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Dominance hierarchy and spatial pattern of a beef-cattle group including different breeds and sexes

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Abstract

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To determine effects of breed and sex on social and spacing behavior in cattle group, a 2-year-old beef cattle group including 18 steers and 20 heifers of Hereford breed and 9 steers of Holstein breed were observed for two consecutive days during grazing in summer and dry-lot feeding in winter. Number of agonistic encounters in the group between 0600h and 1800h were recorded and positions of each lying animal in nighttime through observation periods were determined. The mean body weight of Holstein steers were the heaviest and Hereford heifers were the lightest.

In the grazing, statistical differences of dominance value (DV) were found between heifers and all steers ($P < 0.05$) and between Hereford and Holstein ($P < 0.05$). Mean DV adjusted by covariance for the mean body weight in each breed and sex had no significant difference between breeds and between sexes. In the dry-lot, steers of Hereford were more dominant than heifers ($P < 0.05$), though there was no significant difference between DV adjusted by covariance for the body weight. The distances from each Holstein or Hereford to the nearest groupmate were 3.3 and 5.1m in the grazing, and 1.0 and 1.0m in the dry-lot, respectively. The distances from Holstein to the nearest Holstein were 12.5 and 5.3m, while the distances from Hereford to the nearest Hereford were 5.4 and 1.2m in the grazing and the dry-lot, respectively. The differences of these distance between breeds were significant ($P < 0.01$).

Key words: Beef cattle, Dominance hierarchy, Spacing behavior, Breed, Sex

Introduction

Beef production has recently tended to more intensive system as well as breeding system. For the effect of heterosis as practised in swine production, crossbred and/or three way cross are being used for beef production. Traditionally, difference between specific breeds was not so severely considered in beef cattle management, and it was common that steers and female cattle were grouped together. Thus, beef cattle sometime have been grouped with several breeds and different sexes.

On the other hand, if there is any behavioral difference between breeds and sexes, the management would be difficult rather than groups including single breed and sex. In social behavior, GUHL and ATKENSON (1959) and BRANEL and LEIS (1976) pointed out the effect of breed on dominance hierarchy in dairy herd, and WAGNON et al. (1966) and MCPHEE et al. (1964)

described the same effect in beef cattle groups. Concerning the effect of sex on dominance, the most dominant is male, followed by castrated male and female (HART 1985). In spacing behavior, breed specific behavior in their spatial pattern was also described in sheep flocks (ARNOLD and DUDZINSKI, 1978).

To determine the effects of breed and sex on social and spacing behavior in beef cattle group, we observed the behavior of 47 beef cattle including Holstein and Hereford breeds and steers and heifers.

Materials and methods

Experimental animals was a group of 2-year old beef cattle including 18 steers and 20 heifers of Hereford breed and 9 steers of Holstein breed that had been kept in the university livestock farm. For the experiment, the group was grazed from May to October and kept in a dry-lot from November to April.

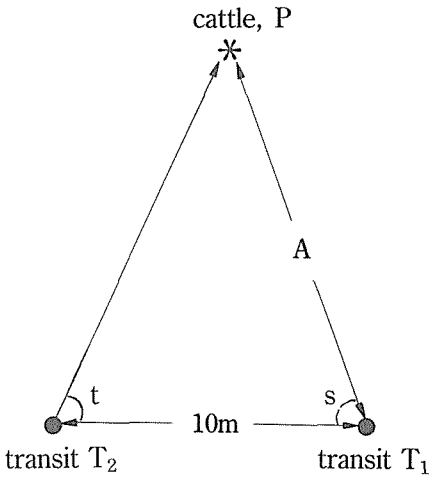
In summer, behavior of the group was observed on two consecutive days in the grazing pasture (4.2 ha). Agonistic encounters between individuals were recorded from 0600h and 1800h in the obserbvation period. Positions of lying animals were determined all the night through by applying a method of triangular surveying (Fig. 1).

In winter, the same observation of social behavior was done also between 0600h to 1800h of two days. Positions of lying animals in the night were determined by the position of poles in fences at 1.8m intervals, and recorded as X-Y coordinates (Fig. 2).

