo and Broom, 2000).

To aid in breeding, the estrous cycles of the heifers were synchronized by treatment of two injections of prostaglandin F2a (PGF2a; Lutalyse, 25 mg, Pfizer Animal Health, New York, N.Y.) given 14 d apart. At the time of the second PGF2a injection, HeatWatch (DDx Corp., Denver, Colo.) transmitters were placed on the heifers for continuous monitoring of mounting (estrus) activity over the next 45 d. The HeatWatch system electronically recorded the time of onset of estrus, the length of estrus, and the number of mounts during the estrus period. The HeatWatch parameters for estrus were three or more mounts of at least 2 sec duration each within a 4-h period. The time of the first mount within the 4-h period was considered the onset of estrus.

All heifers were artificially inseminated approximately 12 h after onset of estrus, using frozen-thawed semen from a single Jersey sire. An experienced technician performed all inseminations. Pregnancy status was determined for heifers failing to return to estrus by ultrasonography, using an Aloka 500V (Aloka Corp., Tokyo, Japan) ultrasound with a 5 MHz trans-rectal transducer at approximately 35 d post-insemination. Heifers that returned to estrus after the first insemination were inseminated again and pregnancy status was determined by ultrasonography approximately 30 d later.

Data were analyzed using JMP statistical software (SAS Institute, Cary, N.C.). For analysis, heifers were placed into three groups (top, middle, and bottom one-third of the herd) based on displacement index scores. Analysis of variance was used to determine any differences among the three groups of heifers for length of estrus, number of mounts during estrus, and number of mounts/h. Treatment means were compared, using Student's t test. Pregnancy rate was compared among groups using chi-square analysis.

RESULTS AND DISCUSSION

Overall, 27 of 30 (90%) heifers were detected in estrus by the HeatWatch system (Table 1). Visual observation of heifers for estrus (i.e., mounting activity) can only detect about 50-70% of animals in estrus during any given estrous cycle (Rorie et al., 2002). The use of the HeatWatch system to continuously monitor animals for estrus illustrates the greater efficiency of an electronic estrus-detection system over that reported for visual observation alone.

With a range approaching 100 kg difference in body weight among individual heifers, it might be assumed that larger heifers might be the more dominant animals in the herd. However, the mean weight of heifers in the three social groupings only ranged from 320 to 333 kg and were similar ($P = 0.369$), regardless of the group's social rank. These results are an agreement with others who report that several factors in addition to weight contribute to dominance, including age, breed, temperament, and presence or absence of horns (Ewing et al., 1999).

Subordinate heifers, ranked in the bottom one-third of the herd, exhibited a shorter estrus ($P = 0.001$) than more dominant heifers (Table 1). The number of mounts recorded during estrus declined with decreasing social status ($P = 0.009$). The number of mounts/h tended to be greater for heifers in the top one-third of the social hierarchy ($P = 0.074$). Previous research (Dransfield et al., 1998) reports that ~ 25 % of cows have infrequent mounts during estrus and/or estrus periods of short duration. With visual observation, cows are typically observed for about an hour twice per day for signs of estrus, and thus this method may fail to detect cows undergoing infrequent mounting activity. Study results suggest that the animals not detected as in estrus by visual observation could be the more subordinate animals in the herd.

Of those heifers detected in estrus and inseminated, pregnancy rate (Table 2) was similar among the social groups after the first insemination ($P = 0.315$), as well as for the cumulative pregnancy rate after the second insemination ($P = 0.608$). Therefore, duration and intensity of estrus had no effect on subsequent fertility. These results are in agreement with previous findings of Rorie et al. (2002), who evaluated estrus parameters of over 500 beef cows and found no relationship between the length of estrus or mounting activity and pregnancy status after artificial insemination.

In summary, this study indicates that the social status of dairy heifers within a herd influences the length and expression of estrus. Subordinate heifers have less

mounting activity during estrus and a shorter duration of estrus. Social status does not influence subsequent pregnancy rates of heifers detected in estrus. However, social status could reduce the overall pregnancy rate due to failure to detect subordinate heifers in estrus by visual observation. It would likely be advantageous to manage cows or heifers in small rather than large herds for estrus detection and artificial insemination. Smaller groupings should reduce social stress and increase the chances of detecting subordinate animals in estrus.

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Table 1. Effect of social status of heifers on length and mounting activity during estrus.

Social group	Detected in estrus	Length of estrus (h)	Number of mounts	Mounts per hour
Top one-third	10/10	15.0 ± 1.4^{a}	36.0 ± 5.2^{c}	2.4 ± 0.3^{f}
Middle one-third	9/10	13.7 ± 1.0^{a}	22.4 ± 5.3^{d}	1.6 ± 0.2^{g}
Bottom one-third	8/10	8.1 ± 1.1^{b}	13.8 ± 2.4^{e}	1.9 ± 0.3^{g}

Numbers within columns with different superscripts differ ($^{ab}P = 0.001$; $^{cde}P = 0.009$; $^{fg}P = 0.074$).

Table 2. Effect of social status of heifers on pregnancy rate after artificial insemination*.

Social group	Pregnancy rate (first insemination)	Pregnancy rate (second insemination)
Top one-third	4/10 (40.0%)	7/10 (70.0%)
Middle one-third	4/9 (44.4%)	6/9 (66.7%)
Bottom one-third	6/8 (75.0%)	7/8 (87.5%)

*There were no significant differences among means ($P \geq 0.315$)