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Research Article

Movements of Hokkaido Native Horses in Pasture under Continuous Grazing Conditions with GPS Loggers: A Preliminary Study

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Abstract

The Hokkaido native horse is one of eight breeds endemic to Japan. However, only 1,083 of these horses were registered in 2021, indicating that the breed requires protection. To ensure effective protection, more knowledge is needed, especially about the behavior of the horses while grazing. Therefore, to clarify their behavioral characteristics, we used a Global Positioning System logger to record the routes taken by a herd of native Hokkaido horses while moving around their grazing land. The experiment was conducted in the pastures of the Hokkaido native horse breeding ranch in Memuro, Hokkaido. Here, a herd of 70 Hokkaido native horses grazes on a site of approximately 80 ha from spring to autumn when the forage is abundant. Records were made between May and October of 2019. The temperature and related humidity were also recorded hourly during route tracking. The speed during recording was 6.1 km/h to 35.2 km/h. When the speed exceeded 30 km/h, the herd was moving at a gallop or canter due to the effects of management. The herd did not move on a specific route on a regular basis, and it could not be said that the temperature and humidity affected the route taken by the horse herd. In this study, some features of the behavior of the Hokkaido native horse under grazing management were clarified.

Keywords: Route Tracking, GPS, Hokkaido Native Horse, Grazing Management, Behavior

Abbreviations

GPS: Global Positioning System

Introduction

The Hokkaido horse is a pure-bred horse endemic to Japan. Among Japanese native horses, Hokkaido horses are most commonly used for horseback riding, trekking, and equine therapy. They are highly suitable for beginners because of their small stature (their body height is ≤ 140 cm), comfortable yet fast gait [1], and mild temperament [2]. However, only 1,083 Hokkaido native horses were registered in 2021 [3]; this is a very small number, indicating that the breed needs to be protected. Therefore, appropriate protocols for breeding and management are necessary. For this purpose, it is necessary to obtain sufficient knowledge about the Hokkaido horses and clarify their behavioral characteristics. In this study, we investigated the behavior of horses using a Global Positioning System (GPS) data logger in a group of Hokkaido native horses, where approximately 70 horses were grazing in groups.

The Hokkaido Japanese horse breeding ranch where the experiment was conducted is located in Memuro, Hokkaido. Here, a herd of Hokkaido native horses grazes on a site of approximately 80 ha from spring to autumn when the grass is abundant. Horses on this ranch freely eat grass and bamboo grass (*Sasa senanensis*) in the grasslands and forests on the premises. Humans provide a minimal amount of feed (only concentrate), and the horses drink water from the rivers. Therefore, there is almost no human interference. The managers arrange that one stallion is present in the herd, but otherwise, there is almost no human interference in breeding and parturition and subsequent foal breeding and weaning. A ranch such as this, where a large number of horses are bred in a state close to nature, is rare in Japan. Therefore, this ranch provided the opportunity to investigate the behavior of Hokkaido native horses free from anthropogenic effects or human interventions that could influence their behavior.

In previous studies, GPS data loggers have been used for Thoroughbred horses to investigate training loads [4] and stride length during canter and gallop [5]. In addition, horse behavior surveys in rangelands using GPS data loggers have also been conducted in Thoroughbreds. These include surveys of behavioral changes in foals and their dams as the foals grow older [6] and surveys of distances between dams and their foals [7]. However, Thoroughbred surveys are often conducted on managed rangelands and are susceptible to anthropogenic influence. Studies of pasture lands, including forests, such as the ranch where this experiment was conducted, have been conducted on ponies [8] and Yonaguni horses [9]. Regarding Hokkaido Native horses, comparisons of foraging behavior with mixed breeds in mountain forests [10] and the effect of snowfall on foraging behavior [11] have been reported. Nevertheless, no studies have yet examined the movements of Hokkaido native horses in conditions with almost no anthropogenic influence. The purpose of this study was to clarify the characteristics of the behavior of Hokkaido native horses by investigating their movements across grazing land in near-natural conditions.

