Seasonal Variation of Area Occupied and Spatial Behavior in Grazing Beef Cattle

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Introduction

The behavior of grazing cattle has been studied by various authors, especially in relation to pasture since it was described by TRIBE (1950), and these results were well reviewed by HAFEZ (1969) and HANCOCK (1953).

But behavior as a herd, including its organization, movement, spacing and leader-followership behavior, which has been pointed out by HAFEZ (1965) to be a future concern in a research of grazing behavior, has not been fully elucidated. There were a few reports on behavior study in the view point of spatial structure of a herd. BEILHARZ and MYLREA (1963) have attempted to investigate the relation between social rank and spatial distribution for 41 heifers in the paddock, and suggested some relationship between them. SYME and SYME (1975) studied a relationship between those two factors in 17 cows at the experimental arena, but found no significant relation. For a flock of sheep, DOVE *et al.* (1974) and SQUIRE (1974) studied spatial distribution of them, and concluded the same as cattle herd. In recent study, SATO (1976) has studied a distance between individual animals in a small grazing herd throughout grazing period of a year, and found seasonal variation in the distance of individual animals suggested by HAYAKAWA and MIYASHITA (1973).

The present study was carried out to investigate the effect of the environment such as climate, grass yield and social organization on the area occupied by a herd and spatial position in the herd.

Material and Method

1. Experimental pasture and animals

The study was conducted in the Livestock Farm of Hokkaido University from May to October in 1976. The experimental pastures, established by hoof cultivation in 1967 and 1968, are given in Fig. 1 and 2. These pastures were rotationally grazed at a monthy interval, except May and October because of a lack of grass yield. The sown grasses consisted of primarily timothy, orchard grass, Italian ryegrass, perenial ryegrass, meadow fescue,

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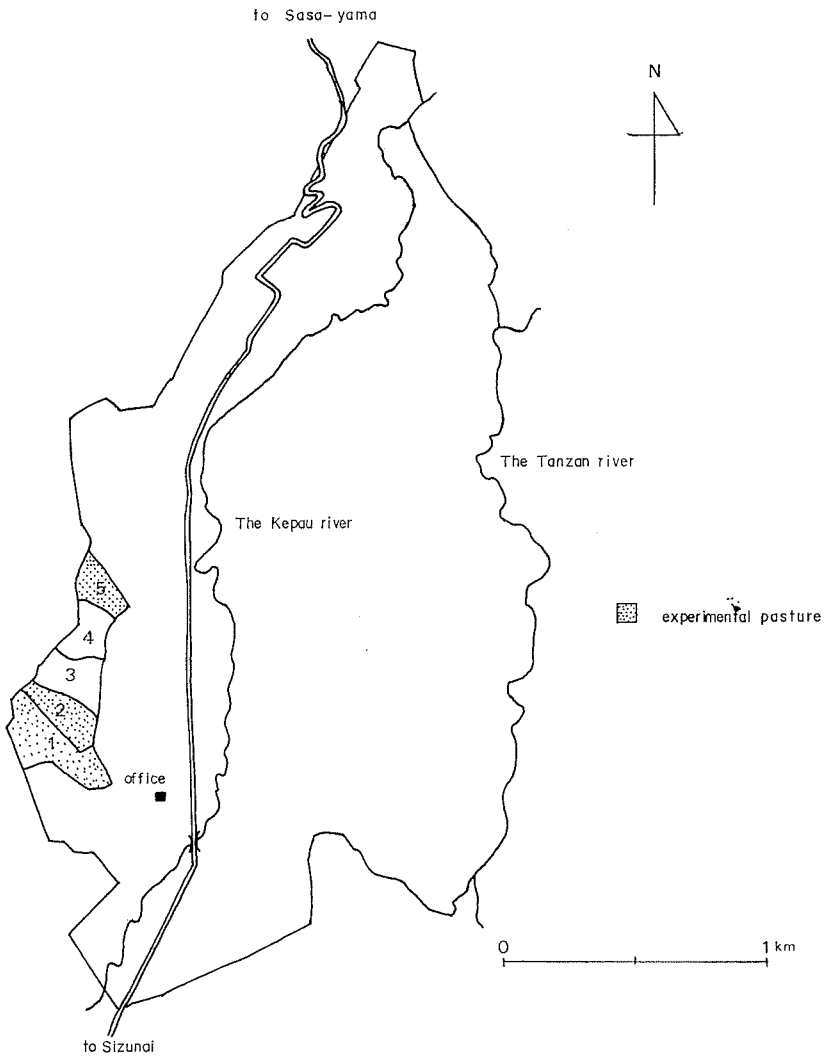

Fig. 1. Site of the experimental pasture.

