Time budget-, behavioral synchrony- and body score development of a newly released Przewalski's horse group *Equus ferus przewalskii,* in the Great Gobi B Strictly Protected Area in SW Mongolia

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Abstract

The Przewalski's horse (*Equus ferus przewalskii*) became extinct in the wild in the 1960s, but survived as a species due to captive breeding. There have been several initiatives to re-introduce the species in central Asia, but until now only two projects in Mongolia establish free-ranging populations. Data on basic ecology and behavior of the species prior to extinction is largely lacking and a good documentation of the re-introduction process is essential. Between 13 May and 2 September 2003 we documented the time budget-, group synchrony and body score development of a newly released Przewalski's horse group in the Gobi area of SW Mongolia.

Contrary to our expectations, the newly released Przewalski's horses did not show the expected succession of an exploration-, acclimatization-, and established phase. Grazing activity was very high after the release, decreased to a minimum in July and increased again towards the end of the study in September. Resting activity followed the opposite trend, whereas moving activity was more or less constant over the entire observation period. Behavioral synchronization of the group was high throughout the study period and immigration or emigration of members did not result in a de-synchronization of the group. The body score index never dropped, but rather increased for all group members.

Our data suggests that captive bred Przewalski's horses experience little behavioral and nutritional stress when being released into the desert steppe of the Gobi regions after one year in an adaptation enclosure.

Keywords: Adaptation; Activity pattern; *Equus ferus przewalskii*; Mongolia; Przewalski's horse; Reintroduction

I. Introduction

The Przewalski's horse (*Equus ferus przewalskii*) – or "Takh" in Mongolian – is classified by the IUCN as extinct in the wild (EW). Among the 7 recent equid species, the Przewalski's horse is the only true species of wild horse in the world (Wakefield et al., 2002). The last free-ranging individual was seen in 1969 in the Dzungarian Gobi area, in SW Mongolia (Solokov and Orlov, 1986; Bouman and Bouman, 1994). The reason for the species decline and extinction in the wild are generally seen as a combination of factors, namely competition with livestock, hunting, capture of foals for zoological collections, military activities, and very harsh winters recorded in 1945, 1948 and 1956 (Bouman and Bouman, 1994; Van Dierendonck and Wallies de Vries, 1996).

As a species the Przewalski's horse survived due to captive breeding, based on a carefully managed founder population of only 13 animals (Volf, 1996; Mohr and Volf 1984). With the captive population increasing, interest arose to re-establish the species onto its native range in Mongolia and China (Wakefield et al., 2002). In Mongolia two re-introduction projects were launched in 1992 and by 2005 have resulted in small populations of free-ranging Przewalski's horses, 85 animals in the Great Gobi B SPA in SW Mongolia (Kaczensky, Ganbaatar and Walzer, unpubl. data December 2005), and 177 animals in Hustai NP in central Mongolia (Bandi

unpubl. data December 2005). A third initiative was started in 2004 in Khomin Tal in NW Mongolia, where the captive population numbered 22 animals (Zimmermann, 2005). Several other re-introduction programs were attempted in China, Kazakhstan and Uzbekistan, but so far none were able to establish free-ranging populations (Zimmermann, 2005). However, further re-introduction initiatives are presently being discussed (Kaczensky, 2006) or in the planning stage (e.g. Kalameili reserve, Xinjang province, China; Zimmermann, 2005).

In the past re-introduction programs and methods were often poorly documented and reasons for success and failure are not easily accessible (Stanley-Price, 1991). Any re-introduction is a challenge and the outcome could provide important lessons for basic ecology and management alike (Sarrazin and Barbault, 1996; Van Dierendonck and Wallies de Vries, 1996). For a species like the Przewalski's horse a good documentation of all stages of a re-introduction program is especially critical because almost no data exists on its behavior or basic ecology prior to extinction in the wild (Wakefield et al., 2002).

The biological rhythm of an individual is linked to its nutritional condition, its social status and its stress condition (Berger et al., 1999; Scheibe et al., 1999; Kaczensky et al., 2006). Thus the study of time budgets and activity patterns of re-introduced individuals can provide important information about their well-being and adaptation status (Boyd and Bandi, 2002). Studies carried out on captive and free-ranging Przewalski's horses in summer, show that the time devoted to grazing is lowest and the time devoted to resting is highest in the middle of the day (Boyd, 1988; Boyd et al., 1988; Van Dierendonck et al., 1996; Boyd, 1998; Berger et al., 1999; Boyd and Bandi, 2002). Thus, long grazing periods during the typical midday resting period could be a symptom of nutritional stress (Klimov, 1988).

Behavioral synchronization is another important feature in social ungulates. A good social integration of all members generates a high degree of behavioral synchronization and generally translates into high group cohesion and group stability (Boyd and Bandi, 2002). Behavioral synchronization can help to reduce insect harassment (Klimov, 1988) and predation (Jarman, 1974; Bertram, 1978) and thus is a critical factor for the successful release of group living animals into a novel environment (Mongolian Takhi Strategy and Plan Work Group, 1993).

