This study observed the behavioral characteristics of 122 steers in eight pens and 1,136 steers at six pastures. Nonhuman animals kept in pens performed less nutritive oral behaviors and more nonnutritive oral behaviors than animals kept at pasture. Although these could not be described as stereotypies, they did represent a replacement of nutritive oral behaviors by nonnutritive oral behaviors, rather than simply an increase in resting time. This could be indicative of a level of oral frustration. At pasture, there was a greater proportion of oral behaviors in animals with low pasture availability as compared to high availability, but this was an increase in nutritive oral behaviors rather than nonnutritive oral behaviors. Factors other than oral frustration—for example, rumen fill—probably drove this increase.
There is little documentation of abnormal oral behavior in steers (Sato, Nagamine, & Kubo, 1994) versus calves (Margerison, Preston, Berry, & Phillips, 2003; Kerr & Wood-Gush, 1987; Seo et al., 1998) and dairy cows (Redbo, 1990, 1992, 1993; Redbo, Emanuelson, Lundberg, & Oredsson, 1996; Redbo & Nordblad, 1997). The reason is that restricted feeding and housing are a common practice for calves and cows, leading to more abnormal oral behavior. Cross-sucking has been observed (Margerison et al., 2003) in calves who are highly motivated to suck. In tethered cattle, oral stereotypies like tongue rolling have been observed (Redbo, 1990; Sato et al., 1994).

In fattening enterprises in Japan, beef steers are group-housed in pens throughout all stages of production. Even though steers are allowed to move and access hay freely in their pens, it is possible that cattle fed a restricted quantity of high-concentrate diet and kept in a confined pen might show distinctive oral behaviors. So, in this study, we observed the oral behaviors of beef steers raised in either pens or in pastures, having different availability of grass.

**MATERIALS AND METHOD**

**Animals and Observation Procedure**

*Pen environment.* A total of 122 steers ages 7 to 11 months at one farm in Sano (36°N, 138.5°E), Tochigi Prefecture, Japan, were observed. Of these, 103 were Japanese Black × Holstein (F1) steers kept in 5 to 8 pens (each 6.0 m in width × 9.5 m in length) with between 12 and 16 steers (3.6–4.8 m²/head), and 19 Japanese Black (JB) steers kept in one pen (12.0 m in width × 9.5 m in length, with 6.0 m²/head). Each pen housing the F1 steers permitted access to a feeding alley (6.0 m in length) for grain feed, a wood trough (0.7 m in width × 1.8 m in length) for dry hay, a self-filling water bowl (0.5 m in diameter), and a resting space. The pen for JB steers allowed access to a feeding alley (12.0 m in length) for grain feed and dry hay, a self-filling water bowl (0.5 m in diameter), and a resting space. The pens used in this study were in a part of two open-sided buildings, and each pen was divided by a metal fence 1.4 m in height.

The steers were observed by scan sampling every 10 min during three mornings (from dawn until 11:50) and three afternoons (from 12:00 until dusk) during March 2004. The duration of all morning observations was 6 hr 10 min, whereas the minimum and maximum lengths of the afternoon observations were 5 hr 50 min and 6 hr 0 min, respectively. The observation was taken in turns by two experienced observers. The minimum and maximum temperatures during the six observations ranged from −1.2 to +5.7 (3.4 ± 2.7) °C to +10.3 to +24.4 (15.1 ± 5.9)°C, respectively. Stormy weather characterized by high winds and (or) precipitation was not encountered during any observations.
The steers kept in the pen environment were provided a commercial concentrate diet based on the average body weight in each pen, twice daily between 08:30 and 08:40 and between 15:40 and 16:00 at the feeding alley. The steers were also allowed free access to a trough containing Italian ryegrass hay. The dry hay was added to the trough at the same time as the concentrate diet was provided. The diet contained 57% of grain crops (corn, wheat flour, and soy flour), 18% of bran (corn gluten feed and wheat bran), 14% of plant-origin oil meal (soybean oil meal and rapeseed oil meal), and 11% of the other additives (alfalfa meal, molasses, calcium carbonate, and common salt).

**Pasture environment.** A total of 1,136 steers ages 5 to 15 months, kept continually at pasture on six commercial beef cattle farms near Dubbo (33°S, 148.5°E), New South Wales, Australia, were observed. The details of the farms are shown in Table 1. Observations were conducted on one farm in both 2003 and 2004 (C03 and C04, respectively) but on different animals each year. The majority of animals were British breeds and crosses, although there were some Santa Gertrudis and Santa Gertrudis cross animals.

