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Comparative Aspects of Behavioural Activities of Beef Cows before and after Introducing a Stranger at Night

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Two groups of dry-lot feeding beef cows comprising 7 residents and a stranger (Groups A and B) were used to examine differences in social and maintenance behaviours before and after introducing the stranger at night, i.e. after dark when most resident animals were recumbent while resting or ruminating and there was less social activity. Agonistic and social licking interactions and incidents of eating, lying, standing and locomotion of each animal in each group were recorded during the daytime.' Body weight change for each cow in the groups after introduction was also estimated. In Group A, there was little change in the frequencies of agonistic and social licking behaviours during the observation period. In Group B, there was more than a 2-fold increase in the frequency of agonistic behaviour following the introduction, though social licking changed little over the period. In each group, a relatively higher frequency of aggressive behaviour initiated and received by each stranger occurred on the 1st to 2nd day after introduction, which thereafter tended to decrease until the 7th day. The stranger in Group A significantly received more frequent aggression from residents than a stranger in Group B ($P < 0.05$). The strange cow in each group spent less time eating and more time in locomotion than residents. A significant negative correlation between eating time and relative body weight change in Group A ($P < 0.05$) suggested that a greater weight reduction in the strange cow after introduction is mainly associated with her less eating time.

INTRODUCTION

Organized social groups of mammals have characteristic features that include a tendency for the group to be impermeable to conspecific intruders (Eisenberg, 1966). Since domestic cattle are also social animals, the occurrence of conflicts among individuals when residents in a given group meet with unfamiliar animals is inevitable. Under modern management systems domestic cattle show a very different way of life compared to the natural one. Some animals living in groups are often subjected to social stress eliciting from social disorganization such as introducing unfamiliar animals into established groups, mixing groups of animals or exchanging group members (Bouissou, 1980). The change over time in acute aggression of cattle subsequent to social disorganization and/or its effects on productivity have been clarified in many studies (Schein and Fohrman, 1955; Brantas, 1968; Bremner, 1975; Brake1 and Leis, 1976; Kay et al., 1977; Collis et ***al.,*** 1979; Arave and Albright, 1981; Tennessen et al., 1985; Kondo and Hurnik, 1990; Mench et ***al.,*** 1990; Nakanishi et ***al.,*** 1991; Sato et

al., 1991a). By contrast, there is a relative scarcity of information on how the acute aggression in cattle can be reduced or alleviated. Therefore, it is urgent to develop effective management techniques which would depress the amount of aggression occurring in unestablished groups from the standpoint of animal well-being as well as productivity.

Several techniques to control aggression deriving from social disruption in farm animals have been proposed (Albright, 1969; Lamb, 1976; Kiley-Worthington, 1977; Sambraus, 1978; Curtis, 1983; Fraser and Rushen, 1987). Albright (1969) described in his review that keeping animals in adjacent sites which permit limited physical contact prior to mixing can reduce agonistic interactions. However, there is some evidence to suggest that this approach is not sufficient to prevent fighting in dairy cows (Brake1 and Leis, 1976), whereby the beneficial effect on cattle seems to be obscure and inconclusive. Lamb (1976) also suggested that when strange cows are introduced into an established group 'introducing the strangers at night when there is less social activity' is effective in reducing fights and social stress within the herd. For herdsmen it is more useful to adopt the proposal by Lamb (1976) rather than Albright (1969) in light of capital investment and limited land area. However, the changes over time in social and maintenance behaviours of beef cows fed in a dry-lot before and after introducing a stranger at night are not elucidated.

The present study was performed to investigate the changes over time in social (agonistic and social licking interactions) and maintenance (eating, lying, standing and locomotion) behaviours of Japanese Black cows before and after introducing a stranger at night and to examine the interrelationships among maintenance behaviour, body weight change and dominance order for each animal in the post-introduction group.

