Social Rank and Social Index as Related to Age, Body Weight and Milk Production in Dairy Cows[1]

Eugene P. Barton, Susan L. Donaldson, MaryAnn Ross and Jack L. Albright
Department of Animal Sciences
Purdue University, West Lafayette, Indiana 47907

Abstract

Social Index and Schein-Fohrman rank in 53 dairy cows were highly significantly correlated ($p<0.001$) with each other. Significant correlations between measures of social behavior and age and weight were also noted. Correlations between social behavior and milk production approached significance ($p<0.07$). Because of its objective nature and computational ease, Social Index may be substituted for Schein-Fohrman rank. Based upon many scores of dominance and submission and upon lack of statistical significant correlation coefficients, we believe that dominance and submission are not separate ends of a continuum. Therefore, at least four distinct social orders exist in dairy cattle—dominance, submission, leadership-followship, and entrance into a milking parlor.

Introduction

Several authors have studied and verified the existence of a complex social organization within a herd of dairy cattle (1 through 10). They have showed that at least three distinct hierarchial orders (dominance, leadership, and milking) determine priority rights for status, food and water. Milking and leadership were shown to be related (3). The dominance order has been demonstrated to be so stable that a single day's observation substantiates it. The dominance-submission tendencies of calves may be altered by manipulating early feeding and rearing conditions (5). The following factors have been identified as influences on the ultimate dominance pattern: age (seniority), weight, breed, absence of horns, and early experiences.

One interesting aspect of social dominance research has been the variety of schemes used to combine observations into numerical scores. Schein and Fohrman (9) ranked all subjects studied in a straight-line peck order, and did not report any reversals. A least-straight method of analysis has been used (1, 3) to rank animals for various categories of behavior. Donaldson (5) formulated ratios by which various behaviors were then defined for each pair of subjects:

$$\text{Aggression} = \frac{\text{Number of times one animal initiated encounters with another}}{\text{Number of encounters between those 2 animals}}$$

$$\text{Dominance} = \frac{\text{Number of times one animal displaced another}}{\text{Number of times animal initiated encounters}}$$

$$\text{Submission} = \frac{\text{Number of times one animal yielded to another}}{\text{Number of times animal was approached by the same animal}}$$

Each subject was scored in relation to every other subject with which it interacted and the scores for each animal were averaged for each day of the experiment.

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A majority of previous work in this area has been conducted in herds maintained for research purposes. What effect simultaneous nutritional, physiological and long-term breeding experiments may have had on other behavior studies remains undetermined. This study was devised to determine various measures of social behavior in the Burk-Barton Guernsey dairy herd and to correlate these measures to each other and to physical traits.

Methods

The subjects were 53 Guernsey cows that ranged in age from 25 to 168 months (average 64) and from 680 to 1,500 lbs. in weight (average 1,060). The herd was developed primarily from additions; only 3 of the 53 cows were purchased. Bred heifers usually were introduced into the milking herd between 18 to 26 months old. They were maintained in a free stall-milking parlor installation near Mulberry, Indiana. Feed consisted of an 18% crude protein grain ration fed in the parlor according to milk production. Corn silage was available free-choice at a feed bunk 60 feet long; feeding could occur on either side of the bunk. No hay was fed. A 10-acre field adjacent to the concrete poured feeding lot was available for exercise. A 3-year-old bull was maintained with the milking herd. Although he constantly displaced females and was never aggressively approached by them, interactions with females were not used in any calculations. Milking was usually begun at 6:30 AM and 4:30 PM. The feed bunk was normally filled with silage at the beginning and refilled at the conclusion of each milking. When observations were made of behavior, the first evening was delayed until after all those cows being milked had returned to the feed bunk area.

Observations were made as the cows were feeding between 6:30 PM and 7:30 PM on the four consecutive evenings in autumn and repeated 1 month later in early winter. Each observation and notation of interactions between subjects indicated which subject initiated the encounter and whether the other cow involved yielded (*i.e.*, between Cow 1 and Cow 2, 1+2), retaliated (*i.e.*, 1-2) or neither yielded nor retaliated (*i.e.*, 1-0-2). A portable battery-operated tape recorder was used in the collection of data. This allowed the observer to maintain a continuous watch of the subjects during observation periods.

Measures of behavior were calculated in a manner similar to that described by Donaldson (5).

A measure of behavior called rank was calculated by attempting to arrange the cows in a straight-line peck order as described by Schein and Fohrman (9). This was done by visually inspecting the data and attempting to determine the Alpha, Beta, through Omega, cows. The first and last subjects could easily be placed into definite positions. However, the subjects ranking near the center often were involved in triangular, pyramidal or more complex relationships. An attempt was made to rank near the top of the herd these individuals who consistently were able to defeat those who were near them in rank. The entire process was quite subjective and required frequent judgments besides requiring several hours of tedious labor.

The age of each subject was obtained from herd records and the weight of each subject at the time of her previous calving was obtained from Dairy Herd Improvement Association records. The 305-day lactation, twice daily milking records, standardized to a Mature Equivalent age for milk production, were calculated for each cow based on her most recently completed lactation.

