The 24-h time budget of a takh harem stallion
(Equus ferus przewalskii) pre- and post-reintroduction

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Abstract

Focal animal sampling was used to determine the 24-h time budget of a takh harem stallion (Equus ferus przewalskii) during the 2 weeks prior to, and the two weeks following, reintroduction into the Hustain Nuruu Steppe Reserve, Mongolia. Both before and after release, the stallion spent approximately 47% of his time grazing, 6% standing, and 5% in recumbent rest. The biggest changes to the time budget after release were a 4-fold increase in the amount of time spent moving, and a 50% decrease in the amount of time spent resting in a standing position. During the middle of the day when the temperatures were hottest, the stallion exhibited less grazing and more standing resting behaviour than in the morning or evening hours. Recumbent rest invariably occurred in the hours before dawn. © 1998 Elsevier Science B.V. All rights reserved.

Keywords: Takhi; Przewalski’s horse; Asian wild horse; Mongolian wild horse; Time budget; Reintroduction

1. Introduction

Takhi (Equus ferus przewalskii, takh in singular) are an endangered species of horse, also referred to as Przewalski’s horse or the Asian or Mongolian wild horse. In historical times they were found on the border of China and Mongolia (Bouman and Bouman, 1994). Although they are the closest living relative of domestic and feral horses (Equus caballus), takhi are considered to be a distinct species because they have two additional chromosomes (Benirschke et al., 1965). Competition with domestic livestock, hunting,
and a series of severe winters drove the species to extinction in the wild in the 1960s (Bouman and Bouman, 1994). A captive population in zoos prevented total extinction.

A joint effort between the Dutch Foundation Reserves Przewalski Horse and the Mongolian Association for the Conservation of Nature and the Environment led to the return of takhi to Mongolia (Bouman, 1998). In 1992, 16 horses were flown to Mongolia and placed in enclosures within the newly created Hustain Nuruu Steppe Reserve (Bouman et al., 1994). After two years of acclimatization in the enclosures, two harems were released into the wild.

A 24-h focal observation of one of the harem stallions was conducted during the two weeks immediately prior to release, and repeated during the two weeks immediately following release. The intent was to study the effect of release on the time budget, and compare the data to previous 24-h studies of captive takhi to see if consistent patterns in time budget were evident.

No research was conducted on free-ranging takhi before they became extinct in the wild. To date all behavioural data has come from captive takhi. The 24-h time budget of captive takhi was studied at the Prague Zoo by Bubenik (1961), and at the Denver Zoo by Griffitts (1985). These takhi were housed in barren enclosures less than 0.4 ha in size. Boyd et al. (1988) studied the 24-h time budget of captive takhi on grassy pastures of 4 to 12 ha in size. Roddis (1996), Kennedy (1996), King (1996), and Woodfine (1996) recorded the 24-h time budget of a captive takhi bachelor group in a 40 ha grassy enclosure. The reintroduction of takhi into the Hustain Nuruu Steppe Reserve provided the first opportunity to study the behaviour of takhi in the wild.

2. Methods

The Hustain Nuruu Steppe Reserve consists of 60,000 ha of upland and mountainous steppe located approximately 100 km southwest of Ulaanbaatar (Bouman, 1998). Elevations range from 1200 to 1900 m. Mean January temperature is \(-25^\circ\)C and the mean July temperature is \(20^\circ\)C; average annual rainfall is 270 mm (Van Dierendonck and Wallis de Vries, 1996). The steppe vegetation is dominated by fescue (\(Festuca\)), brome (\(Bromus\)) and feather (\(Chloris\)) grasses. Stands of birch (\(Betula\)) cover the peaks and northern slopes of the higher elevations (Bouman, 1998). Several permanent streams flow through the Reserve. The Reserve is not fenced.

In 1992, two harems and a bachelor group were formed from takhi shipped from the Netherlands and the Ukraine. Each group was placed in a separate 50-ha enclosure created by 75 cm high electrified fences. The three enclosures were spaced so as to prohibit visual contact between groups. A stream ran through each enclosure, and each enclosure contained sufficient forage and natural salt licks so that the horses did not need artificial provisions (Bouman, 1998).

The harem observed consisted of the stallion Khaan, age 6 years, from Lelystaad in the Netherlands; four mares, 4 to 5 years of age, from Askania Nova in the Ukraine, and Khaan’s offspring: a yearling son, and two colts and a filly that were 1 to 2 months old at the time of the observations. The adults had been together since their arrival in Mongolia. Khaan’s offspring had been born in the enclosure in Mongolia. This harem
had also been observed by Van Dierendonck et al. (1996) from 1992 to 1993 after their arrival in Mongolia.