In Hustain Nuruu National Park in central Mongolia Boyd and Bandi (2002) documented the successful adaptation process of a newly released Przewalski's horse group in a mountain steppe environment using short observation intervals 2-4 weeks before, 2-4 weeks after and two years after the release. Upon release from the acclimatization enclosure their study group spent considerably more time moving and less time resting, which was attributed to exploration. Group members were highly synchronized and synchronization as well as the distribution of behaviors across the day remained stable over the different observation intervals, suggesting a very smooth adaptation process.

Although the last free-ranging horses were seen in the Gobi areas, it is still debated whether these areas represent a mere refuge or were the typical Przewalski's horse habitat (Van Dierendonck and Wallies de Vries, 1996). Assuming the first, re-introduced Przewalski's horses should experience considerably more difficulties in adapting to the local conditions or might even fail altogether. There is no question, that living conditions in the gobi regions are much harsher than in the mountain steppe zone of Hustain Nuuru, where water and forage is more plentiful and tree cover provides shade and natural wind breaks (Mongolian Takhi Strategy and Plan Work Group, 1993). In addition, the adaptation enclosures in the gobi do not provide enough forage and supplementary feeding is obligatory year-round. This deprives naïve horses of the chance to learn

how to find and select for the best forage plants and influences their daily activity pattern. Thus the year in the adaptation enclosure mainly enables naïve Przewalski's horses to adapt to the climatic conditions of the gobi and the most critical step in the release process is seen in the actual release from the adaptation enclosure (Ganbaatar 2003).

In the summer of 2003 we followed a newly released group of Przewalski's horses in the Great Gobi B Strictly Protected Area (SPA) in SW Mongolia to document their adaptation to free-ranging conditions. We expected naïve Przewalski's horses in the harsh gobi environment to undergo a more distinct adaptation process than naïve horses in the more productive mountain steppe environment of Hustain Nuruu (Boyd and Bandi 2002). Other than Boyd and Bandi (2002) we followed the study group for a long, continuous study period and employed multivariate statistics to simultaneously test the influence of time since release, time of the day and temperature on the probability of grazing and resting.

Our hypotheses were:

(1)   Upon release, Przewalski's horses will show an **explorative phase**, characterized by high levels of moving activity and low levels of grazing and resting activity.

(2)   The explorative phase will be followed by an **acclimatization phase** with decreased levels of moving activity and higher levels of grazing and resting activity.

(3)   The final **established phase** will reflect time budgets previously published.

(4)   Social cohesiveness, expressed as group synchronization and group member stability, will be lowest in the initial phase and highest in the established phase. Horses immigrating or emigrating will desynchronize the group.

(5)   Body condition will drop in the exploration phase, due to high energy expenditure, stabilize in the acclimatization phase and increase in the established phase.

2. Material and Methods

2.1. Study area

The study area, called Takhin Tal, covers 1,500 km² of semi-arid to arid desert steppe habitat in the SE corner of the Great Gobi B Strictly Protected Area (SPA; ~9,000 km²) in SW Mongolia (Fig. 1). Elevation ranges from 1,400m to 2,000m. The climate is continental with long cold winters, and short hot summers; the average annual temperature is 0.5°C. During the study period (13 May – 2 September) the daily temperature averaged 15.9 °C (range: 0.1-31.0°C; Fig. 2). Average annual rainfall is about 100 mm throughout the park, with most precipitation during the summer months. The ground is principally composed of sand, gravels, salt, and superficial dust due to the wind activity. Hilbig (1990) distinguished three major vegetation types in Takhin Tal: desert steppe (*Stipa spp.*, *Artemisia spp.*), desert shrub (*Haloxylon ammondendron*, *Stipa spp.*, *halophytes*), and oasis vegetation (*Phragmites australis*, *Juncus spp.*, *Achnatherum splendens*).

