Influence of Social Hierarchy on the Expression of Estrus and Subsequent Fertility of Dairy Heifers

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Introduction

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 F2α (PGF2α; Lutalyse, 25 mg) given 14 d apart. At the second PGF2α 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 (P = 0.001) estrus than more dominant heifers. The number of mounts recorded during estrus declined with decreasing (P = 0.009) social status. There was a trend for the number of mounts per hour 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). These 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.

Experimental Procedures

A group of 30 crossbred dairy heifers, predominantly of Holstein and Jersey breeding, ranging from 14 to 16 months of age and weighing between 633 and 829 lb, was used for this study. The heifers were maintained on pasture and fed supplemental grain and hay to achieve a gain of ~1.70 lb/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 F2α (PGF2α; Lutalyse, 25 mg, Pfizer Animal Health, New York, N.Y.) given 14 d apart. At the time of the second PGF2α 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 seconds 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).
Inc., 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 of almost 200 lb 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 705 to 734 lb and were similar (P = 0.369), regardless of the group’s social rank. These results are in agreement with others who reported 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 (P = 0.074) to be greater for heifers in the top one-third of the social hierarchy. 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. Results of the current study 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 (P ≥ 0.315) among the social groups after the first insemination, as well as for the cumulative pregnancy rate after the second insemination. 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.

**Implications**

Social status of dairy heifers within a herd influences the length and expression of estrus, but not pregnancy rate of heifers detected in estrus. Managing cattle in small rather than large herds for estrus detection and artificial insemination might reduce social stress and increase the chances of detecting subordinate animals in estrus.

**Acknowledgments**

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**References**


**Table 1. Effect of social status of heifers on length and number of mounts during estrus.**

<table>
<thead>
<tr>
<th>Social group</th>
<th>Detected in estrus</th>
<th>Length of estrus (h)</th>
<th>Number of mounts</th>
<th>Mounts per hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top one-third</td>
<td>10/10</td>
<td>15.0 ± 1.4&lt;sup&gt;a&lt;/sup&gt;</td>
<td>36.0 ± 5.2&lt;sup&gt;c&lt;/sup&gt;</td>
<td>2.4 ± 0.3&lt;sup&gt;f&lt;/sup&gt;</td>
</tr>
<tr>
<td>Middle one-third</td>
<td>9/10</td>
<td>13.7 ± 1.0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>22.4 ± 5.3&lt;sup&gt;d&lt;/sup&gt;</td>
<td>1.6 ± 0.2&lt;sup&gt;g&lt;/sup&gt;</td>
</tr>
<tr>
<td>Bottom one-third</td>
<td>8/10</td>
<td>8.1 ± 1.1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>13.8 ± 2.4&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.9 ± 0.3&lt;sup&gt;g&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Numbers within columns with no superscripts in common 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.***

<table>
<thead>
<tr>
<th>Social group</th>
<th>Pregnancy rate (first insemination)</th>
<th>Pregnancy rate (second insemination)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top one-third</td>
<td>4/10 (40.0%)</td>
<td>7/10 (70.0%)</td>
</tr>
<tr>
<td>Middle one-third</td>
<td>4/9 (44.4%)</td>
<td>6/9 (66.7%)</td>
</tr>
<tr>
<td>Bottom one-third</td>
<td>6/8 (75.0%)</td>
<td>7/8 (87.5%)</td>
</tr>
</tbody>
</table>

*There were no significant differences among percentages (P ≥ 0.315).