Grazing Behavior and Heart Rate of Young Thoroughbreds on Pasture

Yoshihiro OKUDA,* Yuhzo NAGATA,* Katsuyoshi KUBO,* Makoto KAI* and Akito TOKIMI**

The behaviors of Thoroughbred colts and fillies at pasture were observed and estimated with the telephoto-video-tape recorder and the telemeter in order to determine the "locomotion" of horses, grazing pattern and heart rate. In the locomotion a herd of horses which were turned out on the first day took a canter to recognize the environment for a few minutes, became gradually calm, and grazed for the rest of the period. The distance of cantering was 1.5 to 2.0 km. The behavior of environmental recognition diminished on the second day, when the rate of grazing period increased. The heart rate of the horses on the pasture was recorded by electrocardiography in order to determine the physical activity, in which it ranged from 50 to 60 beats/min in standing, walking and grazing. While trotting or cantering, it increased to 120 – 180 beats/min in accordance with the intensity of activities. The maximum heart rate recorded in pasturing was 31 beats/10 s during the behavior of "environmental recognition". The count of chewing (cutting grasses and mastication) revealed in the electromyogram of the masseter muscle was in a range from 1.0 to 1.7/s of grazing. In the colts the rate of grazing period was 87% on the first day and 98% on the second day. Kentucky blue grass was the most palatable for these horses.

For the growth and development, as well as the maintenance of health, of colts and fillies, it is of primary importance to make clear the availability of pasture or grassland through studies on their behavior. It is recognized that grazing on pasture may be effective for the nutrition and the development of the body, especially that of muscle, tendon and bone, in young horses. Therefore, it is required to analyze the behavior of these animals on pasture in relation to their environmental condition, social herd and activity.

Feeding behaviors have been observed in some species, including cattle, sheep and chickens. Several papers have also been published on the feeding behavior of horses. Archer studied the palatability of grasses, legumes and herbs for horses and proved a clover-rich dryland mixture to be the most palatable. Collery, Waring et al., Ödberg and Francis-Smith, and Feist and Mc-
Cullough\textsuperscript{17}) observed the behavior of equine animals under farm and feral conditions and discussed activity patterns and maintenance, reproductive and social behaviors. Randall et al.\textsuperscript{18}) performed research on the response of horses to tastes. Ralston et al.\textsuperscript{19}) reported the relationship between feed intake patterns and blood glucose, free fatty acid or insulin changes. There are, however, few reports published to evaluate the significance of the pasture from the viewpoint of both intake of nutrients and physical fitness of horses.

The activities of horses on pasture must have been influenced by some factors, such as acreage and vegetation of pasture, the community of horses, the time of pasturing and climatic conditions. The present study was conducted to investigate the relationship between activity pattern and heart rate in horses on the limited pasture, and to confirm the effect of different vegetation on grazing behavior.

**Materials and Methods**

The pasture used in the present investigation belongs to the Utsunomiya Rearing Farm, Japan Racing Association, and is approximately 5 000 m\textsuperscript{2} of mostly plain grassland. It was divided into three fields after cultivated at the end of September, 1978. The three fields were sown with orchard grass, Kentucky blue grass and Italian rye grass, respectively, as shown in Fig. 1. After the harvest of the first crop in May, 1979, this experiment was started when grasses became 15–20 cm tall again.

The experimental animals used were ten two-year-old Thoroughbred horses, five colts and five fillies. The five colts were grazed on a pasture in the morning and the five fillies on the same pasture in the afternoon. The behavior of the horses on pasture was observed for 75 to 100 min. The telephoto-video-tape recorder was set outside the pasture. To confirm the location of the horses, photographs were taken at intervals of 30 s with a wide-angle lens from another place. All the gaits shown by each horse were recorded to study the locomotion. The other types of behavior observed consisted of grooming, rolling, pawing and resting (staying motionless and drowsy, standing and lying). The electromyogram (EMG) of
the cheek muscle, or the masseter muscle, was recorded to determine grazing patterns and selectivity of grasses. Besides, the electrocardiogram (ECG) was also recorded by a 4-channel telemeter (San Ei Sokki Co., Ltd.) to study the heart rate as a parameter of the activity. ECG was conducted with the bipolar chest lead. The attachments used are shown in Fig. 2. Two colts and two fillies served for recording of EMG and ECG. The experiment was carried out on June 5 and 6, 1979, when it was fine.