Other large steppe ungulates present in the study area are the Mongolian wild ass (*Equus hemionus)* and the black-tailed gazelle (*Gazella subgutturosa*). The only large mammalian predator in the study area is the grey wolf (*Canis lupus)*. The pastures in and around Takhin Tal are used by up to 50 herder families and their livestock (~27,000 heads), mainly in fall, winter and spring (Kaczensky et al., 2006 in press).
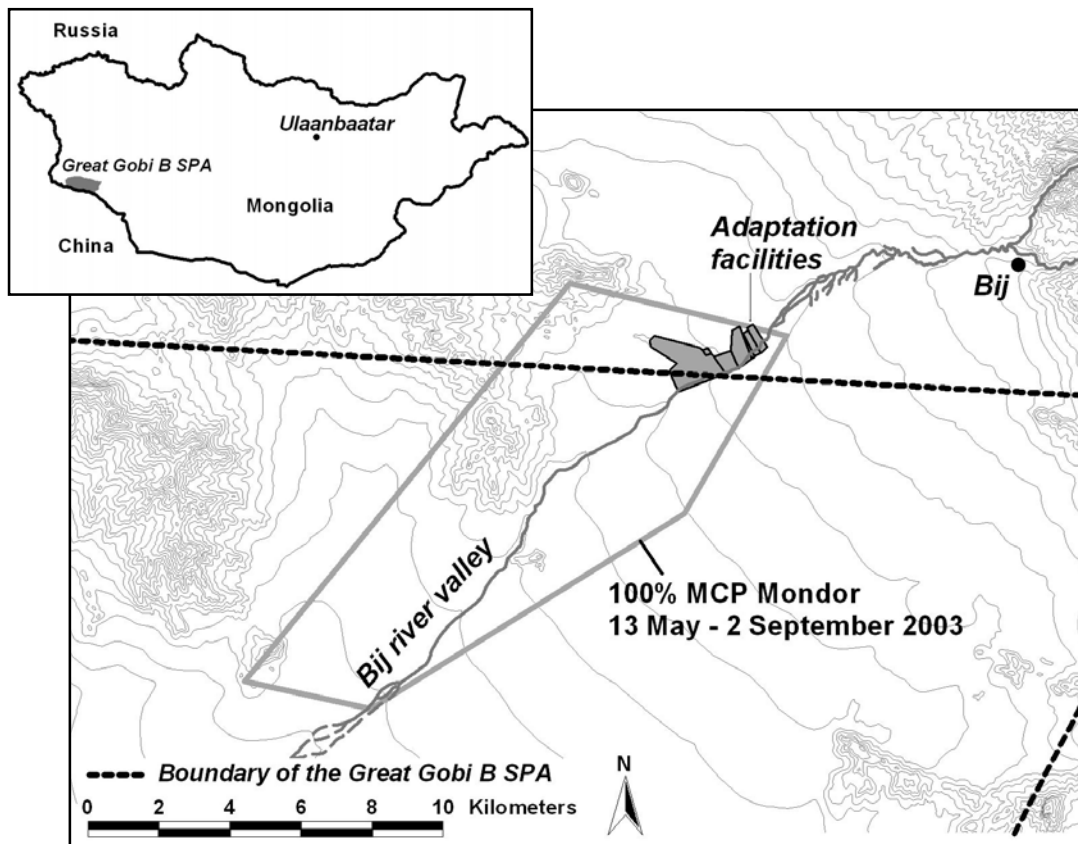
Fig. 1. Takhin Tal study area at the NE edge of the Great Gobi B Strictly Protected Area (SPA) in SW Mongolia.

2.2. The re-introduction program in Takhin Tal

The Takhin Tal reintroduction project was initiated in 1992 (Van Dierendonck and Wallies de Vries, 1996; Slotta-Bachmayr et al., 2004). The first Przewalski's horse group (three stallions and three mares) arrived in Takhin Tal in 1992 from Askania Nova, Ukraine. Subsequent transports followed, and by the summer of 2003 9 transports had brought 77 captive-bred horses from various zoos in Europe and Australia to Takhin Tal. The first foal in Takhin Tal was already born in 1992. In spring 1997 the first Przewalski's horses were released from the adaptation facilities and this same year the first foals were born in the wild (Slotta-Bachmayr et al., 2004).

For adaptation and disease monitoring, all newly imported Przewalski's horse groups are held in the adaptation facilities for up to one year (Slotta-Bachmayr et al., 2004; Robert et al., 2005). The adaptation facility consists of 5 separate enclosures with a total of 2.600 ha (Fig. 1). In each enclosure a stable provides thermal protection and the Bij river provides drinking water. In the enclosures, Przewalski's horses are fed hay 1-2 times a day, depending on available natural forage and body condition.

In April 2003, at the beginning of this study, there were a total of 59 Przewalski's horses in 7 groups in the Takhin Tal study area: 3 in the adaptation facilities and 4 free-ranging (Pas group, Mundol group, Tuulai group and Bachelor group).
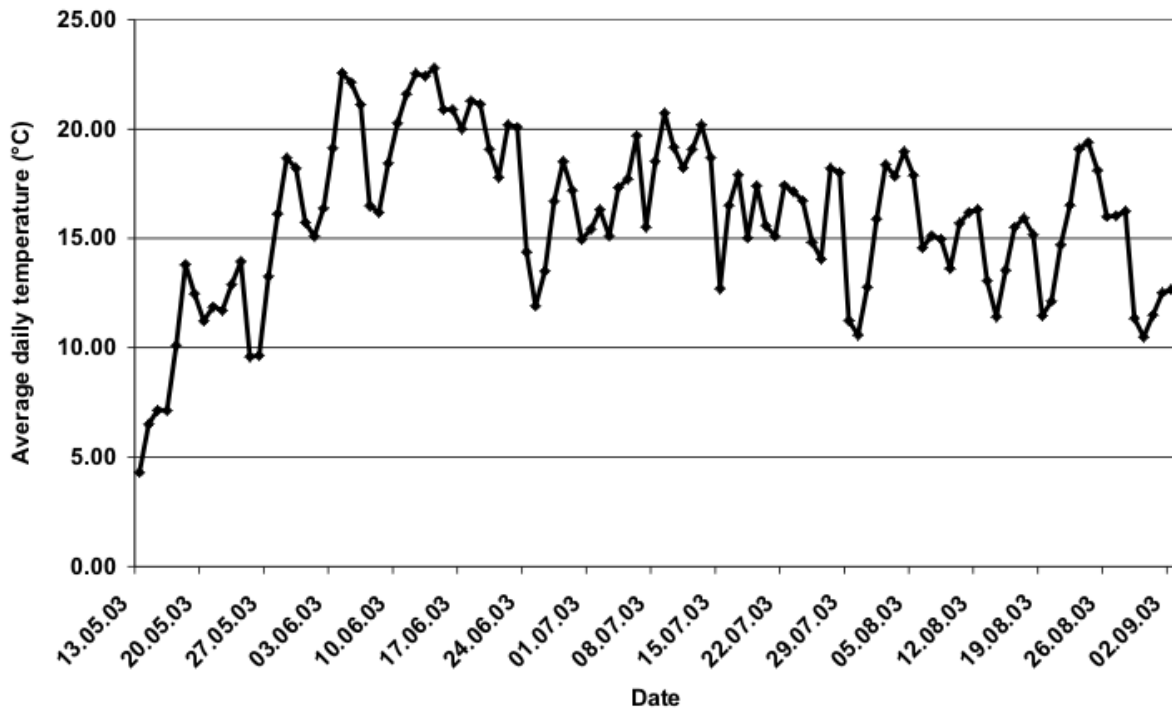
Fig. 2. Average daily temperature recorded at hourly intervals at the Takhin Tal field station from 13 May to 2 September 2003 (Hobo H8 datalogger, Hoskin Scientific Limited, Vancouver, Canada).