MATERIALS AND METHODS

Animals and management

This study was carried out at the Kuju Agricultural Research Center of Kyushu University during 12/9/90-25/9/90 (Group A: Period 1) and 21/10/90-2/11/90 (Group B: Period 2). The experimental animals (7 residents plus a stranger in each group) were all dehorned multiparous Japanese Black cows. Their profile is presented in Table 1. The strange cow in each group had been fed in a separate group (cow-calf group) for 90 days postpartum. The cohabiting period of residents in each group prior to the introduction of the stranger was more than 20 days. During the observation periods (Periods 1 and 2), the cows were kept in a dry-lot which was flatly concreted and surrounded with iron fences (15 × 13.5 m). They were offered grass hay ad *libitum* using a Z-sided hay rack (4.5 × 2.2 m, 2.7 m in height) placed in the center of the lot (Fig. 1). Water and salt were also given *ad Zibitum* in the lot.

Observations

For behavioural observations all cattle were numbered with decolorizer on both sides so that they could be individually identified. Behavioural observations were made for 3 consecutive days before introducing strangers and for 7 consecutive days following the introduction (0900-1800 h in Period 1 and 0900-1700 h in Period 2), however data on day -3, + 1 and +4 in Period 1 were not recorded because of rainy

Table 1. Outline of experimental cows.

Cow No.	Date of birth (Day/Month/Year)	Parity	Group		Remark
1	4/ 6/81	6	A	B	
3	16/ 6/81	6	A	B	
5	3/ 2/82	5	A	B	
9	8/ 4/83	6	A		
12"	6/11/84	4	A	B	Introduced into A at 15/9/90
14'	10/12/84	4		B	Introduced into B at 25/10/90
17	22/10/84	4		B	
22	5/11/85	4	A		
24	30/ 7/86	2	A	B	
29	13/11/86	2	A	B	

*Newly introduced cow.
Cohabiting period of the cows in each group before introducing a stranger was more than 20 days.

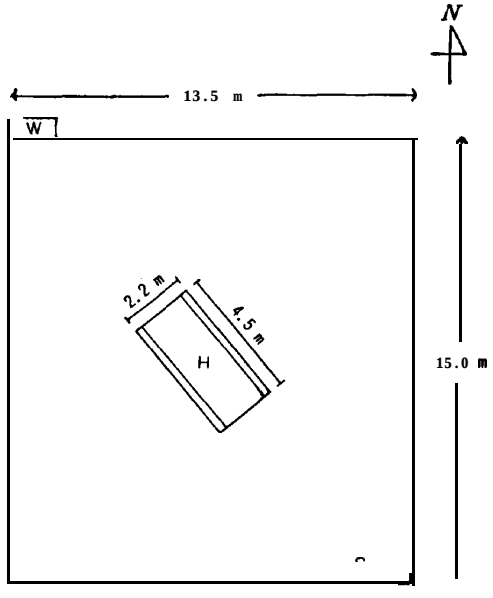

Fig. 1. Scheme of experimental dry-lot.
W: Waterer, H: Two-sided hay rack, S: Salt rack.

weather or occurrence of oestrous. The weather during observation days exclusive of days -3, +1 and +4 in Period 1 was relatively stable (fine or cloudy); maximum temp., minimum temp. and relative humidity were 25.4 ±1.6°c, 19.0 ±2.6°c and 75.1 ± 13.8% in Period 1, and 18.3±3.9°c, 10.9±1.5°c and 70.7±9.5% in Period 2. The introduction of the strange cow was performed in the following way: after weaning her calf (90 d postpartum) she was introduced into the group after dark when most residents were recumbent while resting or ruminating and there was less social activity (2000-2100 h).

During observation periods, agonistic behaviour (fighting, bunting, pushing, threatening and avoiding) as defined by Hafez and Bouissou (1975) and social lickings were recorded whenever they occurred. Agonistic behaviour was categorized into total agonistic encounters (fighting, bunting, pushing, threatening and avoiding) and aggressive behaviour (fighting, bunting, pushing and threatening) initiated and received by each newly introduced cow. Dominance orders in the pre- and post-introduction groups were estimated according to the method of Schein and Fohrman (1955) by direct observation of wins and losses of agonistic interactions. Additionally the incidence of maintenance behaviour, i.e. eating, lying (rest and rumination), standing (rest and rumination) and locomotion of each cow was recorded at 5-min intervals. The cows in each group were weighed at 0900 h on the day of introduction of the stranger (15/9/90 in Period 1 and 25/10/90 in Period 2) and the final day of the study (25/9/90 in Period 1 and 2/11/90 in Period 2). Body weight change for each animal was calculated from the difference between weighing days.