The steers were continually at pasture with no housing and fed at times of their own choosing. One important difference was the amount of pasture available. A qualitative assessment of the pasture indicated that pasture quantity on two of the farms (Farms D and E) was low as indicated by the low pasture height and density. On another two of the farms (Farms A and B), pasture height and density were high. On the fifth farm (Farm C), the one that was studied in 2003 and 2004, pasture availability was intermediate.

The steers in a pasture were observed by scan sampling every 15 min over three mornings (from dawn until 11:45) and three afternoons (from 12:00 until dusk) at intervals of 3 or 4 days during August and September in 2003 and 2004. Minimum and maximum lengths of the morning observations were 5 h 45 min and 5 h 30 min, respectively, whereas the minimum and maximum lengths of afternoon observations were 5 h 30 min and 6 h 0 min, respectively. The observation was taken in turns by three experienced observers. Because pasture area was vast, the observers divided into two places so that they could observe subgroups of steers. For fear of disturbing steers' behavior, the observers moved away from steers and observed them by use of binoculars. The minimum and maximum temperatures during the six observations at each farm in 2003 ranged from 0.3 to 11.5 (4.1 ± 3.2)°C to 12.8 to 21.1 (16.0 ± 2.2)°C and from 0.2 to 14.1 (5.0 ± 3.3)°C to 13.4 to 27.2 (19.5 ± 4.2)°C, respectively, in 2004. During periods of inclement weather, observations were not conducted because such conditions caused the steers to curtail their activity and simply stand in the pasture until the weather passed. This has also been reported previously by Gonyou and Stricklin (1984).
<table>
<thead>
<tr>
<th></th>
<th>Farm A</th>
<th>Farm B</th>
<th>Farm C03, C04&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Farm D</th>
<th>Farm E</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Animal</strong></td>
<td></td>
<td></td>
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<tr>
<td>No. of subject cattle</td>
<td>56</td>
<td>120</td>
<td>500, 170</td>
<td>150</td>
<td>140</td>
</tr>
<tr>
<td>Mean no. of cattle observed</td>
<td>47.5</td>
<td>103.1</td>
<td>371.4, 166.6</td>
<td>143.4</td>
<td>125.1</td>
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<tr>
<td>Range of age (in months)</td>
<td>12–15</td>
<td>6–12</td>
<td>6–12</td>
<td>6–12</td>
<td>5–14</td>
</tr>
<tr>
<td>Breed</td>
<td>Murray Grey</td>
<td>Angus</td>
<td>Murray Grey</td>
<td>Shorthorn</td>
<td>Angus × Hereford</td>
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<td></td>
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<td>Angus × Hereford, Santa Gertrudis</td>
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<td>Angus × Santa Gertrudis</td>
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<td>Shorthorn ×</td>
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<td></td>
<td></td>
<td></td>
<td>Various crosses</td>
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<tr>
<td><strong>Pasture</strong></td>
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<tr>
<td>Grazing system</td>
<td>Continuous grazing</td>
<td>Continuous grazing</td>
<td>Rotational grazing (rotation every 2, 3 days)</td>
<td>Rotational grazing</td>
<td>Rotational grazing</td>
</tr>
<tr>
<td>Pasture type, area of paddock (ha)</td>
<td>Native pasture, 250</td>
<td>Native pasture, 250</td>
<td>Native pasture, 200</td>
<td>Native pasture, 420</td>
<td>Improve pasture&lt;sup&gt;b&lt;/sup&gt;, 40</td>
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<tr>
<td></td>
<td>Improve pasture&lt;sup&gt;b&lt;/sup&gt;, 50</td>
<td>Various pasture areas ranging from 60 to 150</td>
<td>Various pasture areas ranging from 60 to 150</td>
<td>Various pasture areas ranging from 60 to 150</td>
<td>Improve pasture&lt;sup&gt;c&lt;/sup&gt;, 40</td>
</tr>
<tr>
<td>Contexture (main grass)</td>
<td>Wild and pasture grass</td>
<td>Poaceous wild grass</td>
<td>Wild grass</td>
<td>Wild grass</td>
<td>Papilionaceous pasture grass</td>
</tr>
<tr>
<td>Grass height, density&lt;sup&gt;d&lt;/sup&gt;</td>
<td>Low, sparse</td>
<td>Low, sparse</td>
<td>Middle, moderate</td>
<td>High, dense</td>
<td>High, dense</td>
</tr>
</tbody>
</table>

<sup>a</sup>Farm C03 was observed in 2003, and Farm C04 was observed in 2004. <sup>b</sup>After harvesting. <sup>c</sup>Rusan. <sup>d</sup>Assessment by the experimenter.
Behavioral observation. Oral behaviors consisted of nutritive oral behaviors such as eating (grazing) and drinking and nonnutritive oral behaviors such as self-grooming, allogrooming, licking objects, and tongue rolling. Because of the distances involved and because the animals tended to form large groups when resting in the shade, it was difficult to determine whether they were ruminating or simply resting. For this reason, ruminating was recorded as resting. The other behaviors that we recorded were grooming with objects, moving, investigating objects, and agonistic, mounting, and excretory behavior.