Results

Physical activity patterns. Figs. 3 and 4 show the “locomotion” of one of the five colts on the first and the second days when all the colts were grazed on pasture. The colts were moving about in a group most of the time. So they were represented by Horse No. 101. When this horse was placed in the first field, it moved continually on trot, canter or gallop for a few minutes, as shown in Fig. 3. At first, it moved on canter for approximately 4 min and on trot nearly for 1 min, or at a distance of about 1.5 km. Then, it became calm gradually and began to graze. The grazing behavior was shown in the rest of pasturing, with occasional aggression, idling, resting and excretion. On the second
day the horse became so familiar with the pasture that it was comparatively quiet from soon after pasturing. The behavior of grazing and idling was occupied.

Figs. 5 and 6 show the "locomotion" of Horse No. 201 on the first and the second days when the horse was grazed on pasture with four fillies as another herd. The five fillies were rather active at the beginning of the first day, and took canter or gallop for approximately 4 min and trot for nearly 2 min, covering a distance of about 2 km. They ran along the fence several times, became calm gradually, and began to graze. They showed almost the same behavior as colts on the second day. Tables 1 and 2 present the rate of appearance of behavior among the time limits of pasturing on the first and the second days.

Grazing patterns and selectivity of grasses. Fig. 7 shows ECG and EMG recorded by telemetry in pasturing. Table 2 presents the grazing period and movement of the masseter muscle (the chewing count, including cutting grasses and mastication) of two colts, Nos. 102 and 103, and two fillies, Nos. 201 and 202. The chewing count ranged from 1.0 to 1.7/s, or 1.4/s on the average, during grazing. The rate of grazing period was nearly 87% in the colts on the first day and in the fillies ap-
proximately 91% on the first day. When the grazing duration was estimated from EMG of the masseter muscle in both colts and fillies, it averaged 3'36" on the first day and 6'02" on the second day.

As far as the selectivity of grasses in horses was concerned, three kinds of grasses, orchard grass, Kentucky blue grass and Italian rye grass, were provided. The selectivity of grasses in horses was conjectured from the place of grazing and the length of the respective grazing period measured from EMG of the masseter muscle as a parameter of palatability of grasses. The grazing period in the division of two colts or two fillies is shown in Table 3. Kentucky blue grass exhibited a higher palatability than any other grass.

Heart rate. Fig. 8 shows changes in heart rate in horses showing various behaviors in the pasturing period. Figs. 9 to 10 present the response of heart rate in colt No. 102 and filly No. 202 on pasture on the first and the second days. The heart rates in standing, walking and grazing showed comparatively small changes, ranging from 50 to 60 beats/min. In trotting and cantering the heart rate...
increased to a range from 120 to 180 beats/min in accordance with the intensity of activities. In the primary experiment where horses were turned out into the pasture for the first time, the heart rate during cantering increased to 31 beats/10 s in colt No. 102 after 4 min of pasturing, but this heart rate did not continue. In filly No. 202, the heart rate rose to 27 beats/10 s 2 min after the start and was kept in a range from 25 to 28 beats/10 s during cantering. The sum of heart rate in the colt in pasturing was 3 590 beats/h on the first day, while the total of this rate in the resting state was 2 550 beats/h.

**Discussion**

Experimental colts and fillies were turned out with the same herds on other pastures until the day before the experiment. Therefore, the pasture provided with this study was primary experience for them. The horses were running at first for a few minutes. Although they were moving about parallel with the fence, they were also observed cantering in the middle of the pasture. This random behavior might have been taken not only to recognize an unknown environment, but also to control themselves from the sense of uneasiness,
which might be defined to be the behavior of “environmental recognition.” It is supposed to be very changeable in accordance with various types of acreage and environmental conditions. The heart rate during cantering in this behavior increased to nearly 180 beats/min at a maximum. Tatsumi et al.\(^{21}\) stressed the significance of heart rate as an index of the labor intensity of horses. They recognized the relative coefficient of significance between the consumption of oxygen and the heart rate, that was +0.83. The work load in their experiment was at a maximum speed of 120 m/min. The report of Tatsumi et al., however, might be able to apply to the physical activities of horses at pasture. Ehrlein et al.\(^{22,23}\) noted that the racing speed in horses was related to the heart rate. According to them, the