Kentucky blue grass, New Zealand white and alsike clover. These grasses occupied 60–70% of the pasture structure. The experimental pasture 1 and 2, which were partially marsh and inclined slightly toward south east, were 7.0 ha. and 4.2 ha., respectively. The pasture 5 was 2.3 ha., though relatively flat and simple landscape.

For this study, 41 cattle were used containing 25 Holsteins, 15 Herefords and one hybrid (Holstein × Hereford). All the animals were 2-year-old. In this herd, there were 8 female animals. One of the Holsteins and 7 of the Herefords were heifers, while the remaining were all steers.

They had stayed in a loose barn until the end of April and began the grazing from the first of May to the end of October. During the experi-

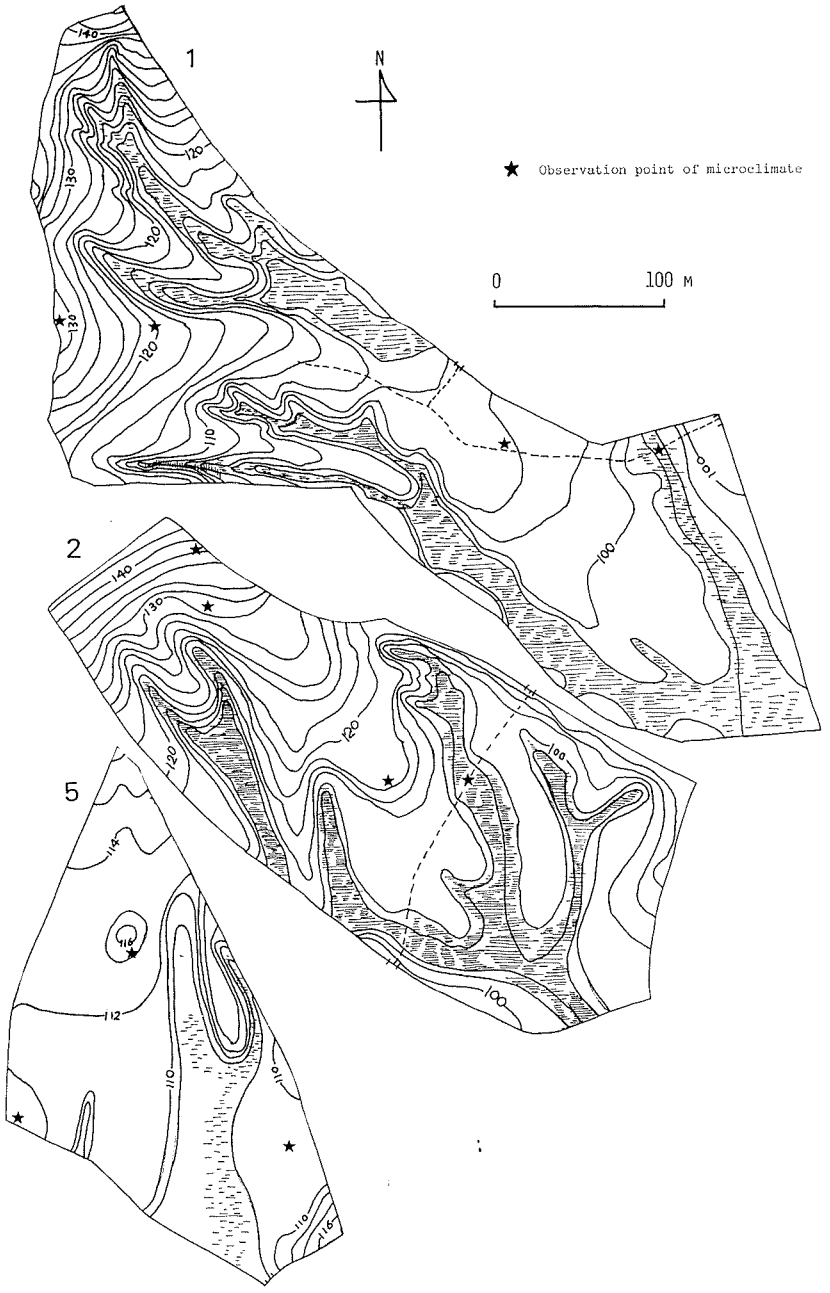

Fig. 2. Topography of experimental pasture (No. 1, 2 & 5).