Before observations, body weight of experimental animals were measured. From the numbers of win and loss in encounters for each animal, dominance values (BEILHARZ and MYLREA 1963, COLLIS 1967) were calculated for each individual (DV: arc sine ($\sqrt{\text{number of win/total number of encounters}}$)). From the position of cattle, mean distance from individual to others in the group (ID) and mean distance from individuals to the nearest neighbor (rA) were calculated. The data were analysed by analysis of variance and convariance.

Results and discussion

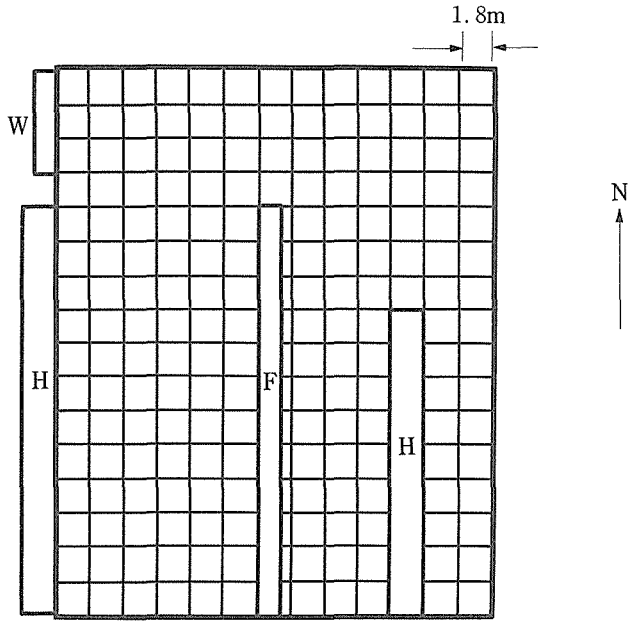
In the grazing, the means of body weight of steers and heifers in Hereford breed and steers of Holsteins were 387.7, 305.8, and 363.5kg, respectively, while in the dry-lot, they were 371.6, 342.4 and 411.8kg, respectively. Holstein cattle were heavier than Hereford cattle ($P < 0.01$)and steers were heavier than heifers ($P < 0.05$).



P : (A, s)

$A = 10 \cdot \sec s \cdot \tan t \cdot (\tan s + \tan t)^{-1}$

Fig. 1 A method of the triangular surveying to locate the position of cattle in the grazing (The position of cattle P is expressed as a distance A from transit T_1 to the cattle P and as a angle s)



H : hay rack ; F : feed bunk ; W : water

Fig. 2 Experimental dry-lot

Fig. 3 shows mean DV in each breed and sex group in the grazing and the dry-lot. In the grazing, Holstein steers were the highest dominant in the group, and Hereford steers were next. The difference between Holstein steers and Hereford heifers was significant ($P < 0.01$). In the dry-lot, steers of Hereford had the highest DV, and next was Holstein steers ($P > 0.05$). Hereford steers were significantly dominant than Hereford heifers ($P < 0.05$).

In the case of the grazing, the differences of DV between breeds and between sexes were not so obvious. Thus, the group was classified into Holstein and Hereford (steers + heifers), and into steers (Holstein + Hereford) and heifers. Means of DV in each class were 51.1, 43.5, 47.1 and 41.9, respectively. The both differences between breeds and between sexes were significant ($P < 0.05$). In the dry-lot, means of DV in steers (Holstein + Hereford) and heifers were 47.0 and 41.5, respectively. The difference between sexes was significant ($P < 0.05$).

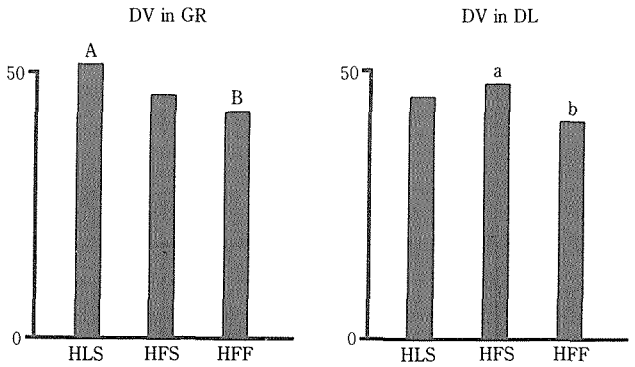


Fig. 3 Mean dominance value (DV) of Holstein steers (HLS), Hereford steers (HFS) and Hereford heifers (HFF) in the grazing (GR) and the dry-lot (DL). a-b : $P < 0.05$, A-B : $P < 0.01$