<table>
<thead>
<tr>
<th>Table 1. Rate of various behaviors in pasturing (%)</th>
<th>1st day</th>
<th>2nd day</th>
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<tbody>
<tr>
<td>Grazing and Idling</td>
<td>87.6</td>
<td>91.6</td>
</tr>
<tr>
<td>Trotting</td>
<td>1.4</td>
<td>2.0</td>
</tr>
<tr>
<td>Cantering</td>
<td>5.6</td>
<td>4.1</td>
</tr>
<tr>
<td>Others</td>
<td>5.4</td>
<td>2.3</td>
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| Table 2. Grazing period and chewing count |
|-----------------------------------------|---------|---------|---------|---------|---------|
| No. 102                                 | 1st     | 2nd     | 1st     | 2nd     | 1st     | 2nd     | 1st     | 2nd     |
| Pasturing period                        | 76°00"  | 76°31"  | 76°00"  | 76°31"  | 97°37"  | 90°30"  | 97°37"  | 90°30"  |
| Grazing period                          | 66°35°  | 74°43"  | 66°38"  | 75°27"  | 89°25"  | 90°01"  | 88°57"  | 89°32"  |
| Total chewing count                     | 6429    | 6487    | 4136    | 4866    | 8748    | 9207    | 7470    | 7812    |
| Average chewing count per s of grazing  | 1.60    | 1.44    | 1.03    | 1.07    | 1.63    | 1.70    | 1.39    | 1.45    |
| Grazing/Pasturing (%)                   | 87.60   | 97.67   | 87.67   | 98.60   | 91.59   | 99.50   | 91.12   | 98.90   |

| Table 3. Grazing pattern and selectivity of grasses |
|-----------------------------------------------------|---------|---------|---------|---------|
| No. 102                                             | 1st     | 2nd     | 1st     | 2nd     | 1st     | 2nd     | 1st     | 2nd     |
| Kentucky grazing time                               | 26°46"  | 37°51"  | 20°20"  | 34°25"  | 59°18"  | 75°54"  | 59°16"  | 76°33"  |
| (50.6%)                                             | (45.6%) | (84.3%) | (84.3%) | (84.5%) |
| orchard grazing time                                | 22°23"  | 24°21"  | 20°15"  | 8°31"   | 5°29"   | 9°25"   | 5°28"   | (6.1%)  |
| (32.8%)                                             | (26.8%) | (6.1%)  | (6.1%)  | (6.1%)  |
| Italian rye grazing time                            | 17°26"  | 12°22"  | 23°57"  | 20°47"  | 21°36"  | 8°38"   | 20°16"  | 7°31"   |
| (16.6%)                                             | (27.8%) | (9.6%)  | (8.4%)  | (8.4%)  |
| Pasturing period                                   | 76°00"  | 76°31"  | 76°00"  | 97°37"  | 90°30"  | 97°37"  | 90°30"  | (9.6%)  |

Remarks. In parentheses indicate the rate of each grazing time to pasturing period.
cantering speed at the heart rate of nearly 180 beats/min was determined to be 600 m/min. Then, the physical activity of cantering at the beginning of pasturing in the present study was evaluated to be considerably intensive. The behavior of cantering on pasture, however, did not consist of enduring hard exercises in this study. As far as the recovery of the heart rate after intensive activity was concerned, the heart rate which increased to 31 beats/10 s decreased to 13 beats/10 s approximately 2 min after the horse finished cantering.

The acreage in the present study was comparatively narrow for a herd of horses. Then it was estimated that both time and distance of the “environmental recognition” behavior were considerably short, as compared with grazing time. It is an interesting problem, however, whether these factors may be changeable to a certain extent in accordance with the width of acreage of pasture. Of course, the intensity of physical activity should bring a change accompanied with it.

The horses became calm gradually and began to graze after the behavior of “environmental recognition”. The heart rate in the grazing period increased by 10 to 20 beats/min in addition to the value of resting. During grazing, emotional factors, such as threatening by some noises from the circumference, appeared sometimes to increase the heart rate transiently.

On the second day most horses recognized the pasture and their activities became almost calm. In the colt the sum of heart rates on the first day was 1.41 times as much as that in the resting state. In the filly it was 1.45 times as much as that in the resting state. On the following day it lowered 1.12 times in the colt and 1.09 times in the filly. So that, the horses
were surmised to have been comparatively quiet.