Analysis of data

Wilcoxon signed-rank test was used to compare the means of frequency of aggressive behaviour initiated and received by each strange cow (days + 2, +3, + 5, + 6 and +7) between groups. Concordance among estimated dominance orders for observation days within each post-introduction group was tested by Kendall's rank correlation method (Siegel, 1956). The proportion of time spent eating, lying, standing and in locomotion by cows were expressed as percentage of total number of observations during daily observation hours. Relative body weight change: (body weight change/body weight on the introduction day) x 100, was estimated for each animal and interrelationships among proportion of each maintenance behaviour, relative body weight change and dominance order during post-introduction periods were analysed using Spearman's rank correlation method (Siegel, 1956).

RESULTS AND DISCUSSION

Activities of cows immediately after introducing a stranger

Although behavioural activities of each cow could not be observed elaboratly because of night darkness, it was roughly found that there were some approach, investigative (sniff and flehmen), fighting, bunting and chase behaviours. These were initiated mainly by residents in Groups A and B. This behavioural pattern was in general agreement with the finding of Sato et *al.* (1991a) who made 1-h observations on social behaviour of Japanese Black heifers newly introduced into an established group of cows. Intensive agonistic interactions lasted for approximately 12 min in Group A and 5 min in Group B.

Changes in agonistic and social licking interactions of cows over the peri-introduction period

Figure 2 shows total agonistic encounters and social licking interactions per hour in groups during observation days before and after introducing a stranger. In Group A, there was little change in the frequencies of agonistic and social licking behaviours during the observation period. In contrast, in Group B there was a great variation in

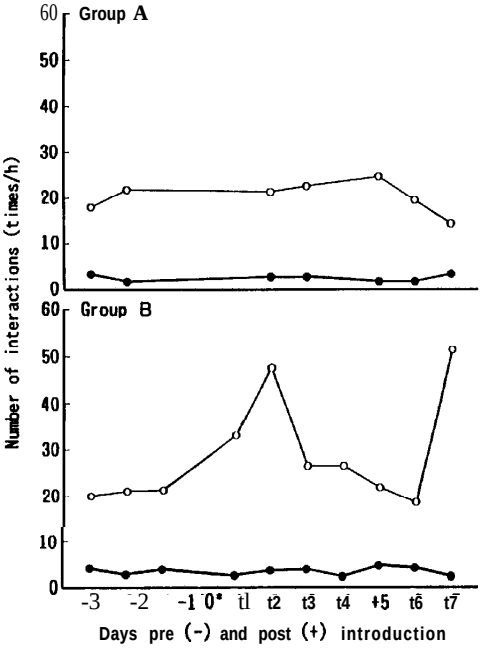

Fig. 2. Changes in frequencies of total agonistic encounters (fighting, bunting, pushing, threatening and avoiding:○) and social licking interactions(O) before and after introducing a strange cow into each group at night.
*Introduction day.

the frequency of agonistic behaviour subsequent to the introduction of the stranger. During the pre-introduction period (days -3, -2 and -1) the frequency of agonistic interactions was nearly constant (approximately 20 times/h), however after introduction higher frequencies (2.5 - fold) occurred on days +2 and +7. According to the regression equation of Kondo et *al.* (1989) obtained from the relationship of agonistic encounters per hour with group size and space allowance in adult cattle, the estimated number of agonistic encounters in the pre-introduction group (7 animals, 27.5 m^2 per animal) is 25.6 times/h. This is relatively close to the values actually observed in this study. The estimated value for the post-introduction group (8 animals, 24.1 m^2 per animal) is 32.2 times/h. Values observed on days +2 and +7 are beyond the estimated value because of social disruption of the group. The increased total agonistic encounters on day +2 in Group B was probably caused by the addition of a stranger. Elevation in agonistic behaviour on day +7 is likely due to a displacement of dominance relationships in residents (animals 3, 24 and 29) and resultant increased social activity on that day. Nakanishi et al. (1991) reported that when a strange cow was introduced into an established group in the daytime, over twice as many agonistic events occurred as in the pre-introduction group and lasted for 6 days after introduction. Such an increase in total agonistic encounters on consecutive days during the post-introduction period did not occur in this study. This result may indicate a less

agonistic environment for cattle in the present study than for animals surveyed by Nakanishi et al. (1991).