Social index, dominance and submission scores obtained as percentages were converted to arcsins ($\phi = 2$ Arcsin $\sqrt{x}$). Pearson moment-product linear correlation coefficients were calculated by electronic computer between each of the following: social index, dominance, submission, Schein and Fohrman rank, age, weight, and milk production.

Results and Discussion

The total number of encounters recorded was 3,948. Data on individual cows are found in Table 1. Linear correlation coefficients between variables are listed in Table 2.

TABLE 1. *Individual data for the dominant, mid-dominant, submisssive and purchased cows.*

Cow	Social Index	Dominance	Submission	Schein-Fohrman Rank	Age (Months)	Weight (lbs.)	Milk Production (lbs./lactation)
21[3]	1.41	2.16	2.41	37	55	1070	6800
26[1]	2.61	2.55	2.01	1	113	1090	8780
28[3]	1.69	2.25	2.44	33	47	1220	7930
33[3]	1.88	2.70	1.97	8	97	1500	7050
39[2]	1.58	2.24	2.20	28	46	1020	6440
41[4]	0.35	0.84	2.31	53	39	680	6040
Mean	1.55	2.36	2.43	27	64	1060	7350
Standard Deviation	.54	.40	.25	15	30	150	1420

[1] Dominant cow; [2] Mid-dominant cow; [3] Purchased animals; [4] Submissive cow.

Social index and rank (9) were significantly correlated ($r = 0.85$, $p < 0.001$), indicating that these two measures were interpreting essentially the same behavior. There was a significant correlation of Social Index to age ($r = 0.75$, $p < 0.001$) and of rank to age ($r = 0.86$, $p < 0.001$). This is in agreement with previous findings (3, 9). The correlation between Social Index and weight approached significance ($r = 0.32$, $p < 0.07$). The correlation between milk production and Social Index approached significance ($r = 0.25$, $p < 0.07$). Schein and Fohrman rank correlated with milk production showed a slightly higher correlation coefficient ($r = 0.33$, $p < 0.06$). These correlations are similar to those found by Schein and Fohrman (9) ($r = 0.28$) but considerably larger than that found by Dickson (3) ($r = 0.07$). Part of the difference could be due to the measure of behavior used by each worker. Schein and Fohrman (9) worked in one herd whereas Dickson *et al.* (3)

worked in many herds. In the study reported herein, all correlation coefficients which were negative were obtained when submission was one of the variables.

TABLE 2. *Linear correlation coefficients comparing Social Index, dominance, submission, Schein and Fohrman rank, age, weight, and milk production in dairy cows.*

	Social Index	Dominance	Submission	Schein-Fohrman Rank	Age	Weight	Milk Production
Social Index	——	.534**	—.133	.851***	.755***	.322	.254
Dominance		——	.185	.545**	.422**	.181	.214
Submission			——	—.247	—.280	—.309	—.137
Schein-Fohrman Rank				——	.860***	.400*	.329
Age					——	.333*	.283
Weight						——	.196
Milk Production							——

*** = $p<.001$; ** = $p<.01$; * = $p<.05$.

The mean dominance score was 2.36, the mean submission score was 2.43 and the mean Social Index was 1.55. This can be interpreted to mean that in this herd, when a given cow would initiate an attack, the attacker won. Also, when cows were approached (subject to attack) about 88% of the time they would yield, *i.e.*, lose. These cows tended to initiate only those encounters which they stood a good chance of winning and refrained from initiating encounters with cows to whom they stood a good chance of losing. This can be construed as evidence for social stability in the herd. As noted in the methods sections, almost all the cows studied had grown up in the herd. In other words, this was a very stable herd approaching natural conditions as opposed to assembled dairy herds used in some other behavioral studies. (The only cows purchased were numbers 21, 28 and 33. Cows 21 and 28 were 2 years old at the time of purchase, while 33 was 5 years old when she entered the herd. Number 33 was a large cow weighing 1,500 lbs., with a lower Social Index than would be expected for her age and Schein-Fohrman rank. She also had the lowest submission score: 1.97, and a rather high dominance score: 2.70). Apparently the younger cows had "learned their place" and waited for a position within the social hierarchy. As long as cows generally yield when approached, energy and effort will not be expended to determine which cow has priority but "useful" work (*i.e.*, milk production and weight gain) can more readily be done.

The lack of statistically significant correlations of submission to other quantities seem to indicate that in a stable herd of dairy cows submission is a different kind of social behavior, not merely one end of the dominance-submissiveness continuum. Donaldson (5) also theorizes that submission is a valid measure in its own right, not a part of previouly described social orders. It is postulated that Social Index interprets the overall hierarchial pattern within the herd but that submission is separate and distinct from some other previously described social orders: dominance, leadership-followership, and milking.

Social Index and Schein and Fohrman rank show nearly the same correlations with the other quantities measured. Social Index scores were obtained by objectively applying a computational formula to the raw data. Schein and Fohrman rank was calculated by subjectively analyzing raw data and judging rank. The objective nature and computational speed of Social Index suggest its use rather than that of Schein and Fohrman rank.

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