2.3. Study group

The study group arrived by plane in June 2002. This transport brought 14 Przewalski's horses (6 stallions and 8 mares) to Takhin Tal. The animals were kept in two adaptation enclosures, separated by sex. During the winter, the stallion KHUCHIT jumped the fences and joined the mare group. In addition, one mare was moved to the captive breeding group because she was considered unsuitable for release due to poor body condition. Thus by April 2003, the study group consisted of 8 animals (1 stallion and 7 mares; Table 1).

On 13 May 2003 this group was released into the Gobi by slowly pushing them 10 km downstream of the adaptation enclosure along the Bij river (Fig. 1). Two mares left the group by the end of May by changing to another harem group, whereas a second stallion joined the group from the Bachelor group by the end of May. The group was than accompanied by two stallions until the end of July, after which the original harem stallion left the group (Table 1).

Previous to the release, each individual was treated against piroplasmosis (Robert et al., 2005) and one mare was equipped with a GPS / ARGOS collar (TGW-3580, Telonics, Mesa, USA) to track movement patterns and habitat use of the group (Kaczensky et al., 2006 in press).

While the study group was still in the adaptation enclosure, the first author observed it daily for 2 weeks in order to reliably identify each individual based on coat color, shape, body size and body condition.

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Table 1
Study group composition for the period 13 May – 2 September 2003 (total number of scan samples: 2,555).

Name	Sex	Age	Origin/arrival in TT (fate before / after leaving study group)	In study group	N scan samples
KHUCHIT	Stallion	4	Langenberg, CH / 2002 (left to bachelor group)	Start – 29.07.03	1,919
TAYAN	Stallion	6	Berlin, D / 1999 (came from bachelor group)	28.05.03 – End	2,171
ERDENE	Mare	5	Rotterdam, NL / 2002 (left to Tuulai group)	Start – 25.05.03	314
MONDOR	Mare	5	Springe, D / 2002	Entire study period	2,544
MONGON	Mare	4	Winterthur, CG / 2002	Entire study period	2,535
OODON	Mare	4	Whipsnade, GB / 2002 (left to Pas group)	Start – 27.05.03	281
TSAKIR	Mare	4	Leipzig, G / 2002	Entire study period	2,544
ZOGII	Mare	3	Winterthur, CH / 2002	Entire study period	2,549
ZORGOL	Mare	3	Winterthur, CH / 2002	Entire study period	2,539

2.2. Monitoring time budget and activity pattern

Between 13 May and 2 September, the first author observed the study group with binoculars (Buschnell 8×42), mostly at distances of 500-800 meters. Observation periods were restricted to daytime hours from 08:00 to 20:00.

The observation periods generally lasted 6 consecutive hours with alternating morning and afternoon observation periods to allow an even coverage over all hours. We recorded individual behaviors every 10 minutes (10-minutes scans) using the Instantaneous Scan Sampling method (Altmann, 1974). Based on the protocol of Boyd (1991), only behaviors with duration of more than 3 seconds were recorded. We classified behavior based on definitions provided by Feist and McCullough (1976) and Boyd and Houpt (1994), but for this analysis grouped all behaviors into five main activities: grazing, resting, standing, moving, and other (Table 2). If one individual was not in view, it was recorded as "out of sight".

For analysis, we only considered individuals in view. We first calculated the time budget for each individual over the entire monitoring period and then averaged over all individuals to obtain the average group time budget. To document changes over time, we calculated the time budget per 7-day interval, referred to as weeks (the first 7 days following release being week 1). We excluded the two mares which left the group at the beginning of the observation period from the average group time budget calculation, but included them for the weekly analysis.

We used a multiple additive logistic regression model with cubic B-spline smoothes for the influence of time since release (expressed in weeks from 1-17), time of the day (expressed in hours from 8-20) and temperature (expressed in °C) on the probability of grazing (coded as

binary variable) and resting (also coded as binary variable, but after excluding all observations of grazing behavior) for each 10-minute scan.

We did all statistical analysis either in SPLUS (Version 2000, MathSoft, Seattle, WA, USA) or SPSS 10.0 (Statistical Package for the Social Sciences; SPSS Inc., Chicago, Illinois, USA).

Table 2
Ethogram of recorded behaviors based on Boyd and Houpt (1994) and Feist and McCullough (1976).