Social licking patterns in Groups A and B revealed little change during peri-introduction periods. Contrary to this finding, Nakanishi et al. (1991) found a drastic reduction in social lickings among beef cattle during 1 to 3 days following the introduction of a stranger. Social licking is thought to serve as an affiliative behaviour leading to social stability of a cattle herd and to have a tension-reducing effect within the herd (Hart, 1985; Nakanishi et al., 1991; Sato et al., 1991b). Therefore, the lack of a distinct decrease in social licking interactions for 2 post-introduction days in this study may also reflect a less agonistic cattle environment.

Table 2. Frequency of aggressive interactions? initiated and received by each strange cow during daily 9 h (Group A) and 8 h (Group B) observation periods after introducing the stranger at night (times/house/head).

Group	Days after introduction							Mean of Days +2, +3, +5, +6 and +7
	+1	+2	+3	+4	+5	+6	+7	
A	—[2)]	4.0	3.7	—	3.2	1.5	1.9	2.9(2.3[a])
B	6.3	6.6	3.1	2.5	1.5	0.1	1.9	2.6(1.2[b])

"Fighting, bunting, pushing and threatening.
[2)]Data not recorded.
Figures in parenthesis represent the number of aggressive interactions received by each stranger.
[a–b]Significantly different ($P < 0.05$, Wilcoxon signed-rank test).

Table 3. Social order in each group before and after introducing a strange cow at night.
<Group A>

Item	Cow No.							
	1	3	5	9	12'	22	24	29
Pre-introduction[1)]	7	3	5	5	—	1	2	3
Post-introduction[2)]	8	3	5	5	7	1	2	3

≪Group B≫

Item	Cow No.							
	1	3	5	12	14*	17	24	29
Pre-introduction[3)]	6	3	4	5	—	7	2	1
Post-introduction[4)]	7	3	4	6	5	8	2	1

"Determined from the results of agonistic interactions during 2-day observation period.
[2)]Determined from 5-day observation.
[3)]Determined from 3-day observation.
[4)]Determined from 7-day observation.
*Newly introduced cow.

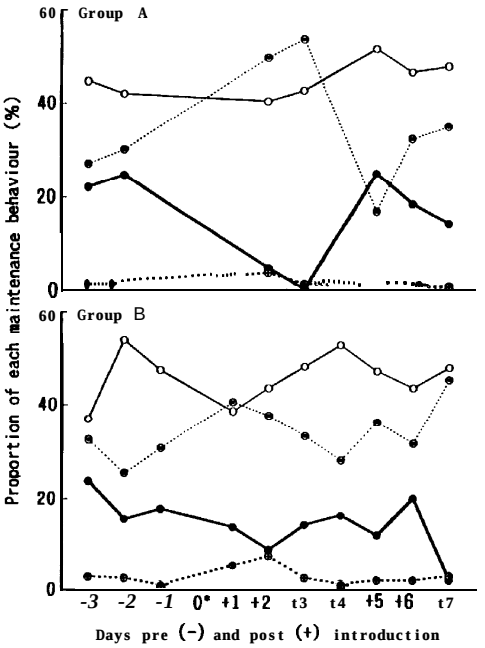

Fig. 3. Proportion of eating (○), lying (●), standing (◎) and locomotion (⊕) time of cows before and after introducing a stranger into each group at night.
*Introduction day.

Changes in aggressive behaviour related to a strange cow over post-introduction period

Table 2 shows the number of aggressive interactions per cow (stranger) initiated and received during the post-introduction period in Groups A and B. The frequencies of aggressive behaviour initiated and received by each cow before introducing strangers were 2.7 and 2.5 times per cow/h in Groups A and B, respectively (values not shown in Table 2). A relatively higher frequency of aggressive behaviour initiated and received by each stranger (4.0-6.6 times per cow/h) was observed on days + 1 and + 2, and then tended to decline until day + 7. This pattern of aggressive behaviour was similar to the finding of Brake1 and Leis (1976) who found a decrease from 9.4 to 4.3 times per cow/h in the number of agonistic interactions of the transferred cows within a week following the intergroup transfer of dairy cows. The frequency of aggressive behaviour initiated and received by strange cows showed no difference between Groups A and B during the post-introduction period: days + 2, 3, 5, 6 and 7 ($P > 0.10$, Wilcoxon signed-rank test). However, the frequency of aggressive behaviour received by the stranger in Group A was significantly higher than that in Group B ($P < 0.05$, Wilcoxon signed-rank test). This result suggested that the strange cow in Group A was subjected to greater social stress than the animal in Group B.