mental period, no concentrate was fed to the herd.

2. Observation and measurement of behavior

There were 17 experimental days every month, i. e., 7 days on pasture 1, 6 days on pasture 2 and 4 days on pasture 5. However, in May the herd

grazed the same pasture twice, and the observation was made two times in each experimental pasture. Thus the experimental days totaled up to 24 days in this month.

The behavior of the herd was observed from dawn to dusk of each experimental day in each pasture. During the observation, the ratio of the number of grazing animals to all the animals, and area occupied by the herd were recorded at hourly intervals. The area occupied by the herd was measured within an imaginary line surrounding the entire herd. The herd was considered one group when herd members were standing or lying, or when all animals were moving in the same direction and with the same behavior. Except under these conditions, it appeared that the herd was separating and was considered as various smaller groups.

Every two hours, individual position of the animals in the each area occupied by the herd was recorded. During the observation period, the social rank in the herd was estimated from the dominance value (DV) of each animal as described by BEILHARZ and MYLREA (1963).

Grass yield was estimated by two 1-m^2 plots per ha. in each experimental pasture before and after grazing.

The ambient temperature and relative humidity of the observation period were recorded by one or two auto-recorders set on the neighboring pasture of the experimental pastures. Every fourth hour, dry and wet bulb temperatures, wind direction, wind velocity or force and weather were recorded at three or four points in each experimental pasture.

Result

Since breed and sex differences were not found to affect behavior pattern, social dominance and spatial position of each animal, the data regarding all the animals were combined.

1. Diurnal variation of area occupied by the herd and grazing patterns

The diurnal variation of area occupied by the herd and grazing patterns are shown in Fig. 3 (a), (b). In the figure for May, there are demonstrated patterns of just after grazing began (May 2 and May 3), about two weeks after (May 14 and May 15), about three weeks after (May 23), and about four weeks after (May 29).

The area occupied by the herd was characteristically varied as reported previously (KONDO *et al.*, 1977). That was found to be grouped into three sizes and varied periodically. The area considered to be large size was observed at dawn and dusk. The area occupied by the herd was founded to be rather small for the rest of the time.

For example, in August in Fig. 3 (b), area increased extremely at 5 : 00 and 19 : 00. At 11 : 00 and from 14 : 00 to 16 : 00, the area was observed as