Behavior	Description
Grazing	Head down, chewing and biting mouth movements. The horse may stand still or walk slowly
Resting	The horse is standing and relaxed. The neck can be horizontal or low, the head relaxed and a little low or in the continuation of the neck, nose directed toward the ground, and the eyes closed or half-shut. The ears are in lateral position or directed behind and one of the three hind legs is flexed
Standing	The horse is standing, with a sustained position. All legs are stretched. The head is high and the neck is held with tension. The ears are directed forward or are moving to intercept surrounding sounds
Moving	Walk, trot or gallop with a minimum duration of 10s. The horse is not involved in grazing
Other behaviors	All other behaviors, e.g. social behaviors, urination, defecation, drinking, interaction with other Przewalski's horse groups or other species

2.3. Synchronization and body condition

The behavioral synchronization of a group represents the number of individuals simultaneously engaged in the same activity. At each 10-minute scan, we recorded the number of individuals engaged in the same activity. We expressed individual synchronization of each horse as the number of horses showing the "own" behavior, divided by the total number of horses in the group at this day. We only considered grazing, resting, standing, drinking and moving.

We recorded the body condition of each horse every two weeks using the *Body Score Condition Index* from Rudman and Keiper (1991). It ranges from 0 (for a very thin individual) to 5 (for a very fat individual).

3. Results

3.1. Time budget and activity pattern

Over the entire monitoring period, the core study group spent 46% of their time grazing, 35% resting, 11% traveling, 7% standing and 1% showing other behavior.

Different behaviors were not equally distributed over the day, but followed a distinct pattern, especially for grazing and resting. Grazing was lowest and resting highest in the middle of the

day (Fig. 3). Ambient temperature was an important variable in predicting the probability of grazing and resting. When the temperature rose above 10°C the probability for grazing decreased (Temperature effect, adjusted to week and hour: χ^2=235.84, d.f.=1, P<0.0001; Fig. 4a), whereas the probability of resting increased more or less continuously with temperature (Temperature effect, adjusted to week and hour: χ^2=40.43, d.f.=1, P<0.0001; Fig. 4a). However, after correcting for the effect of temperature and weeks, time of the day was still a major factor predicting the probability of grazing and resting (Hour effect, adjusted to week and temperature, grazing: χ^2=721.26, d.f.=12, P<0.0001; resting: χ^2=520.00, d.f.=12, P<0.0001; Fig. 4b).
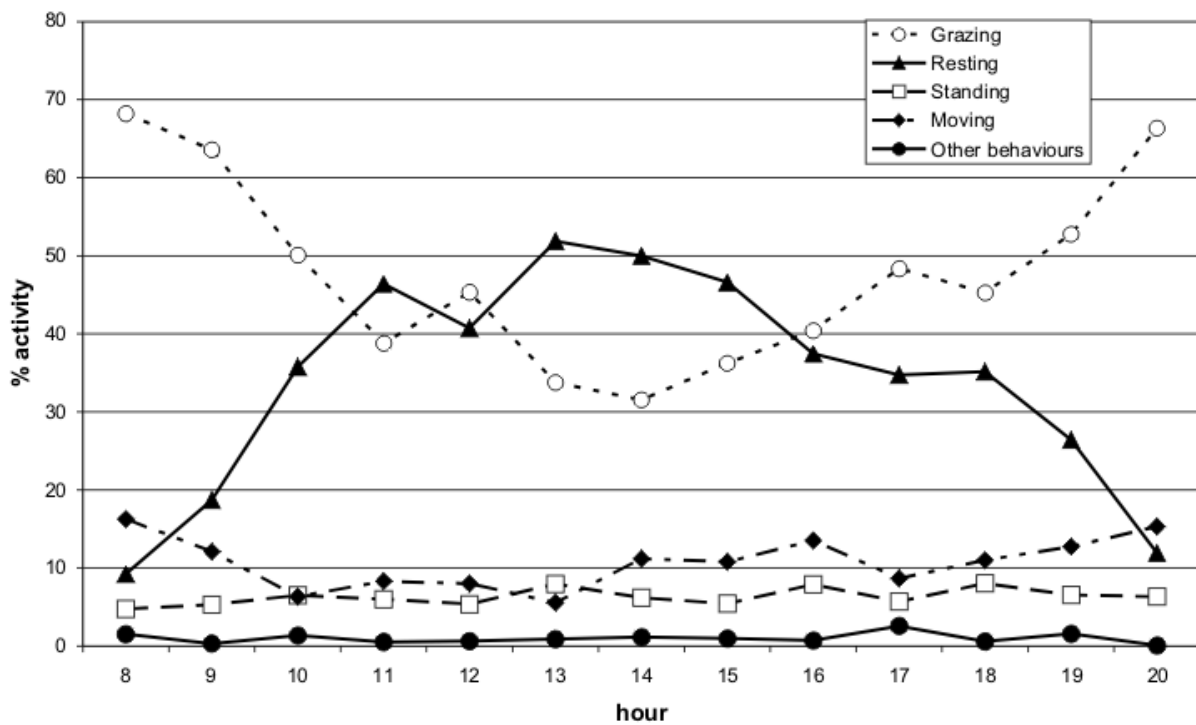

Fig. 3. Daytime distribution of the five main activity classes averaged first per hour and day and subsequently over all days.