Above results show that the breeds and sexes appearently seemed to play a important role on the dominance hierarchy. Holstein cattle were more dominant than Hereford cattle, and steers were more dominant than heifers. These results were agreed with conclusions of WAGNON et al. (1966) and MCPHEE et al. (1964). Since there were significant differences of mean body weight between each of the breeds and sexes, the social difference of breeds and sexes in this group could be related to the differeces of their body weight.

The coefficients of SPEARMAN's rank correlation between DV and body weight were + 0.7 ($P < 0.01$) and + 0.6 ($P < 0.01$) in both grazing and dry-lot, respectively. The analysis of covariance in DV for the body weight was applied to the means of DV for breed and sex. The

results were shown in tables 1 and 2. In spite of significant difference between breeds and between sexes, there was no statistical difference of DV adjusted by covariance for the mean body weight between breeds and between sexes.

WAGNON et al. (1966) and MCPHEE et al. (1964) suggested these might be accorded to the difference of nervous temperament of breed specifics, and had no concern with the differences of body weight or body size. In the present study, the difference of dominance hierarchy was not only related to the breed, but also to the difference of body weight in each breed. BRAKEL and LEIS (1976) found the breed difference of dominance values in dairy herd including 5 dairy breeds, though they simply concluded these were caused by the difference of body weight in each breed.

Table 1. Mean dominance values (DV) of each breed and sex in the grazing

	DV	DV'
Holstein (steers)	51.1^a	44.8
Hereford (steers and heifers)	43.5^b	45.0
Steers (Holstein and Hereford)	47.1^a	44.0
Heifers (Hereford)	41.9^b	45.9

DV' : Adjusted by covariance for the mean body weight
a—b : $P<0.05$

Table 2. Mean dominance values (DV) of each breed and sex in the dry-lot

	DV	DV'
Hereford (steers)	47.8^a	44.0
Hereford (heifers)	41.5^b	45.0
Steers (Holstein and Hereford)	47.0^a	45.1
Heifers (Hereford)	41.5^b	44.5

DV' : Adjusted by covariance for the mean body weight
a—b : $P<0.05$

In general, male cattle are more dominant than castrated animals, and castrated animals are more dominant than female (HART, 1985). In the present study, DV was related to the difference of body weight in each sex.

Fig. 4 shows ID in intra-groupmate and intra-breed. According to the change of space allowance per animal from the grazing (893.6m^2) to the dry-lot (15.4m^2), these distances considerably decreased, though the differences between breeds were little in both grazing and dry-lot.

Fig. 5 shows rA in intra-groupmate and intra-breed, involving mean distance from Holstein or Hereford to the nearest neighbor and mean distance from Holstein or Hereford to the nearest

neighbor of the same breed. The differences of rA in intra-groupmates between breeds were not significance in both grazing and dry-lot, while there were significant differences of intra-breed rA between breeds in the grazing ($P < 0.05$) and in the dry-lot ($P < 0.01$).

ARNOLD and DUDZINSKI (1978) described spatial difference between breeds of sheep. In the present study, ID showed no significant difference between breeds: the spacing behavior of Holstein cattle did not differ from that of Hereford. Therefore, Holstein cattle which had smaller population than Hereford dispersed from each other in the group, this resulted in the significant difference of intra-breed rA between breeds.

As the conclusion, dominance hierarchies exsisting between breeds and sexes were depended on the difference of their body weight. No significant tendency of sub-grouping together with the same breed was found in the cattle group including different breeds.