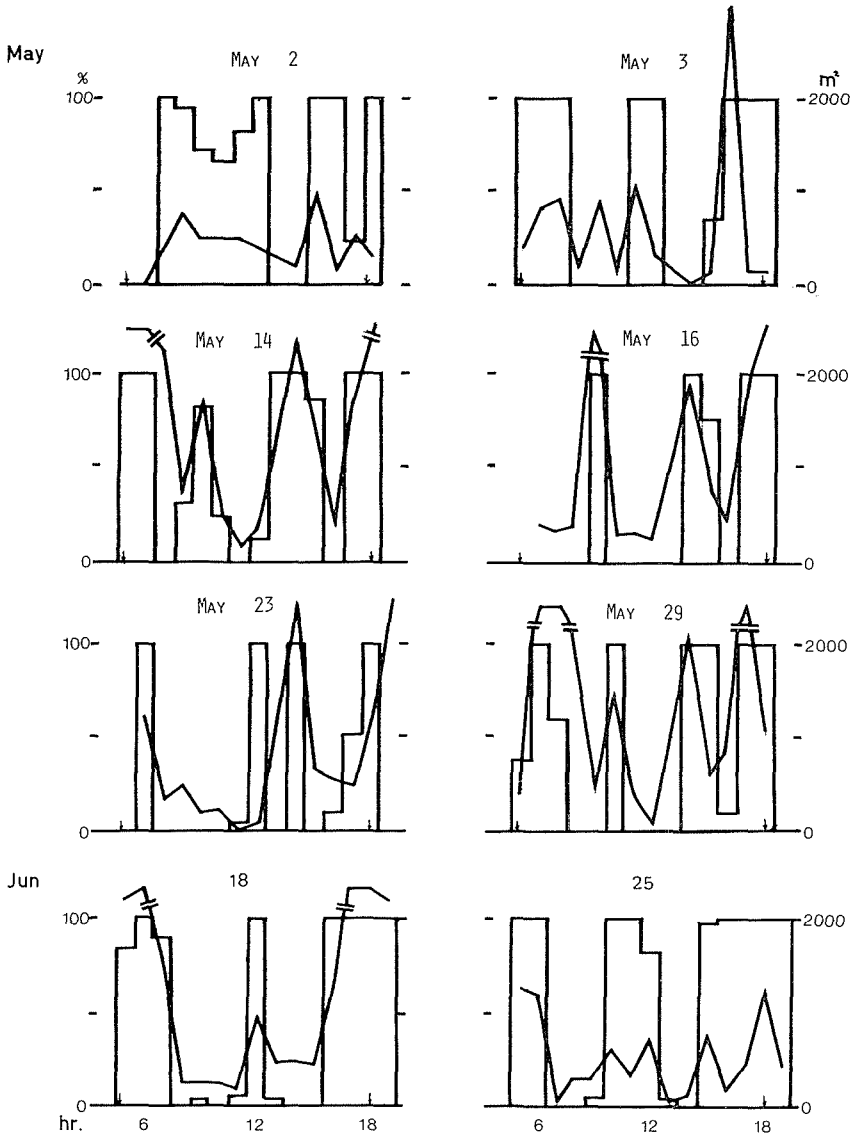

Fig. 3 (a). Diurnal variation of area occupied by the herd (m^2) and grazing pattern (%).

line : area occupied by the herd. histgram : grazing pattern.

being between 100 m^2 and 200 m^2, and during the rest of the time, it was consistently under 100 m^2.

As for the behavior pattern, the large sized area showed that the herd was mainly in grazing form at dawn and dusk. For the middle sized area, the herd was found to be in the grazing form during the daytime. Samll sized area represented the resting form. It has been confirmed by previous