Contrary to our expectation, there was no peak in moving activity following release (Fig. 5). Furthermore, grazing activity did not show a steady increase, nor did it reach a plateau after some time spent in the wild. Quite contrary, grazing activity was very high following release, then steadily decreased to reach a low around the 9th week, and then increased again. Time spent resting basically showed the opposite trend (Fig. 5). This pattern was even more distinct when correcting for the influence of hour and temperature (Fig. 4c. Week effect, adjusted to hour and to temperature: grazing: χ^2= 1459.68, d.f.=16, P<0.0001; resting: χ^2= 897.45, d.f.=16, P<0.0001).
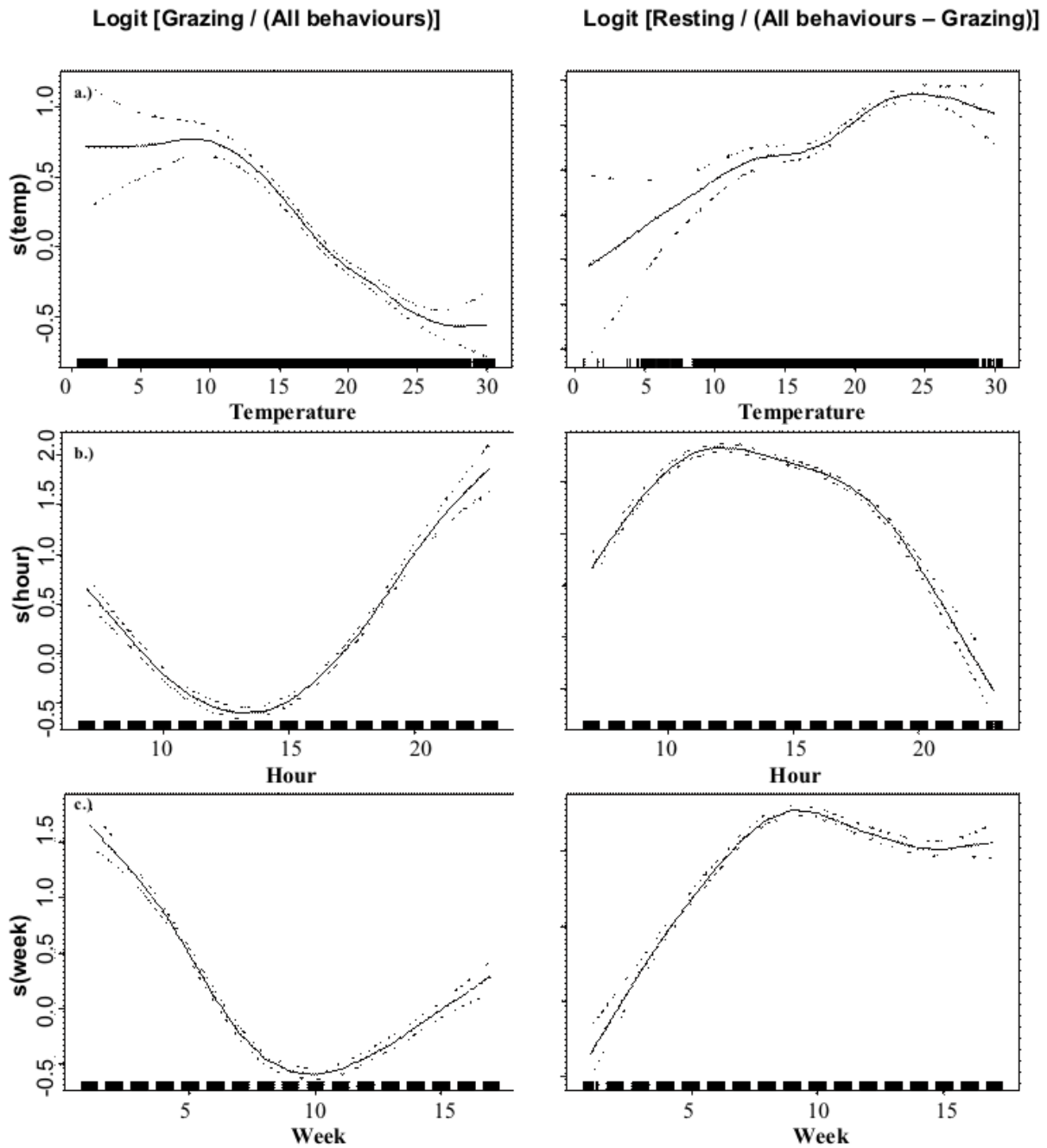
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Fig. 4. Multiple additive logistic regression model with cubic B-spline smooth to account for effects of temperature, hour and week on the probability of the two main behaviors grazing (on the left) and resting (on the right). a.) Temperature effect adjusted to week and hour. b.) Hour effect adjusted to temperature and week. c.) Week effect adjusted to hour and temperature.
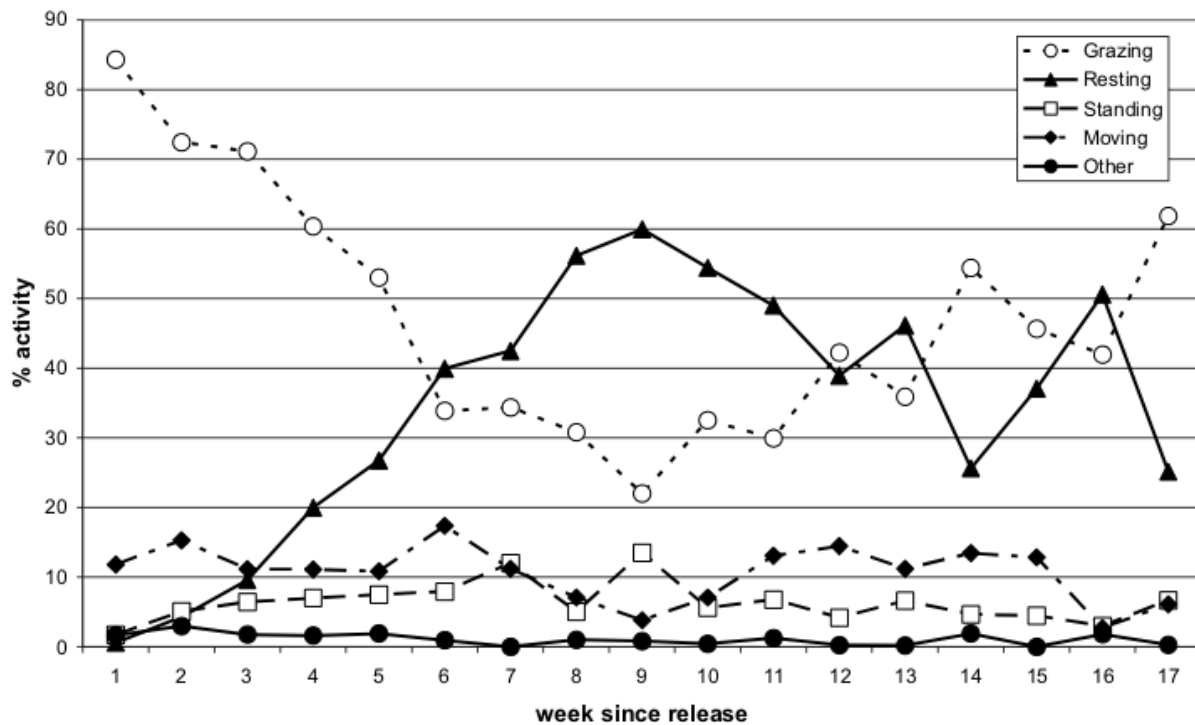
Fig. 5. Time budget development in the weeks following release from the adaptation enclosure.