Statistical Analysis

Although the observations in the pen environment were conducted on one farm, the data for the two breeds were analyzed as Farm F1 and Farm JB. The proportion of steers performing nutritive and nonnutritive oral behaviors and the other behaviors over the total period of the observations on each farm was analyzed using the chi-square test. A post hoc test was then performed using Tukey’s studentized range test to analyze the effect of farm on the proportion of steers performing each behavior.

RESULTS AND DISCUSSION

Nutritive and nonnutritive oral behaviors and the other behaviors of steers differed significantly from one farm to another, $\chi^2 = 7578$, $df = 14$, $p < .001$ (Figure 1). It can be seen that there is a decline in the proportion of steers performing nutritive oral behaviors as we move from the farms with low pasture availability (Farms A and B) to the two pens (Farms F1 and JB). This study showed that beef steers raised in pen and fed a restricted concentrate ration spent less time performing nutritive oral behaviors than steers raised at sparsely vegetated pasture. Especially in Japanese Black steers (Farm JB), the proportion of steers performing oral behaviors was small. It might be caused by their feeble appetite compared with crossbred steers.

The steers raised in pen, especially F1 steers ($p < .05$), might perform more nonnutritive oral behaviors than steers raised at pasture (Figure 1). However, the nonnutritive oral behaviors we observed were neither excessive ones nor stereotypies. In this study, the maximum proportion of performing tongue rolling per one day was only 1.11% in F1 steers. In our previous studies in which we used F1 steers at the same farm as this study, only a brief period of tongue rolling has been observed (Ishiwata, Uetake, Abe, & Tanaka, 2003). Sato, Sako, and Maeda (1991) also have reported that social grooming of calves kept in groups tended to increase when food was restricted. In our study, the steers were allowed to eat hay
and move freely, even though they were fed a restricted quantity of concentrate diet and kept in a bare pen. In calves kept in individual stalls, high frequency of self-grooming has observed (Kerr & Wood-Gush, 1987). More than 30% of the JB steers kept in stalls were reported to perform tongue playing (Sato et al., 1991). It has also been reported that tongue playing, grooming, and other behaviors with tongue movement appeared more for the calves raised in individual pens than for the calves raised in group pens (Seo et al., 1998). In tethered dairy cows, there were some reports that restrictive allowance of roughage and restricted feeding of a diet with high levels of concentrate increased oral stereotypies (Redbo et al., 1996; Redbo & Nordlad, 1997). Furthermore, it has been reported that tethered cattle almost stopped performing stereotypies after they have been released into pasture or loose barn, and they resumed high levels of stereotypies after the retethering post-grazing (Redbo, 1990, 1992, 1993). Oral stereotypies might occur when the steers were raised in a bare environment that limited social contacts and moving in addition to when the steers were fed restrictedly.

In fact, the total proportion of steers performing the behaviors other than oral behaviors in Farm F1 was not different from that in all farms in the pasture environment (Figure 1). In addition, on Farm JB, the total proportion of steers performing the other behaviors was not different from that on Farms C03, D, and E in the pasture environment (Figure 1). This means the total proportion of steers performing oral behaviors in pen was not different from that in pasture. The more nonnutritive oral behaviors did represent a replacement of eating by other oral behaviors, rather than simply an increase in resting time. This could be indicative of a level of oral frustration.

At pasture, there was a greater proportion of oral behaviors in steers on low pasture availability compared to high availability, although the significant differences were not shown among the farms (Figure 1). The level of oral behaviors was affected by nutritional quality and quantity of grasses in the pasture. This was an increase in nutritive oral behaviors rather than nonnutritive oral behaviors. This increase was probably driven by factors other than oral frustration, for example, rumen fill. It has been known that cattle on sparsely vegetated rangeland have longer grazing time (Phillips, 1993). Farms A and B had a sparsely vegetated native pasture. Most of the grasses in Farm A were poaceous wild grass. Grasses in pastures on Farms A and B were poor in nutritional quality compared with the other farms in the pasture environment. The proportion of steers performing nutritive oral behaviors reduced with better feed conditions.

CONCLUSION

In conclusion, steers in a pen environment under a restricted feeding period might compensate for a lower amount of time spent feeding by performing
nonnutritive oral behaviors. However, the level of nonnutritive oral behaviors was enough to compensate for the lack of feeding behaviors.

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