The Influence of Experienced Cattle on Grazing Behaviour of Calves in the Novel Pasture

Michiru FUKASAWA, Shusuke SATO, Aya NISHIWAKI and Kazuo SUGAWARA

Graduate School of Agricultural Science, Tohoku University, Aoba-ku,
Sendai-shi 981-8555, Japan

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Abstract The objecting of this study was to examine and discuss how experienced cattle influence behaviour, especially grazing behaviour, of unexperienced calves. ① In experiment 1, 10 castrated calves and 2 cows were grazed in an artificial pasture for one month to familiarize and interact with each other. Then they were separated into 2 groups : one had 4 calves (M1) with 2 cows and another had 6 calves only (C1). Two groups grazed separately on each native pasture with vegetation similar to each other. Grazing time, travelling speed and variety of grazed plants and drinking frequency of calves were compared. C1 behaved nervously only at the beginning of grazing : they moved more, grazed less and they drank more than M1. Later calves in both groups behaved in the same way. ② In experiment 2, 6 grazing unexperienced calves and 2 grazing experienced heifers were grouped into 2 : one consisted of 2 calves (M2) with 2 heifers and another consisted of 4 calves only (C2). The 2 groups were each grazed on artificial pasture. Grazing time and rate of eating were compared between groups. Grazing time of M2 was significantly longer ($P < 0.05$) than C2. Rate of eating in M2 was significantly higher ($P < 0.01$) than in C2. It is thought that the existence of experienced cattle influences behaviour of calves under grazing situations.

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Recently, grazing has been reassessed from views of labor saving, efficient use of land and improvement of animal welfare. However, it has been indicated that there are some disadvantages of grazing in terms of production efficiency, such as climatic stress, instability of grass production, parasite infection, ingestion of plant poisoning. Growing calves are so influenced by those adverse conditions that their growth rates in pasture are lower than in shed, especially at the beginning of grazing. Therefore the technique of smoothly adapting calves to a new environment is very important for grazing management. Behavioural adaptation is more difficult than physiological and ruminal adaption¹⁴⁾. At the beginning of grazing, the behaviour of calves is disturbed, because they are suffering from environmental stress and adapting to new surroundings and foods. They have to cope with en-

vironmental impacts, adapt to their habitat, and become familiar with various edible plants.

Adaptation and learning are both influenced by social factors. Arnone and Dantzer¹⁾ reported that the presence of a companion appeared to moderate the impact of environmental stressors. The photographic images of their companion also suppressed isolation stress in sheep²³⁾. Even the existence of a caretaker suppressed conflict stress and isolation stress²¹⁾. Those results suggest that psychological stability is enhanced by the presence of a companion and that the companion plays an important role in suppressing environmental stress. In studies of gathering cattle by conditioned sound, Entsu⁴⁾ *et al.* showed that the existence of experienced cattle promoted the learning of unexperienced calves. In addition, social learning or imitative learning, a transfer of information from

Corresponding : Michiru FUKASAWA (fax : +81 (0) 22-717-8697, e-mail : fuka@bios.tohoku.ac.jp)

experienced animals to unexperienced, has been widely noticed on feeding behaviour. Many studies about social learning using sheep^{2, 3, 12, 16, 17, 22)} suggested that lambs learned which foods were edible from social models which were experienced adults. In these studies, the best models were nurturant and peers¹⁵⁾.

These results suggest the benefit of mixing adults which have abundant grazing experience with infant group which have no experience, even in cattle. The object of this study was to examine and discuss how experienced cattle influence behaviour, especially grazing behaviour of unexperienced calves.

Materials and Methods

Two experiments were conducted at the Tohoku University Farm, Naruko, Miyagi Pref., Japan. Subjects in experiments 1 and 2 were produced from a beef breeding herd and a dairy herd of the Tohoku Univ. Farm, respectively. Every year two herds were grazed from May to October and reared in a cattle shed afterward.