Focal observations of free-ranging ungulates are difficult at night, therefore one animal was chosen as the subject. The stallion, Khaan, was selected as he had been studied as part of a bachelor group in the Netherlands (Leboucher, 1992) and was more habituated to the presence of an observer than the mares from Askania Nova. Sexual dimorphism also aided in identifying him at night.

The herd was located and followed on foot. The horses became habituated to the observer while in their enclosure and accepted being followed after release. The release was a ‘soft’ one; the enclosure gates were opened on 29 June 1994 and the harem allowed to leave at will, which took place the evening of 2 July 1994. During the daylight hours the observer remained 30 to 50 m from the animals. Nocturnal observations were made during the full moon at distances of 7 to 15 m from the stallion. Other than the moon, no light source was used except for an illuminated watch dial. Use of flashlight has been known to disturb the behaviour of takhi (King, 1996). Data was recorded in ink on paper, with start and stop times noted to the nearest second.

The focal observations were 15 min in duration. In most cases, several samples were taken consecutively. The longest string of consecutive samples was taken during night observations (28 consecutive samples = 7 h) because the herd was difficult to locate after dark and it was easiest to stay with them from dusk to dawn. All hours of the day were represented once from samples taken on 10 of the 14 days prior to release and 11 of the 14 days after release. Ambient temperature was taken by thermometer at the end of each 15-min sample.

The ethogram used was that of Boyd and Houpt (1994). For the purposes of presenting the time budget by hour of the day, the data were aggregated into the categories of grazing, moving, standing, resting while standing (standing resting), recumbent rest, and other. Wilcoxon matched pairs signed-rank tests (Siegal and Castellan, 1988) were used to compare average temperatures before and after release.

<table>
<thead>
<tr>
<th>Behavior</th>
<th>Pre-release (% of total)</th>
<th>Post-release (% of total)</th>
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</thead>
<tbody>
<tr>
<td>Grazing</td>
<td>47.0</td>
<td>47.8</td>
</tr>
<tr>
<td>Moving</td>
<td>5.3</td>
<td>21.7</td>
</tr>
<tr>
<td>Standing</td>
<td>5.4</td>
<td>7.7</td>
</tr>
<tr>
<td>Resting: Standing</td>
<td>36.4</td>
<td>15.7</td>
</tr>
<tr>
<td>Recumbent</td>
<td>3.8</td>
<td>5.3</td>
</tr>
<tr>
<td>Others: Drink</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Aggression</td>
<td>0.0</td>
<td>0.3</td>
</tr>
<tr>
<td>Self-groom</td>
<td>0.2</td>
<td>0.3</td>
</tr>
<tr>
<td>Mutual groom</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Play</td>
<td>0.5</td>
<td>0.1</td>
</tr>
<tr>
<td>Mate</td>
<td>0.5</td>
<td>0.4</td>
</tr>
<tr>
<td>Mark excretions</td>
<td>0.7</td>
<td>0.2</td>
</tr>
<tr>
<td>Urinate/defecate</td>
<td>0.1</td>
<td>0.2</td>
</tr>
</tbody>
</table>
Fig. 1. Percent of time Khaan spent grazing, moving, standing, standing resting, and in recumbent rest from 24-h time budgets recorded (a) during the two weeks before and (b) the two weeks after release. Average temperature during the observations are given in °C above the columns.
and the magnitude and direction of pre- and post-release differences for each behaviour across the day. Spearman rank correlation coefficients were used to look for relationships between the time budget and temperature variations.

3. Results

Table 1 gives a summary of Khaan’s 24-h time budget before and after release. The obvious changes are the increase in time spent moving and the decrease in time spent resting in the standing position after release.

Fig. 1 shows the distribution of time spent grazing, moving, standing, standing resting, and recumbent across the day, both before and after release. Wilcoxon matched pairs signed-rank tests showed no significant differences in the amount of time spent before and after release for the behaviours of grazing, standing, or recumbent rest ($Z = 0.0, -0.76, \text{ and } -0.37, \text{ respectively}; \text{ all } n = 24, \text{ and all } p > 0.4$). However, after release there was a significant increase in the amount of time spent moving ($Z = -3.52, \quad p = 0.0004$) and a significant decrease in the amount of time spent standing resting ($Z = -2.91, \quad p = 0.004$). There was no difference in average temperature before versus after release ($Z = -0.70, \quad n = 24, \quad p = 0.48$).