Social order of groups of cows before and after introducing a strange cow

Table 3 shows social order of Groups A and B before and after introduction of a stranger. In both groups there was perfect concurrence in social order of cows among observation days before introduction. Displacements of dominance relationship among resident cows were observed on day +5 in Group A (animals 3, 5, 9 and 29) and on day \$7 in Group B (animals 3, 24 and 29), respectively. However, the introduction of a stranger into each group induced no change in the relationship among residents per se. High Kendall's coefficients of concordance among social orders for observation days in both post-introduction groups ($W = 0.982$ and W x0.983, respectively, both $P <$ 0.001) indicated that dominance relationships among cows in each group were comparatively stable during post-introduction periods. The newly introduced cows in Groups A and B were ranked low and middle, respectively. The greater social stress which the strange cow in Group A suffered from residents seems to be related to her lower ranking in a post-introduction group. The establishment of social position by the newly introduced cow within a short period in this study is in agreement with other reports (Hafez and Bouissou, 1975; Coollis et al., 1979; Nakanishi et al., 1991).

Changes in daily maintenance behaviour of cows over the peri-introduction period

Figure 3 shows the changes over days in proportion of eating, lying, standing and locomotion time of cows before and after introducing a strange cow in Groups A and B. In Group A, there was no marked change in the frequency of eating and locomotion of cows during the peri-introduction period. However, lying incidents showed a dramatic decline, while standing showed an increase following the introduction. Thereafter, the incidences of lying and standing had a tendency to approach those of pre-introduction days by day +5. The marked changes in lying and standing during the peri-introduction days seems to be related to social disruption elicited from the introduciton of a stranger, in particular a great number of aggressive behaviours received and initiated by the stranger as presented in Table 2. In Group B, there was variation in the proportion of time spent eating among days, but no difference before and after introduction of a stranger. The slight increase in the incidences of standing and locomotion on days + 1 and + 2 was probably caused by social disruption as found in Group A. Standing time increased on day +7, whereas lying time decreased drastically. These marked changes were not likely caused by the addition of the stranger but by the displacement of dominance relationships in residents occurring on day +7 as mentioned above.

Interrelationship among maintenance behaviour, body weight change and dominance order in the post-introduction group

Table 4 shows the time-budget of eating, lying, standing and locomotion and relative body weight change for each cow over the post-introduction period. Cows in Group A spent mean 45.5% of the observation time eating, 12.5% lying, 37.3% standing and 1.8% in locomotion, whereas animals in Group B spent mean 46.0% eating, 11.1% lying, 36.2% standing and 3.0% in locomotion, In both Groups A and B the frequency of locomotion revealed much greater variation among cows than eating, lying and standing (CV: more than 100%). A newly introduced cow in each group spent less time eating and more time in locomotion than other animals (both $P < 0.001$, χ^2 test).

Table 4. The time-budget of maintenance behaviours[1] and relative body weight change for each cow after introducing a stranger into each group at night.

≪Group A>

Item	Cow No.								
	1	3	5	9	12*	22	24	29	Mean
Eating (%)	28.6	41.4	48.0	50.6	27.8	60.6	53.2	54.0	45.5
Lying (%)[2]	7.8	11.2	15.4	19.8	13.4	12.6	12.2	7.8	12.5
Standing (%)[2]	59.4	43.2	32.2	25.4	49.2	23.2	31.4	34.2	37.3
Locomotion (%)	2.4	1.2	1.0	0.8	6.0	1.0	0.6	1.0	1.8
Others (%)[3]	1.8	3.0	3.4	3.4	3.6	2.6	2.6	3.0	2.9
Relative body weight change (%)[4]	-1.0	-0.2	−1.3	-1.4	-4.7	+2.2	+1.6	-0.6	