Experiment 1

The object of this experiment was to examine

whether grazing behaviour and plants species ingested by castrated calves were different between with cows and without cows on native pastures. Calves were born in summer on mixed pasture (mainly consisted of artificial pasture) in the previous grazing season. Seven Japanese Black (JB) and 3 Japanese Shorthorn (JS) castrated calves and 2 Japanese Black cows which had experienced several grazing seasons were used. Before this experiment, all of them were exposed to artificial pasture with forest of Japanese cedar and pine trees for about a month to get to know each other and to interact. As there were very few edible native plants in this forest because of lack of sunshine and coldness in this pre-experimental period, the animals spent most of their time on an artificial pasture. The experiment took place from 25 June to 27 June 1996. Calves were separated into 2 groups at random. The group M1 consisting of 3 JB and 1 JS calves (Body Weight : 224–262 kg, Average Age : 11.8 months old) was grazed with 2 cows (BW : 455 and 435 kg, AA : 49.5 months old). The group C1 consisting of 4 JB and 2 JS calves (BW : 200–258 kg, AA : 11.5 months old) was grazed without cow.

M1 and C1 were each grazed on one of 2 native

Table 1. Relative appearance frequency and the number of species in both experimental pasture

Group M1		
	Frequency (%)	No. of species
Japanese pampas grass	16.9	1
Bushes and tree	22.5	16
Broad-leaved grass	37.2	32
Carex and Gramineae except Japanese pampas grass	8.0	7
Pteridium	15.4	3
Group C1		
	Frequency (%)	No. of species
Japanese pampas grass	16.3	1
Bushes and tree	13.1	18
Broad-leaved grass	43.4	21
Carex and Gramineae except Japanese pampas grass	12.1	6
Pteridium	15.1	3

Table 2. Observation periods and their respective weather conditions on each day of investigation

(a) Experiment 1

Day	Observation periods	Weather
Day 1	12 : 30~16 : 30	Rainy, later cloudy
Day 2	5 : 00~16 : 30	Cloudy, occasional rainy
Day 3	5 : 00~16 : 30	Fair

(b) Experiment 2

Day	Observation periods	Weather	
		Group M	Group C
Day 1	13 : 00~18 : 00	Rainy	Fair
Day 2	first 4 : 00~11 : 00	Fair	Rainy
	late 11 : 00~18 : 00	Fair	Rainy
Day 3	first 4 : 00~10 : 00	Cloudy	Fair
	late 10 : 00~16 : 00	Rainy	Fair

pastures (50 m × 200 m), respectively. Two experimental pastures were set up in broad slope with no-grazing zone of 10 m distance between them. The no-grazing zone was dominated by bushes and trees so that the groups could not see each other and not influenced by each other's behaviour. Before grazing, plants were recorded every 4 m along five 200 m straight lines in each pasture. Numbers of plant species and frequency of each species were similar between the 2 pastures and the dominant plant species of both native pastures was Japanese pampas grass (*Miscanthus sinensis*) (Table 1). Observation period and weather of each day are shown in Table 2-a.

Grazing behaviour and ingested plants were investigated using a focal animal and instantaneous sampling method every 2 min. The focal animal was changed every 20 min to check grazing behaviour of all calves. Each of M1 with cows and C1 moved as a group. The location of the group was plotted on 1/1,000 map every 10 min except the first observation day because of observational trouble. The travelling route on the map was measured using a digital curvimeter. Travelling distance/observation time was compared between groups. Drinking behaviour, being considered not only maintenance behaviour but also adjunctive behaviour, was determined by contin-

uous sampling for all calves.

Five measurements as follows were compared between M1 and C1 by analysis of variance (GLM procedure : SAS Institute Inc., 1997) : (a) The time budget for grazing in observation time, (b) the number of drinking per hour, (c) the number of plant species ingested, (d) Simpson flexibility¹⁰⁾ of plant species ingested (as an index of variety of ingested plants), (e) the percentage of grazed Japanese pampas grass in the diet. Each data was pooled in each calf in each day. The effects of observation day, the group and their interaction were used as fixed effects. Measurements (a) and (e) were compared by parametric method and others by non-parametric method¹⁸⁾.

Experiment 2

The objective of this experiment was to examine whether time spent grazing and the organic matter intake (OMI) rate of unexperienced calves were influenced by the existence of heifers having grazing experience on artificial pasture. Six Holstein calves with no grazing experience and 2 Holstein heifers with grazing experience on artificial pasture for over at least 2 months, were used. Calves were separated into 2 groups according to body weight. The group M2 consisting of 2 calves (BW : 221 and 276 kg,

AA : 9.5 months old) was grazed with 2 heifers (BW : 522,481 kg, AA : 23.5 months old). The group C2 consisted of only 4 calves (BW : 126–333 kg, AA : 8.0 months old) was grazed without heifer. M2 was pastured in a paddock of 2,200 m² having standing crops of 201 g DM/m². C2 was pastured in a paddock of 1,980 m² having standing crops of 188 g DM/m². The dominant species of both pastures was orchard grass. M2 and C2 were investigated from 2 July to 4 July 1996 and from 5 July to 7 July 1996, respectively. Observation periods and their respective weather conditions on each day of investigation are shown in Table 2-b.