Prior to release, the average temperature showed a significant positive correlation with the amount of time spent standing resting ($r = 0.72, \quad p < 0.01$) and a significant negative correlation with the amount of time spent grazing ($r = -0.58, \quad p < 0.01$) and in recumbent rest ($r = -4.1, \quad p < 0.05$). After release there were no significant correlations between any of the behaviours measured and temperature (all $p > 0.05$).

4. Discussion

After release, the percent of Khaan’s time budget devoted to grazing remained the same as while in the enclosure. Van Dierendonck et al. (1996) developed a time budget for Khaan’s entire harem from scan samples taken every 10 min between the hours of 0600 and 2200 during the 16 months after the horses’ arrival in Mongolia. They found the members of Khaan’s harem spent an average of 50% of their time grazing, which is very close to the percentage recorded during this study. Captive takhi observed on pasture in Front Royal, VA spent 46% of their time feeding (Table 2); remarkably similar to the time spent grazing by Khaan in Hustain Nuruu, Mongolia at the same time of year. However the Front Royal takhi also received supplemental concentrates and Khaan did not. Khaan maintained good body condition throughout this study, while spending less time foraging than reported for captive takhi stallions receiving concentrated feed (Boyd, 1988), therefore the nutritional quality of the forage in Mongolia must have been excellent.

Khaan had been studied when he was a 3-year-old member of a captive bachelor group in the Netherlands (Leboucher, 1992). From daytime focal observations made in winter, as a bachelor he was determined to have spent 68.7% of his time feeding. This larger amount of time spent grazing might have resulted from increased energy demands.
Table 2

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Grazing</td>
<td>46.4</td>
<td>69.3</td>
<td>58.4</td>
<td>69.5/67.7</td>
<td>69.0/59.4</td>
</tr>
<tr>
<td>Moving</td>
<td>7.4</td>
<td>9.1</td>
<td>12.2</td>
<td>9.6/5.4</td>
<td>10.7/15.1</td>
</tr>
<tr>
<td>Standing</td>
<td>20.6</td>
<td>2.5</td>
<td>3.7</td>
<td>2.2/1.2</td>
<td>2.4/3.5</td>
</tr>
<tr>
<td>Resting: Standing</td>
<td>15.7</td>
<td>5.1</td>
<td>11.0</td>
<td>16.3/8.1</td>
<td>12.1/12.7</td>
</tr>
<tr>
<td>Recumbent</td>
<td>5.3</td>
<td>7.5</td>
<td>5.5</td>
<td>2.0/13.8</td>
<td>5.1/7.7</td>
</tr>
<tr>
<td>Others</td>
<td>4.6</td>
<td>6.5</td>
<td>9.2</td>
<td>0.8/3.4</td>
<td>0.6/2.0</td>
</tr>
</tbody>
</table>

Focal samples of an eight-member captive harem in 4–12 hectare pastures (Front Royal, VA) observed in summer over 24-h periods.

Scan samples of five captive bachelor takhi on 40-ha pasture (Eelmoor Marsh, UK), observed in summer between the hours of 04:00 and 00:00.

Scan samples of the same population as Roddis (1996), observed in summer over 24-h periods, data presented are averages of group means from six time intervals that covered the entire day.

Scan samples of the same population as Roddis (1996), observed over 24-h periods, winter/spring data.

Scan samples of the same population as Roddis (1996), observed over 24-h periods, winter/summer data.

in winter, or energy needed by young animals for maturation. Previous studies of a mixed age group of bachelors (Table 2) found slightly higher amounts of time spent grazing in winter.

Van Dierendonck et al. (1996) described a bimodal increase in grazing at dawn and in the evening. In this study the amount of time Khaan spent grazing was also highest in the morning and evening, and lowest in the middle of the day (around 14:00 h) when the temperature was highest (Fig. 1). Other summer-time studies of captive takhi have shown a decrease in time spent feeding during the hotter mid-day hours (Bubenik, 1961; Boyd et al., 1988; King, 1996).