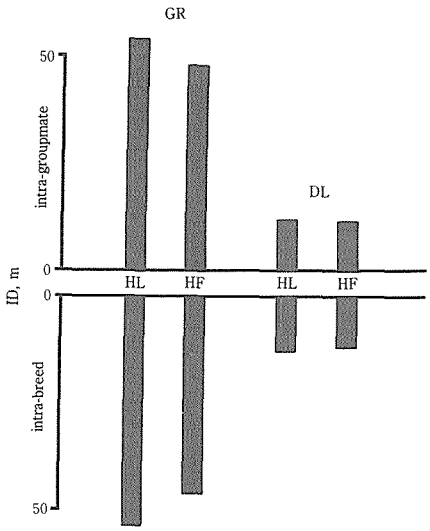


Fig. 4 Mean distance between individuals (ID) of Holstein steers (HL), Hereford steers and Hereford heifers (HF) in the grazing (GR) and the dry-lot (DL).
intra-groupmates: from Holstein or Hereford to other animals
intra-breed: from Holstein or Hereford to the same breed

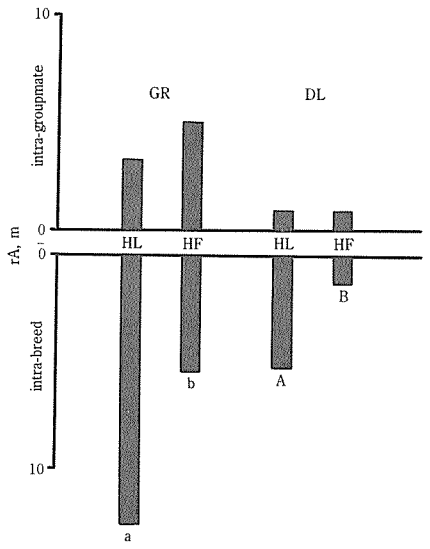


Fig. 5 Mean distance to the nearest neighbors (rA) of Holstein steers (HL), Hereford steers and Hereford heifers (HF) in the grazing (GR) and the dry-lot (DL). a-b: $P < 0.05$, A-B: $P < 0.01$
intra-groupmates: from Holstein or Hereford to other animals
intra-breed: from Holstein or Hereford to the same breed

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異なる品種および性からなる肉用牛群の社会構造および空間構造

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ホルスタイン種去勢牛９頭，ヘレフォード種去勢牛18頭および同雌牛20頭からなる放し飼い肉用牛群内の品種および性差が群の社会構造および空間構造におよぼす影響を検討する目的で一連の行動観察をおこなった。すなわち，本学附属牧場で飼養されている２歳齢肉用牛群47頭について夏期は4.2haの傾斜地を含む放牧地，冬期は725m²のドライロットでそれぞれ２日間，社会行動および空間行動を観察した。

供試牛群の放牧地およびドライロットでの平均体重はそれぞれ328.0kgおよび367.9kgで，ホルスタイン種去勢牛，ヘレフォード種去勢牛およびヘレフォード種雌牛の順に重かった。放牧地での平均 Dominance Value（DV）ではヘレフォード種去勢牛および雌牛間，ホルスタイン種去勢牛およびヘレフォード種去勢牛間に有意な差はなかったが，ホルスタイン種と全ヘレフォード種，および両種去勢牛とヘレフォート雌牛を比較すると，平均 DV はそれぞれ51.1対43.5，および47.1対41.9で，ホルスタイン種はヘレフォード種に，去勢牛は雌牛に対して優位となった（$P<0.05$）。共分散分析により体重差を補正した DV を比較すると，ホルスタイン種去勢牛および全ヘレフォード種は44.8および45.0，両種去勢牛およびヘレフォード種雌牛は44.0および45.9と有意な差はなかった。ドライロットでは，ヘレフォード種の去勢牛は雌牛に対して優位であったが（$P<0.05$），同様に体重を補正して比較すると45.0および44.0と有意な差はなかった。各個体の位置から平均個体間距離（ID）および平均最近接個体間距離（rA）を算出したところ，ホルスタイン種から他の個体までの ID は放牧時に53.6m，ドライロット時に12.6mであり，ヘレフォード種ではそれぞれ47.2および11.9mで品種間に差はなかった。また，rA もホルスタイン種放牧時で3.3m，ドライロット時に1.0m，ヘレフォード種ではそれぞれ5.1および1.0mと品種間に差はなかった。ホルスタイン種から最も近いホルスタイン種までの rA は放牧時で12.5mおよびドライロット時で5.3mであり，ヘレフォード種ではそれぞれ5.4および1.2mとホルスタイン種がどちらも有意に高い値をしめした（$P<0.05$および$P<0.01$）。

キーワード：肉用牛群，社会構造，空間構造，品種差，性差