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Monitoring Body Length of Hokkaido Native Horse's Foals Using a Drone

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Abstract

We investigated the possibility of using drones to monitor the growth of Hokkaido native horse's foals for approximately 10 months. Twenty-two native Hokkaido native horse foals, born between December 2018 and September 2019 and their dams were observed with a drone (Mavic 2 Pro) from May to October 2019. Data from the 0–10-month-old foals were used. Body length was measured from the recordings using Image J software. Logarithmic growth curves with a good regression coefficient were produced using body lengths measured by the drone. It is therefore possible to measure the relative body lengths of native Hokkaido foals using a drone.

Keywords: Body length; Drone; Growth management; Native Hokkaido horse

1. Introduction

The Hokkaido native horse (mainly bred in Hokkaido) is one of the eight native horse breeds endemic to Japan, and it has not been crossed with any foreign horse breeds. Their body heights are≤ 140 cm. Among the Japanese native horses, native Hokkaido native horses are most used for horseback riding, trekking, and horse therapy. They are well-suited for beginners due to their small stature, comfortable yet fast gait [1]and mild-mannered. temperament [2] However only 1,083 Hokkaido native horses were registered in 2020 [3]. this is a very small number, and it indicates that this breed needs to be protected. Therefore, tools for proper breeding and management are necessary.

Regular weight measurement is important for maintaining horse health [4]. However, horse weighing scales are expensive, and there is a concern that the restraints necessary during measurement may be stressful to the horses. In addition, it is usually impossible to measure the weight or assess physical condition at the breeding facilities. taking measurements requires significant time and labor (i.e., to transport a horse for measurement), and some breeders do not have the necessary equipment. Furthermore, if a horse is timid and dislikes contact with people or tools typical measurement techniques risk injury to both the horse and person. Therefore, if there is possibility to ascertain horse body weight without human contact, it would be useful for proper management of Hokkaido native horses.

When considering no-contact methods for estimating the body weight of feral or young horses, using images that are captured from a distance would be ideal. To estimate horse weight, the formula weight (kg) = (heartgirth^2 × body length) / (11,880 cm^3), is commonly used [5].

Therefore, if the horse's length can be measured without touching the horse, it could be useful to use in estimations of body weight.

To take images for measuring body length, aerial images shot by drone were thought to be useful. Drones have improved in safety and functionality in recent years and are being used in various fields. Furthermore, the improved performance of drone cameras has made it possible to take high-resolution images. Labor can be kept to a minimum because images of many horses can be recorded at once, and there is no need to restrain them. Furthermore, it has been reported that drone flights at altitudes of 30 m or higher do not cause stress to horses [6].

There have been a few drone studies involving horses [6-10] however, no study has ever used a drone to monitor the physical condition of horses. Therefore, in our study, we used images recorded by a drone to measure the relative body length of Hokkaido native horses under grazing conditions and thereby monitor the growth of foals.

2. Material and Methods

The experimental procedures in this study followed the Guide for the Care and Use of Agricultural Animals of Obihiro University (Obihiro, Hokkaido). All methods were carried out in accordance with the university regulations on the Management and Operation of Animal Experiments (accepted No. 19-119).

The experiment was carried out at the Hokkaido native breeds production ranch in Mimura, Hokkaido, which contained one pasture (47 ha) and one paddock (0.5 ha).

The group of Hokkaido native horses that we monitored was bred at the study site and consisted of one stallion, mares with foals, unpregnant mares, and geldings. The number of horses changed continuously as foals were born and horses were sold. However, the group size remained at approximately 70 individuals during the entire experimental period. Of these, 22 foals were born from December 2018 to September 2019 and their dams were selected.

A Mavic 2 Pro drone (DJI, Nanshan, China) was used. This drone has obstacle avoidance and automatic airborne position-holding functions that use an ultrasonic sensor. The attached camera was supported by a three-axis gimbal and was set to face downward at a 90° angle. The camera lens had an automatic focus with a viewing angle of 77° (28 mm). The video was recorded in a 4K (60 fps) resolution and saved on a 32 GB micro-SD card (Panasonic, Japan). Drone flights were conducted during the day at an altitude between 30 m and 150 m in a location where the drone was visible, as required by law [11].