Materials and Methods

Experimental location and period

The experimental procedures followed the Guide for the Care and Use of Agricultural Animals of Obihiro University (Obihiro, Hokkaido). The experiment was conducted in a pasture (approximately 47 ha) and a paddock (approx. 0.5 ha) of a Tsurugizan natural horse park, Hokkaido Japanese horse breeding ranch (total site area: approximately 80 ha) in the town of Memuro, Hokkaido (Figure 1). The horses could move around the pasture without restriction. The pastures were dominated by timothy (*Phleum pratense*), orchard grass (*Dactylis glomerata*), Kentucky bluegrass (*Poa pratensis*), and meadow fescue (*Festuca pratensis* Huds.), white clover (*Trifolium repens*), and shepherd wheat (*Elymus repens*). Using GPS data loggers, tracking records of horse herd locations were obtained from May to October 2019.

Figure 1a: Location of Tsurugizan Natural Horse Park, the experimental breeding ranch.

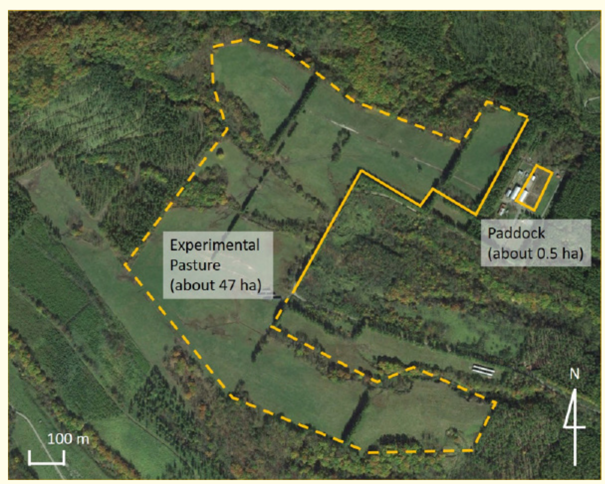

Figure 1b: Aerial image of pasture used for experiment (47 ha) and paddock (0.5 ha).

The solid line shows the fence constructed by the owner that horses cannot pass through. The broken line shows the vertical line for tracking area. The total area of the ranch is 80 ha, including the forest and pasture beyond the photographed area.

Test animal

The herd consisted of a stallion, a dam and her foal, 20 unpregnant mares, and 10 geldings. The number of horses in the herd increased and decreased with the birth of foals and the sale of horses but remained at approximately 70 during the experiment. One mare (estimated age: 10 years) was selected from the group of horses and fitted with a GPS data logger attached to a halter. The mare had foaled prior to the experiment and was nursing a foal approximately 2 months old at the start of the investigation; the GPS data logger and its attachment are described below.

Feeding and breeding management of the test animals

During the experimental period, the horses grazed day and night continuously on a pasture on a farm of approximately 80 ha. In addition, there is a paddock (0.5 ha) for gathering the entire herd in the morning for management work using concentrate. The paddock is fenced so the manager can limit their range of movement. Management work in this context means that some horses need to be separated for various purposes (e.g., health check, show riding for sales). The breeding management at the farm was natural mating, with stallions always present in the herd. There was little human intervention in foaling and subsequent rearing of foals.

Equipment used and data processing

The horse's movement path was recorded using a GPS data logger eTrex10 (Garmin International Inc., 1200 E. 151st St. Olathe, KS 66062-3426, USA). The latitude and longitude were recorded approximately once every 10 s. The eTrex10 was placed in a waterproof bag and attached to the halter at the top of the horse's head (Figure 2). The start and end recording times were not constant because of the ranch management and changes in the sunset time. The eTrex10 was attached to the horse at the beginning of route tracking and recovered at the end of the route tracking. Temperature and humidity were recorded hourly during route tracking using a testo410 (Testo Co., Ltd., Shin-Yokohama, Kohhoku, Yokohama, Kanagawa, Japan).

The latitude and longitude data collected by the eTrex10 were visualized by combining them with aerial photographs of the ranch using Google Earth Pro. Microsoft Excel 2016 was used to process the movement speed, temperature, and humidity. R (version 4.1) was used to compare the maximum speed.