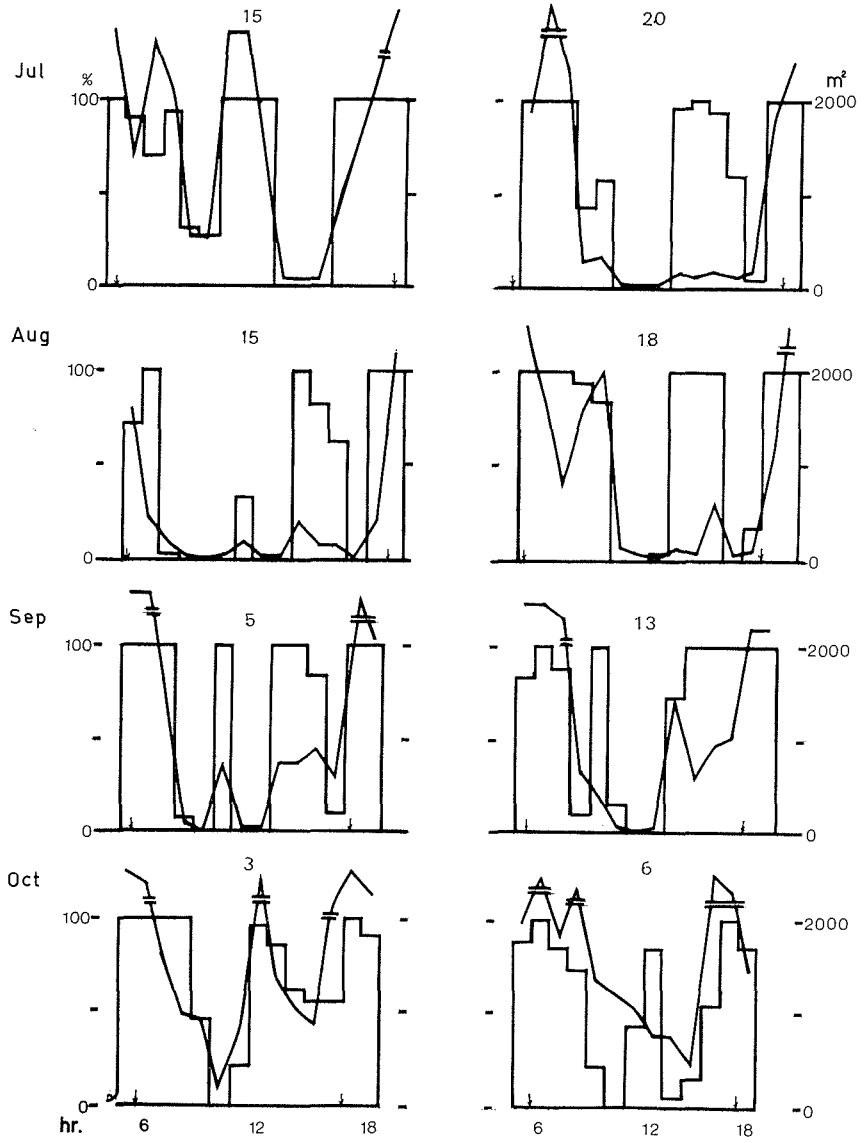

Fig. 3(b). Diurnal variation of area occupied by the herd (m^2) and grazing pattern (%).

line: area occupied by the herd. histgram: grazing pattern.

observation (KONDO *et al.*, 1977) that this phenomenon was also observed in a 24-hour study. At the start of grazing period in May, this phenomenon was not obvious. It occured about two weeks after the start of grazing.

2. Seasonal variation of area occupied by the herd

To clarify the description of the seasonal variation of area occupied by the herd, the data were grouped into three categories:

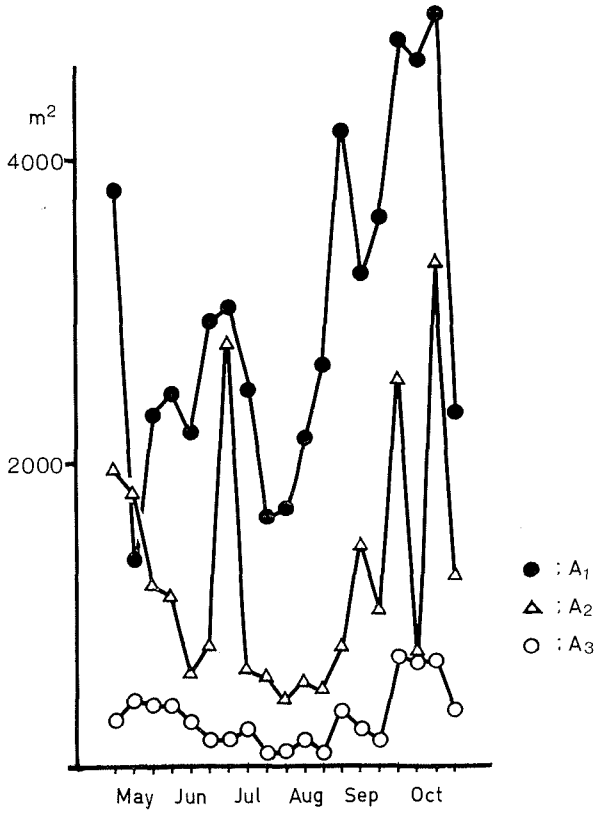

Fig. 4. Seasonal variation of area occupied by the herd. A_1, A_2, A_3: see text.

Fig. 5. Average ambient temperature in pasture.

TABLE 1. Grass yield of each pasture in each month (air DM g/m²)

Pasture No.	1	2	3
May	62.2	150.0	96.3
June	216.1	277.8	227.0
July	223.2	231.2	352.6
August	197.6	192.1	328.7
September	203.6	147.8	187.1
October	125.4	123.2	154.2
	—	—	87.9

A_1: average value of area at dawn and dusk when more than 80% of the herd animals were grazing.

A_2: average value of area when more than 80% of the herd animals were grazing in daytime except at dawn and dusk.