The drone was operated by a pilot located a sufficient distance away from the horse herd, horses could be observed to confirm the safety of both the horses and the pilot. The drone was operated manually by the same pilot for all flights. Video recording with the drone began before

takeoff and stopped after landing. For each observation, the selected mares and foals were marked with blue or red spray paint on their backs.

Flights took place over 14 days between May and October 2019, between 10:00 and 18:00 JST. Once the drone was recording and in flight, where a mare and foal pair was located, the altitude of the drone was adjusted so that both the mare and the foal could be seen directly from above with the camera facing straight down. This position was then held for a few seconds. This process was repeated for each pair, and finally the drone was landed at a safe place near the pilot.

The foal's body length was calculated relative to the body length of the mare, which was defined as one unit. This was because the exact distance between the foal and the drone could not be measured since the grazing land was rough terrain. According to the specifications of the drone, the displayed altitude is the altitude from the takeoff location, and it may differ from the actual altitude, for example, if the ground is inclined. Moreover, we could not record the absolute measurements of the body length, as it was not possible to capture the standard measure of length and the mare and foal pair in the same frame.

First, one frame of each recording taken from directly above each foal and mare pair was extracted (one frame per pair, per flight). From the still image, the body length of the mare was measured in pixel units using an image processing software (Image J). Body length was measured from the point of the scapula (thoracic vertebrae 5) to the first caudal vertebra in a straight line along the vertebral column and defined as one mare length **(Figure 1).** The foal body length was measured as a proportion of this. The relationship between relative body length and age (in days) was analyzed using a bell curve option in Microsoft Excel (2016).

3. Results and Discussion

Image data from a total of 53 flights were obtained. From these flights, 886 body lengths were determined. One flight time was approximately 25 min, which varied due to the influence of the weather conditions on battery life. During one flight, approximately 20 mare-foal pairs were recorded. Although there was a maximum of 22 pairs available, identification challenges precluded the use of all pairs. For example, certain mares could not be identified due to the lack of paint marks as they had escaped during the spray paint marking, or foals of the same age, coat color, and sex could not be differentiated.

A regression was obtained using a logarithmic function **(Figure 2).** The Equine Research Institute reports that body weight and body measurement increase rapidly from birth to weaning [12] and this corresponded to our results. Using the relationship of body measurements (body weight, height of withers, heart girth, cannon circumference) with age in days, significant logarithmic curves have been obtained [13]. In a previous study [13], body length was not reported, but body length measured by the drone and age in days (X) resulted in significant logarithmic curves being produced. In the current study, the following equation was constructed. **Faculty Agriculture**; Hokkaido University: 16: 11-17.

Y (proportion of mare length) = 0.0896 log(x) + 0.2490 ($r^2 = 0.54$, $p < 0.01$).

From these results, we concluded that it is possible to measure the relative body length of foals using a drone. Body length measurements using the drone varied more in this study than in a previous study [13]. The reasons for the variation are the mare's age and body size. The foal of an older, larger mare tends to have a higher birth weight and to grow faster. Alternatively, the milk yield of the mare can be affected by the amount of grass in the pasture. Because parturition timing was widely spread from December 2018 to September 2019, differences in grazing may have affected the development of the foals.

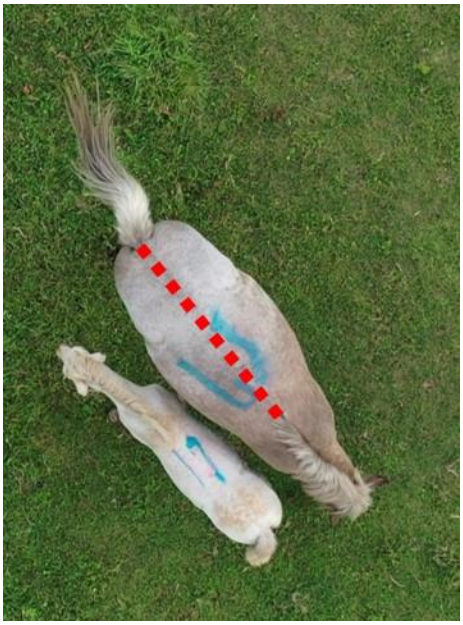

Figure1: Sample aerial drone image of a mare and foal pair used to measure the growth rate of the foal. The dashed line illustrates how the mare's body length was measured. Foal length is in mare equivalents; mare length was measured as 1 unit: point of scapula to first caudal vertebra.