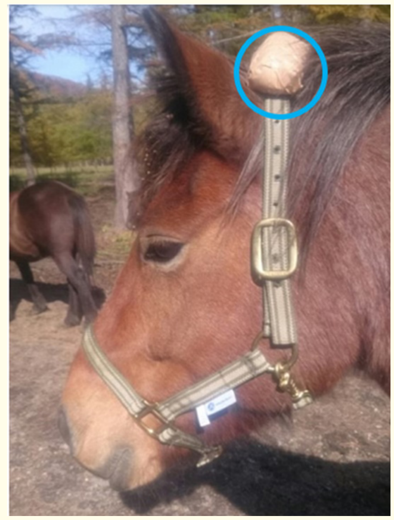

Figure 2: A GPS data logger attached to a horse. The circled area indicates the GPS data logger.

Results and Discussion

The maximum and minimum temperatures and maximum and minimum humidity for the day and days of recording are shown in table 1. In addition, the average hourly speed was calculated from the distance traveled and recording time measured by Google Earth Pro. The distance traveled per day is shown in table 2. Finally, the daily travel routes were plotted on aerial photographs and visualized, and examples are presented in figure 3. The following examples are shown: a day when the horses were thought to have moved at a trot or canter, but the reason for this was unknown (May 28); a day when the speed of movement was particularly slow (June 25); a day when the horses were moved to the paddock for management work and were thought to have moved at a trot or canter at that time (July 6), and the day when the horse spontaneously moved to the paddock and were thought to have moved at a trot (October 30). All days on which routes were recorded were classified as one of the four cases.

The maximum speeds recorded by eTrex10 are shown in figure 4. The minimum speed was 0.2 km/h on all days. This was considered to be the lowest speed that the eTrex10 could measure and reflects periods when the horses were moving very slowly, for example, while foraging.

Day	Max Temperature (°C)	Min Temperature (°C)	Max Humidity (%RH)	Min Humidity (%RH)
May 28	30.1	21.7	60.3	35.3
Jun 10	19.5	17.2	65.9	61.8
June 25	25.3	20.4	74.3	58.7
June 29	17.1	12.6	84.7	64.1
July 6	23.5	17.7	88.6	60.3
August 18	28.5	20.9	87.4	63.2
August 26	25.9	19.8	76.8	54.8
September 6	28.8	22.1	74.7	49.2
September 28	26.2	19.1	73.4	44.8
October 30	16.2	11.3	42.3	39.5

Table 1: Maximum and minimum temperature and maximum and minimum humidity of the recorded day.

Day	Start	Finish	Duration	Distance (km)	Average Speed (m/h)	Amount of Movement (km/day)
May 28	11:34	18:38	7:04	4.99	705.83	16.94
Jun 10	13:44	16:44	3:00	1.24	412.98	9.91
June 25	11:03	14:47	3:44	0.98	262.90	6.31
June 29	10:42	17:14	6:32	2.41	369.41	8.87
July 6	10:54	18:13	7:19	4.51	615.74	14.78
August 18	10:02	18:38	8:36	4.99	579.99	13.92
August 26	9:23	17:45	8:22	4.51	538.47	12.92
September 6	10:53	17:31	6:38	3.70	557.89	13.39
September 28	12:04	16:59	4:55	1.93	392.71	9.42
October 30	10:40	15:59	5:19	3.54	665.79	15.98

Table 2: Recording start and finish times and travel distances recorded by GPS loggers, as well as calculated average speed and amount of movement.

Figure 3: Example of a travel path for the target horse. “S” indicates the start point and “G” indicates the end point. The arrows indicate the movement of the horses into the paddock, the solid lines indicate movement at a trot or canter due to management work, and the dotted lines indicate spontaneous movement at a trot. The dotted and solid lines were determined from the GPS data.