A_3: average value of area when more than 80% of the herd animals were resting.

Fig. 4 shows the variation of these three values at each pasture in each month. Averages of ambient temperature and grass yield of each pasture in each month are shown in Fig. 5 and Table 1.

A_3 value increased in May, June, September and October, while it decreased in July and August. There were statistically significant negative correlation between A_3 values and ambient temperatures.

A_1 and A_2 values decreased in late May, early June, late July and early August. These variations were not correlated statistically with grass yield.

The correlations between A_1 and A_2, and between A_2 and A_3 values were significant, respectively. The effect of area of pasture or topography of pasture on the area occupied by the herd was not confirmed.

3 Social organization and spatial structure of the herd

During the experimental period, there were 336 encounters between pairs of the animals, averaging 8.3 per animal. The DV of each animal was calculated from these encounters and was not correlated to body weight and daily gains of animals.

Data of the spatial position of each animal were divided into two types according to behavior form, and furthermore three categories, respectively, as follows.

1. grazing-moving form (A_1 and A_2)

P_1: first third of herd for moving direction.

P_2: second third of herd for moving direction.

P_3: remaining third of herd for moving direction.

TABLE 2. Frequency in spatial position observed during resting

Social rank	High					Middle					Low				
	2	3	4	5	6	18	19	20	21	22	35	36	37	38	41
Cattle No.	10	14	1	11[2]	12	35[3]	52[3]	53[3]	54[3]	55[3]	9	21	37[3]	51[3]	13
Spatial position[1]															
R_1	20	10	23	4	24	18	10	7	20	12	23	22	19	14	24
R_2	45	34	44	35	49	35	30	36	37	30	46	51	37	34	58
R_3	29	17	34	30	30	48	60	59	44	48	35	32	47	56	22

[1] See text. [2] Hybrid [3] Hereford

2. resting-ruminating form (A_3)

R_1: core zone of the herd.

R_2: zone surrounding the core of the herd.

R_3: fringe zone of the herd.

Table 2 shows the frequency observed in R_1, R_2 and R_3 positions of 15 animals consisting of 5 of high, 5 of middle and 5 of low social rank. The high social rank animals were found in R_2, and middle rank animals tended to be seen in R_3. The low rank animals had no notable tendency. There were no statistical significance in these tendencies.

In grazing form (A_1 and A_2), there was no particular tendency. The effect of breed to the spatial position was not observed.

Discussion

1. Diurnal variation of grazing pattern and area occupied by the herd

It was found that the area occupied by the herd varied periodically according to grazing pattern, and the herd had three area size levels in a daytime. Small sized area was occupied during rest periods, and two larger areas were occupied during grazing. Generally, grazing pattern has 3 or 5 peaks during daytime (HAFEZ, 1969). For the pattern on the area occupied by the herd, these peaks were classified as two. At dawn and dusk, the area was increased to largest size, and the grazing peaks of other times were in the middle sized area.

The difference between each grazing peak has been suggested by some other studies. Grazing peaks at dawn and dusk were described in different ways such as "big morning meal or big meal" (VOISIN, 1961), or "intensively grazing" (HAFEZ, 1969). KUROSAKI *et al.* (1956) defined grazing at dawn and dusk as "grazing form" and the other grazing as "supplement form". These size classifications can be defined more clearly using the size levels of area occupied by the herd.

In May, until two weeks after start of grazing, consistent pattern of the area occupied was not established, while grazing pattern was developed as early as three days after start of grazing. The feeding behavior of the herd in pasture has various aspects, namely grazing pattern, position, or grazing area occupied by the herd, etc. Inside the barn, feeding behavior has a feeding pattern only because it was restricted by feeding time, feeding position and a limited area of barn. Therefore, the establishment of pattern of area occupied was later than that of pattern of grazing. Those two weeks during which a pattern of grazing area was not clearly seen might have been the period of adjustment to grazing from barn behavior. During these first two weeks the average weight of herd animals decreased. Sickness which could be seen in some animals in the herd just after this period was thought partially to be a result of inability to adjust to grazing. These

would suggest the concept of a necessary time period for grazing.