As far as the grazing pattern of the horses are concerned, the intake of grasses may depend upon growing conditions of the grassland, but the mastication in horses presented from 1.0 to 1.7 counts/s in this experiment. These counts agreed with the results of Waring et al. Grazing period which were conjectured from the chewing counts in pasturing were observed to change a little in the colts between the
first and the second days, but change little in the fillies. The rate of grazing period to pasturing one in the present study was comparatively high. Ödberg and Francis-Smith\(^6\) observed the behaviors of adult horses in training, breeding mares and foals in pasturing for 2 h. According to them, the rate of grazing period to pasturing one was considerably high, or 82% in adults, while the rate of grooming and playing was 42% and that of grazing only 21% in foals. The fol-
lowing reasons are surmised why the behavior of grazing in the present study was rather high in rate. (1) Experimental horses were 2 years old, or nearly adult. (2) Environment of the circumference was easy and calm. (3) Growing conditions of the grassland were palatable for horses. (4) Grouping of horses was adequate. (5) The weather was fine.

The grazing duration tended to be a little longer in fillies than in colts. When the horses were turned out on the same pasture day after day, they were generally accustomed to the grassland and would take in palatable grasses exclusively.

Strictly speaking, selectivity of grasses in animals should be speculated to have effects of various factors, such as the location of exit, the wind, the soil condition, and the pile of droppings. It may be, therefore, difficult to judge it only from the quantity of intake or the length of grazing period. Ödberg and Francis-Smith\(^{16}\) noted that adult horses avoided tall grasses and liked to eat short ones, but that foals not always revealed a selectivity of short grasses. Archer\(^{13}\) also reported that grasses around feces were not taken in by any horse. This observation was carried out only to study the effect of different vegetation on the grazing pattern of horses.

When the grazing period was regarded as 100%, the selectivity of colt No. 102 was 40.2% for Kentucky blue grass, 33.6% for orchard grass and 26.2% for Italian rye grass on the first day. On the second day the selectivity of Kentucky blue grass increased to 50.6% in this horse, which implied that this grass was of good palatability. There was the same trend in colt No. 103. This colt selected Kentucky blue grass by 29.6% on the first day, but by 45.6% on the second day. The selectivity of Kentucky blue grass was especially remarkable for the fillies. Both fillies, Nos. 201 and 202, liked this grass by nearly 66% on the first day and by approximately 85% on the second day.

The reason is not known why the palatability of Kentucky blue grass was higher than that of orchard grass or Italian rye grass. Kentucky blue grass may be fit for pasturing horses, as it expands with underground-stems and forms compact, mat-like cushions at a ground level. Marten\(^{20}\) reported that sensitivity to various factors of palatability was different with species of animals and presented an individual difference, and that some compounds, such as alkaloids, in grasses might be related to selectivity. Marten\(^{20}\) concluded that the relative coefficient between the palatability and the concentration of alkaloid was \(-0.88\) in sheep and \(-0.77\) in cattle. As far as the horse is concerned, further studies will be required.

Besides, further research will be needed on the relationship between the physical activity evaluated from the heart rate and the metabolism of energy.

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Literature Cited


放牧地における若馬の食草行動ならびに心拍数について

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甲斐 真*・時見明人**

放牧地におけるサラプレットの行動を、望遠付ビデオレコーダーおよびテレメーターを用いて観察記録し、馬の動き、食草行動時間、牧草の選択性を調査すると共に、心拍数を測定し、心拍数からみた生体負担度について検討を試みた。

動線として描かれた馬の動きをみると、初めての放牧地に放された馬群は、環境認知のため、数分間駆け回り、やがて落ち着いて食草行動に入った。この環境認知行動の運動距離は 1.5～2.0 km であった。2 日目になると、環境認知行動は著しく少なくなった。

放牧時心拍数は、駐立、常歩および食草時 50～60 回/分で比較的変動が少なかった。一方、速歩ならびに騒歩時には、心拍数は 1 分間 120～180 回まで上昇し、運動の強度に応じて増加していた。環境認知行動のとき、放牧時の最高心拍数に増加しており、31 回/10秒まで達していた。

咬筋の筋電図により咬数（食いちぎり及び咀嚼）を調べると、食草 1 秒間当りの平均咬数は 1.0～1.7 回で、咬数から放牧時間帯における食草時間の割合を推測すると、雄馬で初日 87%，2 日目で 98% であった。

また、咬数から見た牧草の選択性では 3 品種の中でケンタッキーブルーグラスが最も嗜好性が高かった。

放牧時における馬の生体負担度を比較するため、放牧時間帯の積算心拍数をみると、初日の雄馬で、安静時の 1.4 倍、雌馬で 1.45 倍となっており、これが 2 日目になると雌雄とも 1.1 倍に下っていた。

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