<Group B≫

Item	Cow No.								
	1	3	5	12	14*	17	24	29	Mean
Eating (%)	40.1	48.3	47.1	57.1	24.7	39.9	52.6	58.4	46.0
Lying (%)[2]	3.5	9.2	19.8	8.9	19.6	4.0	13.3	10.2	11.1
Standing (%)[2]	53.0	38.4	28.3	30.5	42.0	50.0	29.4	18.0	36.2
Locomotion (%)	2.1	0.9	0.9	1.9	12.3	4.0	1.4	0.1	3.0
Others (%)[3]	1.3	3.2	3.9	1.6	1.4	2.1	3.3	13.3	3.8
Relative body weight change (%)[4]	+3.2	-0.8	-0.6	-1.4	-0.2	+0.2	-1.3	+1.1	

"Expressed as percentage of total number of observations during 5 (Group A) and 7 (Group B) days.
[2]Including rest and rumination.
[3]Including drinking, salt licking, defecation, urination and social interactions etc.
"'(Difference in body weight between the introduction day and the final day of the study/body weight on the introduction day) **x** 100.
*Newly introduced cow.

Table 5. Spearman's rank correlation coefficients of percentage of time spent in each maintenance behaviour with relative body weight change within the group after introducing a stranger into each group at night.

	Relative body weight change	
	Group A (n = 8)	Group B (n=8)
Eating	-0.667 *	0.357
Lying	0.467	0.310
Standing	0.405	-0.333
Locomotion	0.366	-0.132

Animal with the greatest reduction in body weight, which spent most time in each maintenance behaviour within the group, was ranked as 1.
*$P < 0.05$.

Table 6. Spearman's rank correlation coefficients of percentage of time spent in each maintenance behaviour with dominance order within the group after introducing a stranger into each group at night.

	Dominance order	
	Group A (n = 8)	Group B (n = 8)
Eating	0.855 **	0.643 *
Lying	− 0.079	0.595 +
Standing	-0.711 *	-0.810 *
Locomotion	-0.307	-0.778 *

The dominant animal, which spent most time in each maintenance behaviour within the group, was ranked as 1.
$^{+}P<0.10$, $^{*}P<0.05$, $^{**}P<0.01$.

Moreover, the strange cow in Group A had the greatest reduction in body weight during the post-introduction period. A significant negative correlation between eating time and relative body weight change in Group A ($P<0.05$) indicates that the shorter the eating time, the greater the reduction in weight (Table 5). This may also indicate that the greatest reduction in body weight of the stranger is caused by the least eating time. A possible reason for the difference in the extent of association of eating time and relative body weight change between Groups A and B is that the strange cow in Group A received significantly more aggressive interactions from residents compared with Group B (Table 2) and most of the aggressive interactions were probably related to food competition. Though the extent of the relationship between maintenance behaviour and social dominance in cattle has been extensively discussed (Friend and Polan, 1974; Syme and Syme, 1979; Arave et al., 1984; Kabuga et *al.,* 1991; Nakanishi et ***al.,*** 1992), this study indicates that subsequent to social disruption, maintenance behaviour was closely associated with dominance order (Tables 3 and 6). The dominant cow in each group had the highest eating and lowest standing frequencies. Therefore, with social disruption, a cow's dominance may have a great influence on her eating behaviour and /or body weight despite higher accessibility of feed (about 1.13 m of hay rack space per cow). With respect to this point, additional information is needed.

CONCLUSION

The present study using two groups of beef cows kept in a dry-lot suggested that behavioural responses of the animals to changed social environment (the introduction of a stranger at night) were manifested by an increase in total agonistic encounters, an increase in aggressive behaviour directed to the stranger and /or both decreased lying and increased locomotion time of all members. A strange cow in each group spent less time eating and more time in locomotion than resident animals. In one of the two groups the stranger had the greatest reduction in body weight over the post-introduction period. Additionally, in the post-introduction groups the dominant animal had the highest frequencies of eating and standing behaviour. From the results of this study, 'effect of night introduction of a stranger on aggression within a group' as

suggested by Lamb (1976) is not predictable. Therefore, in future it is essential to compare the behavioural changes of cattle under different methods of introduction (night and daytime).

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