The grazing behaviour of each calf was checked using scan sampling every 5 min. The biting rate (no. of bites/min) of each calf was measured more than 5 times spanning over various grazing periods in order to estimate the organic matter intake (OMI) per minute by using Forbs' method⁶⁾.

The time budget for grazing and the OMI rate (mg OMI/min/BW^{0.75}) throughout the entire observation time were compared between M2 and C2 by repeated measure analysis of variance (GLM procedure ; SAS Institute Inc., 1997). Data was taken repeatedly from both groups during the experimental period. The effects of the observational period and the group were used as fixed effects.

Results and Discussion

Experiment 1

At the beginning, the animals ran around the experimental pastures. After that, they started grazing, at which time they looked almost calm. Calves and cows in both group were more spread out in the native pasture than in the artificial pasture. Cows led M1 and M1 moved and grazed more gregariously than C1.

The time budget for grazing

On Day 1, M1 started grazing about an hour after turned out, and finished grazing at the end point of observation. On the other hand, C1 walked around while observing the new pasture more seriously. They started grazing in the later half of the observation period on Day 1. The effect on the time budget for grazing of group ($F_{1,24}=9.41$, $P<0.01$), day

Table 3. The comparison of grazing time, drinking frequency and the variety of ingested plants between calves (M1) with cows and calves alone (C1)

(a) The time budget for grazing (%)

Group	Day 1	Day 2	Day 3
M1	64±15.1 ^a	44±12.5 ^b	40±5.4 ^{bc}
C1	40±7.1 ^b	27±1.1 ^c	46±9.9 ^b

(b) Drinking frequency/hour

Group	Day 1	Day 2	Day 3
M1	0 ^a	0.11±0.03 ^b	0.04±0.02 ^c
C1	0 ^a	0.20±0.05 ^b	0.20±0.05 ^{bc}

(c) The number of ingested plant species

Group	Day 1	Day 2	Day 3
M1	6.3±0.4 ^{ab}	11.0±1.1 ^c	8.0±1.9 ^{ac}
C1	5.0±0.5 ^a	8.7±1.2 ^{bc}	8.7±0.6 ^c

(d) Simpson flexibility of ingested plant species

Group	Day 1	Day 2	Day 3
M1	3.5±0.3	5.1±1.1	5.5±1.4
C1	4.3±0.6	5.0±0.8	5.5±0.6

(e) The percentage of Japanese pampus grass in the diet (%)

Group	Day 1	Day 2	Day 3
M1	33.3±7.6	34.8±10.7	29.5±4.0
C1	18.9±4.8	31.8±6.8	32.8±3.3

a, b, c Different superscripts in each table represent significant difference ($P<0.05$).

Each value represents mean±standard deviation.

($F_{2,24}=6.20$, $P<0.01$) and their interaction ($F_{2,24}=5.84$, $P<0.01$) were significant (Table 3-a). On Days 1 and 2, the time budget for grazing were significantly longer in M1 than in C1.

Travelling speed

At the beginning, the cows and calves ran around this experimental pasture. They began to walk in a usual pace⁷⁾ during Day 2, when M1 and C1 walked 2.6 m/min and 2.4 m/min, respectively. On Day 3, M1 and C1 walked 0.9 m/min and 1.3 m/min respectively. There was no difference between groups on each day.

Fig. 1. The time budget for grazing and OMI rate in group M2 (○) and in group C2 (△) in Experiment 2. Each symbol represents mean $\pm$ standard deviation.