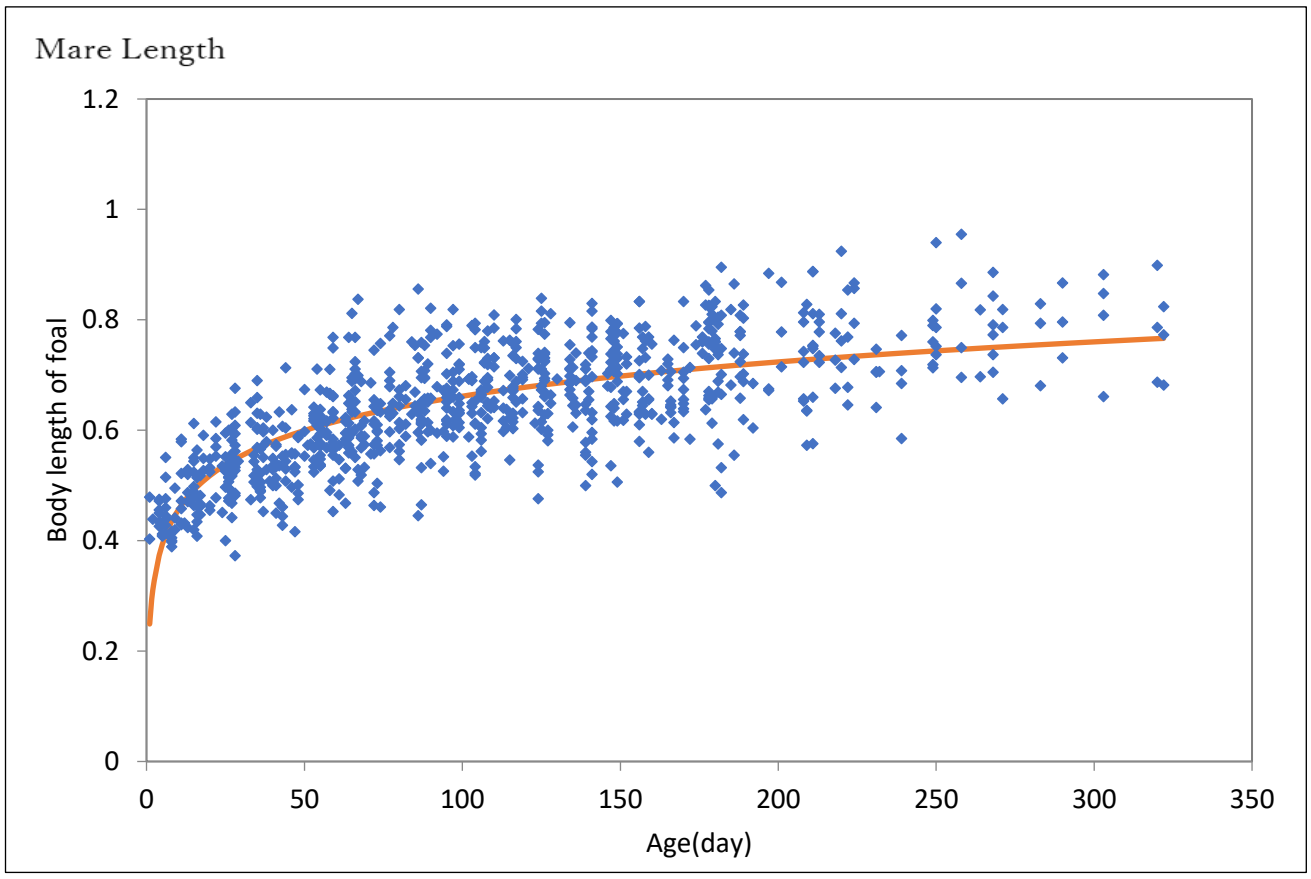

Figure 2. Changes in the body length of native Hokkaido foals from 0 to 10 months of age as measured by aerial photographs taken by a drone. *Foal length is in mare equivalents; mare length was measured as 1 unit: point of scapula to first caudal vertebra.

However, this could not be clarified in the present study.

Based on the above, it can be said that further research is needed, but with progress in this type of research, drones can be applied to horse management.

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