Before and after release, Khaan spent almost no time moving between the hours of 02:00 and 04:00, when recumbent rest was common. Aside from these hours, the amount of his movement was relatively constant throughout the day. Prior to release Khaan spent less than 10% of his time moving, as was observed by Leboucher (1992) for Khaan as a bachelor, and as Van Dierendonck et al. (1996) observed for the harem as a whole in 1992 and 1993. The amount of time Khaan spent moving prior to release was similar to that recorded for the captive Front Royal takhi (Table 2) and slightly less than seen in captive bachelors, who typically spend more time in motion than do harem stallions (Boyd, 1988). But after release the harem stallion Khaan spent more time moving than reported for any captive group. His locomotory behaviour was greatly affected by release, increasing 4-fold. One hypothesis is that the horses were exploring their new environment. In support, during the 2 weeks after release, this harem twice left the Reserve. On the first occasion they were chased back by park staff. On the second occasion they returned of their own accord within a few hours. A second hypothesis is that freedom enabled the horses to trek to desirable resources. If the first hypothesis is correct, the amount of time spent moving should decrease as the habitat becomes explored. If the second hypothesis is correct, the amount of time spent in locomotion will remain elevated. Continued research after the horses become acclimated to freedom.
will be needed to discriminate between these hypotheses. The rise in time spent in movement upon release is probably not attributable to increased harem protection duties. The harem did not encounter wolves while under observation. Only two interactions with the other released harem were witnessed and no increase in vigilance or movement was associated with those encounters. Eliminative marking has been hypothesized to play a role in harem defense by signaling that mares are accompanied by a stallion (Boyd and Kasman, 1986). Stallions move to the urination and defecation sites of mares and cover these sites with their own urine. However the amount of time Khaan spent marking declined after release (Table 1) and the rate at which he marked was significantly lower (Boyd, 1996), so this can not account for the increased amount of time spent moving.

The amount of time Khaan spent standing was relatively constant throughout the day and did not differ before and after release (Fig. 1). Less time was spent standing than reported for captive takhi in Front Royal, but approximated the amount recorded for captive takhi bachelors (Table 2).

Khaan’s resting behaviour was affected by time of day. Recumbent rest was restricted to the early hours of the day, between 02:00 and 05:00, and the total amount of time spent was unaffected by release. Bubenik (1961) found that captive takhi in the Prague Zoo showed a peak of sleeping behaviour between 00:00 and 06:00 h and Boyd et al. (1988) reported a peak in sternal recumbency from 00:00 to 04:00 h for the Front Royal takhi. Additionally Roddis (1996) reported that captive takhi bachelors spent the least amount of time grazing and the most time resting sternoal between the hours of 00:00 and 04:00. King’s (1996) findings were similar, with a peak of recumbency from 00:00 to 04:00 h. Almost all studies have found approximately 5% of the time spent in recumbency. Paradoxical sleep usually occurs in the recumbent position and is thought to be important in memory sorting and consolidation, as well as playing a restorative role (Dallaire, 1986). A certain level of recumbency is therefore critical to well-being. To escape predators, horses depend on vigilance and speed, and are especially vulnerable while in recumbent rest. As most predators of horses are crepuscular or diurnal, recumbency during the early morning hours minimizes vulnerability.

Khaan’s periods of standing rest peaked during the middle of the day. Similarly, in July 1993, Van Dierendonck et al. (1996) recorded a peak of resting for Khaan’s harem from 10:00 to 17:00 h. Van Dierendonck et al. (1996) measured a range of 20–44% time spent resting, which is in line with that reported here for Khaan immediately prior to release. After release the amount of time Khaan spent standing resting dropped by half, approaching the values reported by Leboucher (1992) for Khaan as a bachelor and by Boyd et al. (1988) for captive Front Royal takhi.

5. Conclusion

Acclimatization appeared to be successful in that Khaan’s time budget did not indicate signs of stress after release, such as reduced time spent grazing or increased amounts of time spent resting due to exhaustion. The biggest effect on the time budget was that upon release, the amount of time Khaan spent in locomotion shot up at the
expense of standing rest. More research is needed to ascertain the function of this increase in locomotion, but if it is due to trekking between sites, it appears that even captivity in grassy 40- or 50-ha enclosures does not enable a reasonable approximation of this aspect of the wild time budget. Standing rest appears to be a labile component of the equine time budget, adjusted to fit other requirements. In contrast, the amount of time spent in recumbent rest is relatively inflexible, regardless of housing situation. In summer, crepuscular grazing and mid-day standing rest appear to be the norm in takhi. Recumbent rest occurs primarily in the early morning hours before dawn.

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