3.2. Synchronization and social cohesiveness of the group

Social cohesiveness, expressed as % behavioral synchronization, was high following release. Nevertheless, group stability was low as two mares left the group within the second and third week of the release and a second stallion joint the group in the third week.

The group was accompanied by two stallions until the 12th week, when the initial harem stallion left. Contrary to our prediction, emigration or immigration of group members were not initiated or followed by periods of low synchronization (Fig. 6). Behavioral synchronization was generally high for the mares (mean: 87-91%) and KHUCHIT the initial harem stallion (mean: 87%). The secondary harem stallion TAYAN, on the other hand, showed a significantly lower behavioral synchronization than the rest of the group (mean: 73%, ANOVA, F=27.3, d.f.=8, post-hoc pair wise comparisons for unequal variance, all P>0.05 except for TAYAN all p<0.01). For unknown reasons behavioral synchronization reach a low in week 9.

The highest behavioral synchronization was observed during grazing (91%), resting (89%), and moving (85%) and the lowest for standing (51%).
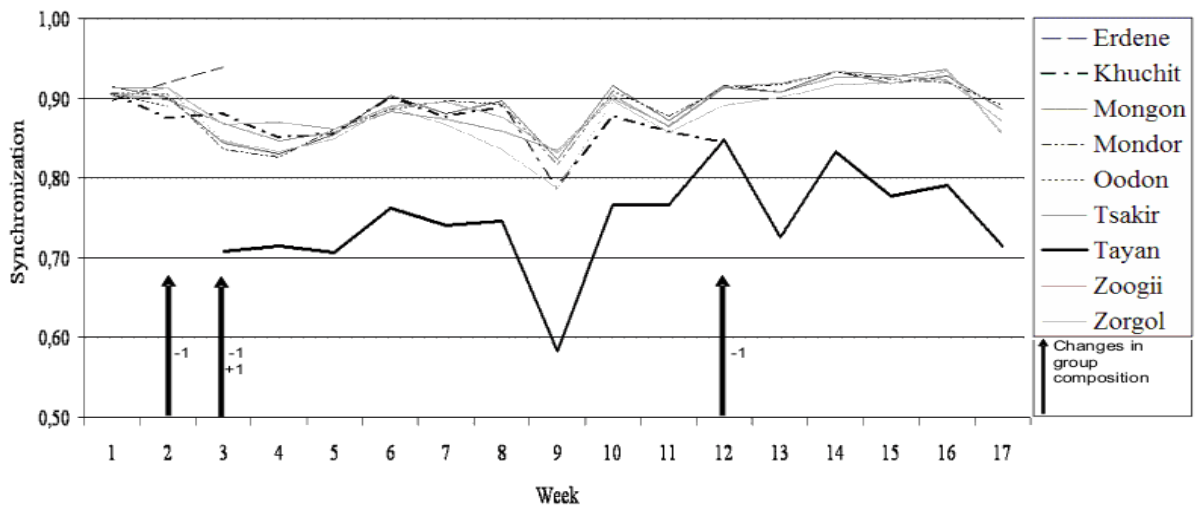
Fig. 6. Behavioral synchronization among all members of the study group averaged over 7-day intervals, starting with the release from the adaptation enclosure.