2. Seasonal variation of area occupied by the herd

Decreasing value of A_3, area for the resting behavior, in summer was found when all the animals were accustomed to approaching the shade of a tree. This behavior was described by the term "shade seeking" and thought to be the behavior to prevent heat stroke. From the view point of heat loss of each animal, shade did not cover all the animals; therefore this explanation was not adequate. ITO (1971) suggested that this behavior was not only shade seeking but also defencive posture against the insects. It may be reasonable to consider both shade seeking and preventing an attack of insects.

A_1 and A_2, when the herd was grazing, had a large variation from month to month. It would be logical that an animal has to graze in a larger area if the grass yield per unit area of pasture has declined. However, there was no statistical relationship between grazing area and grass yield.

Increased grazing area in spring and in autumn apparently coincided with low grass yield. The area occupied by the herd grazing in summer was considered to be influenced by not only grass yield but also preference for grazing, or high ambient temperature. The influence of the ambient temperature on grazing area was greater for A_2 than for A_1. It was shown to have a significant correlation ($P<0.05$).

SATO *et al.* (1976) recorded distances between each cattle during grazing, and reported that cattle have grazed in larger distances from each other in spring and autumn than summer.

3. Social and spatial organization of the herd

It has been well known that there is a certain social organization in a domestic herd. Recently, this organization was classified into two categories, social order and social leadership (DICKSON *et al.*, 1967). In the cattle herd, milking order and weighing order were added to these categories.

On the other hand, BEILHARZ *et al.* (1966) and MCPHEE *et al.* (1964) have reported that animals become used to possessing a certain spatial position in the herd area, and suggested these categories have been related to social organization (DOVE *et al.*, 1974, SYME *et al.*, 1975).

In this study, social rank of the herd was determined by using DV, and no linear but complex hierarchy was observed. The relation between rank and weight of individual animal in the herd was described in many studies. However consistent tendency among studies was not obtained. The relation between DV and withers height, heart girth or breed gave different results in each work, too. In this study, there were no statistical correlations between DV and weight, DV and daily grain or DV and breed.

The herd social organization consisted of strong-weak relation basically.

Thus the determinant factor of this relation would be variable and complex in each pair in the herd. Therefore, the determinant factor of social organization could be varied with each experimental herd used, and could not be generalized. KUROSAKI (1976) has described the same conclusion in his review.

In this herd, animals in the high class DV and those in middle class had a certain spatial position in herd area. BEILHARZ and MYLREA (1963) suggested that high class animals had tended to move away from other herd mates, especially from the same class animals, though SYME *et al.* (1975) described how the cow was observed so closely by other animals of the herd as to be high social rank. The result of this study did not support either theory, but suggested the certain relation of social rank and spatial patterns of a resting herd on a pasture.

Summary

Observations on spatial behavior were taken on 41 grazing steers and heifers with mixed breeds. Grazing patterns, spatial patterns and environmental factors influencing them were investigated.

It was found that the area occupied by the grazing herd varied periodically and could be grouped into three sizes during the daytime. The area considered large sized was observed at dawn and dusk. For the rest of the time, the area seemed to be rather small. For the behavior pattern, the small sized area showed that the herd was mainly in resting form. The large sized area occurred in dawn and dusk grazing time of the herd, and middle sized area represented other grazing peaks. This diurnal pattern of the area occupied by the herd became clear two weeks after grazing began.

The size of the area varied from month to month. It increased in spring and autumn, and declined in summer. The ambient temperature seemed to influence this area. The effect of grass yield on the area occupied by the herd was suggested, but not obvious.

In small size area, in which the herd was resting, it was found that animals with high and middle social classes in the herd tended to maintain a certain spatial position in the herd area. The animals in high social class were usually found in the zone surrounding the core of the herd, and those in middle social class were in fringe zone. However this tendency was not statistically significant.

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放牧肉牛群における占有面積の季節変化と群構造について

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1) 2歳齢のホルスタイン種去勢牛24頭，ヘレフォード種雌及び去勢牛15頭，両種の雑種去勢牛1頭を使い，放牧開始直後の5月から10月まで，面積の異なる3牧区にて各月約17日間，日の出から日没時まで次の事項について観察記録した。すなわち占有面積，行動型，社会的順位及び群れの占有面積における各個体の位置などである。

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