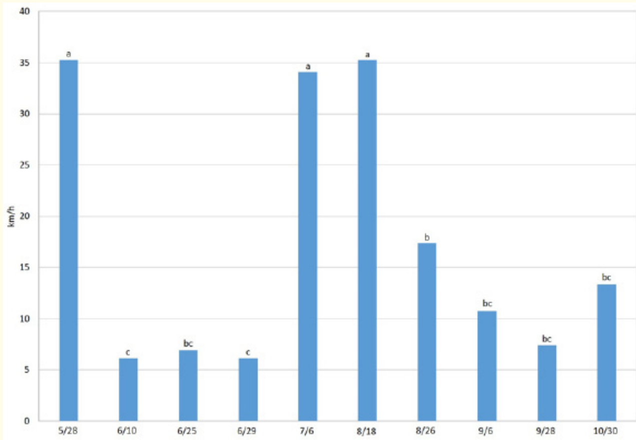

Figure 4: Maximum speed on each tracking day.

a,b,c: Significant difference between different letters ($p<0.05$)

On two of the three days when the maximum speed was significantly ($p < 0.05$) faster than on the other days (July 6 and August 18), the horses had been moved into the paddock for management work. This is indicated in Figure 3 (July 6) by the "S" mark indicating the place where measurement started, which is away from the paddock, and the arrow, which points toward the paddock. The horses at this ranch were conditioned to return to the paddock by the sound of the owner's vehicle horn and the concentrate, and the herd often moved at a trot or a canter at this time, resulting in a maximum speed of approximately 30 km/h. The only other day when the maximum speed exceeded 30 km/h was May 28. The horses were likely to have been moving at a trot or canter on this day, but they did not move to the paddock, and the cause of this fast pace could not be clarified.

For the next two days, when the movement speed was faster (August 26 and October 30), the horses moved from the starting point of the measurement to the paddock and then moved through the pasture. On these two days, it was recorded that the horses moved to the paddock voluntarily, without being encouraged by the ranch management. The other day when the maximum speed exceeded 10 km/h was September 6. On this day, the horse with the GPS moved spontaneously and stayed in the paddock as above. When the horse returned to the pasture after staying in the paddock, it appeared to move at a fast-walking speed on occasions when no management work was involved. However, on June 29, the horses moved from the pasture and stayed in the paddock spontaneously, but the maximum speed was 6.1 km/h. The reason for this was not apparent. Comparing the records for these four days, the movement route after returning to the pasture from the paddock differed every day, suggesting that the horse herd did not regularly travel around the pasture on a fixed route. Therefore, we concluded that the horse herd somehow determined the direction and speed of movement, but the precise method could not be established in this study. Further research is needed on this topic, and more details are given in the Conclusion section.

On the two days (June 10 and June 25) when the maximum movement speed was significantly ($p < 0.05$) slower than on other days, it was thought that the horses were moving while foraging. They were not moving due to management work or traveling at a gait faster than a trot. In experiments with Thoroughbred horses, the amount of movement in the pasture per day has been reported to be 9.7–15.2 km/day for foals and 10.1–16.4 km/day for dams (6). In the present experiment, the speed of the target horse (the mare with her foal) ranged from 6.1 km/h to 35.2 km/h. On days when the herd was affected by management and cantered to the paddock, their movement speed was much faster than previously reported, about the same as previously reported when foraging with movement, and slower than previously reported when only foraging. This may be due to differences in the breed (Thoroughbred and Hokkaido native) and grazing environments.

The reason for limiting the measurements in this study to daytime was that the ranch was vast and included mountain forests, as shown in Figure 1b. If the GPS data logger was to fall off in the forest at night, there was a possibility that it could not be recovered. In addition, there were days when the horse shook off the GPS data logger together with the halter while moving, making measurement impossible, and these events were not included in the analysis. If a method of attaching GPS data loggers to horses over a long period without burdening the horses and without using a halter becomes practical, it will be possible to record movement routes at night and over several consecutive days, even in terrain like that used by the horses in this study.

Conclusion

This study revealed some aspects of the behavior of the Hokkaido horse under herd grazing management. The study was made under natural conditions, so the results show the "natural" behavior of this native horse. Knowing the natural behavior of the Hokkaido horse is essential for the conservation of the breed, so it is believed that this research can contribute to the preservation of the Hokkaido Japanese horse.

In the future, more experiments are needed, such as increasing the frequency of tracking, extending the tracking time to record the movement path even at night, and conducting more detailed observations such as tracking over several consecutive days.

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Conflict of Interest

All authors declare that they have no conflict of interest.

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