Drinking

The effects on drinking frequency of group ($F_{1,24}=4.39$, $P<0.05$) and day ($F_{2,24}=22.71$, $P<0.01$) were significant (Table 3-b). C1 drank more frequently than M1. Falk⁵⁾ suggested that obstruction of intake brought out adjunctive behaviour. Adjunctive behaviour occurs when animals are under mental conflicts or frustration. Commonly, adjunctive behaviour is excessive grooming or drinking behaviours. It is said²¹⁾ that adjunctive behaviour has a calming effect for the agitation caused by mental conflicts or frustration. In this experiment, the sudden change of grazing environment might be an obstruction of their usual grazing behaviour and had the effect of accelerated drinking, which was thought of as an adjunctive behaviour. It is suggested that calves with cows might be psychologically more stable than without cows.

Ingested plant

Tables 3-c, d, e show that there were no significant differences between groups. Both groups grazed Japanese pampas grass more selectively than the other species of vegetation.

In experiment 1, the existence of cows hardly influenced the grazing behaviour of calves except at the beginning of native pasture grazing. It is said that selection of edible food and preference are seriously affected by experience before weaning¹²⁾. In this experiment, calves were born in the previous summer and had experienced grazing in the mixed pasture

(mainly consisted of artificial pasture) before weaning. In addition, calves had experienced another grazing season in the pre-experiment.

At the beginning of grazing, the behaviour was more disturbed in C1 than in M1. C1 moved more and grazed less. As empirically known, many incidents (e.g. escape from pasture) occur just after the start of grazing. The disturbance of behaviour, even if slight, should be paid attention from the view of behavioural management.

Experiment 2

Time budget for grazing

Figure 1-a shows that M2 grazed longer than C2 ($F_{1,4}=15.14$, $P<0.05$). Hafez⁷⁾ reviewed that grazing time was 4–9 hours per a day (17%–38%). Considering cattle scarcely graze at night, it is thought that time budget for grazing in M2 was at normal level, and in C2 was at a slightly low level.

OMI rate

Fig 1-b shows that M2 ingested organic matter more quickly than C2 ($F_{1,4}=21.28$, $P<0.01$). This might be attributed to the difference in a rate of biting between groups. Kobayashi *et al.*¹¹⁾ suggested that calves having no grazing experience have poor grazing technique and our result agreed with this. OMI rate differed between groups even in the last day, so it is needed to ascertain how long the effect of cohabitation with heifers lasts.

Ishii⁹⁾ reported that young cattle could learn “right grazing behaviour” and then they could gain higher

body weight. "Right" means an adaptive grazing pattern (e.g. when and where they start grazing and how long to spend) and the skills of efficient grazing.

Diffusion of grazing behaviour by social imitation was reported on many animals¹³⁾. Experience through imitation may lead to more efficient learning than trial and error. In experiment 2, it was suggested that imitation leads more to efficient grazing even in cattle.

Experiment 1 revealed that calves without cows were more psychologically disturbed than with cows, at the beginning of grazing. Experiment 2 revealed that grazing behaviour of unexperienced calves without heifer was less effective than with heifers. As previously suggested, we think that the different effect of experienced cattle on the calves' behaviour mainly derived from various previous experiences (feeding, handling, etc.) of the experimental calves.

In addition, the following factors may also be responsible :

① Breed : Sato *et al.*¹⁹⁾ showed that castrated Holstein calves behaved more cohesively than JB and JSs. It may be thought that Holstein cattle are easily affected by companionship.

② Geographic features : Geographic features were more complex in the paddock of experiment 1 than experiment 2. Native pasture used in experiment 1 consisted of ridges and slopes. Artificial pasture of experiment 2 was plain and simple. Hayashi⁸⁾ reported that the more complex geographic features were, the more spread out cattle were, and that cattle gathered on plain artificial pasture. It may be thought that cattle are easily affected by their companions on plain pastures.

③ Age difference between calves and experienced cattle : Age difference was 3 years in experiment 1 and 1 year in the experiment 2. Social learning studies revealed¹⁵⁾ that the best models were nurturant and peers. Psychological intimacy may be effective for social learning. Sato *et al.*²⁰⁾ showed that intimate relationships were made more easily among cattle when their age difference was within a year. In this case, heifers in experiment 2 might be effective as a social model.

It is concluded that the existence of experienced cattle influenced behaviour of calves due to psychological stability and imitation. It may be possible to reduce the stress of calves by rearing them with cows just after the start of grazing when many grazing incidents occur. We need to examine how soon calves can adapt to new environments under the existence of experienced cattle and how long these changes will be kept, even if calves are separated from them. It is also needed to examine how this difference affects the productivity of calves, especially growth on a long span view.

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