3.3. Body score index development

Contrary to our expectation all animals of the study group either held their body score index or improved it. By the end of the study period all individuals were in good condition (Table 3).

Table 3
Body score development from 5 May to 2 September 2003.

| | Body score of individual horses[2] | | | | | | |
| | Stallions | | Mares | | | | |
Date	KHUCHIT	TAYAN	MONDOR	MONGON	TSAKIR	ZOGII	ZORGOL
05.05.2003[1]	3		3	2.5	3	2.5	2
15.05.2003	3		3	2.5	3	2.5	2
01.06.2003	3	3	3.5	3	3	3	2.5
15.06.2003	3	3	3.5	3	3	3	2.5
01.07.2003	3	3	3.5	3	3	3	3
15.07.2003	3	3	3.5	3	3	3	3
01.08.2003	3	3	3.5	3	3	3	3
15.08.2003	3	3	3.5	3	3	3	3
01.09.2003	3	3	3.5	3	3	3	3

[1] Body score in the adaptation enclosure prior to the release on 13.05.2003.
[2] after Rudman and Keiper (1991); 0 = very thin, 3 = good condition, 5 = very fat

4. Discussion

Contrary to our expectations, newly released Przewalski's horses did not show the expected succession of an exploration-, acclimatization-, and established phase; neither in respect to their time budget-, behavioral synchrony-, nor their body score development. Instead, grazing activity was very high following the initial release, then decreased to a low in the 9th week and increased again towards the end of the study at the beginning of September. Resting activity followed the opposite trend, whereas moving activity was more or less constant over the whole observation period. Synchronization was high throughout the study period and immigration or emigration of members did not result in a de-synchronization of the group. The body score index also did not drop upon release, but rather increased for all group members. It seems that after one year in the adaptation enclosure the release of Przewalski's horses into the wild may be less stressful for the animals than originally assumed. Apparently Przewalski's horses are equally able to adapt to the harsh gobi environment as they are to adapt to the more productive mountain steppe environment (Boyd and Bandi 2002).

4.1. Time budget

Przewalski's horses were released into the Gobi in mid May after the first green-up occurred and when water in the Bij river ran several kilometers downstream into the SPA. Pasture quality in the adaptation enclosures is compromised due to past agricultural activities (1960s – 1980s) and restricted size (Ganbaatar, unpubl. data). Fodder hay is only provided twice a day, and has been stored in the open throughout the fall and winter and most probably lost some of its nutritional contents. Upon release, several of the study animals were only in fair condition and the new pastures in the Gobi most likely were a welcome alternative to the fodder hay. The percentage spend grazing was much higher in the gobi than in Hustain Nuruu (Boyd and Bandi 2002), however monitoring in Hustain Nuruu was done later in the year.

Examinations in semi-captive Przewalski's horses demonstrate a May peak in metabolic rate and subsequent gain in body mass (Scheibe and Streich, 2003; Kuntz, 2005; Arnold et al., 2004). The authors postulated that Przewalski's horses considerably reduced their metabolic rate during winter in order to cope with food shortage and harsh climate and then upped the metabolic rate in spring when abundant food became available to prepare for reproduction. Interestingly, Kuntz (2005) pointed out that the high energy expenditure for reproduction did not entirely explain the pronounced metabolic rate increase in spring. It is assumed that the increase in metabolic rate reflects the preparation of the organism for the upcoming task of processing large amounts of high quality food.

Thus the high level of grazing activity upon release and the decrease in grazing activity following the increase in body condition is not unusual and rather showed that the study animals were able to make the most of the newly available pastures. Several previous releases were not as well synchronized with vegetation green-up and water availability and groups repeatedly tried to re-enter their adaptation enclosure to gain access to water and hay (Ganbaatar 2003; Sinnmayer, 2003; Schönpflug, 2004). The 2003 study group, on the other hand, never tried to re-enter the adaptation enclosure and rarely grazed near the adaptation facilities. The overall time budget was within the values reported from other studies of semi-captive and free-ranging Przewalski's horses and does not suggest nutritional deficiency or a particular high stress levels of this newly released group (Van Dierendonk et al., 1996; Berger et al., 1999; Boyd and Bandi, 2002; King, 2002). Given the seasonal component in the time budget development, direct comparisons

between studies and even years should be viewed with caution as they may well reflect differences in climate rather than in the behavior of the study animals.

The daily distribution of grazing and resting also followed the pattern observed in feral horses, captive and free-ranging Przewalski's elsewhere; resting peaked and grazing was at its lowest during midday (Boyd, 1988; Boyd et al., 1988; Van Dierendonck et al., 1996; Boyd, 1998; Berger et al., 1999; Boyd and Bandi, 2002). In the Gobi regions, temperatures vary considerably not only between summer and winter, but also between day and night. The probability of grazing and resting of the study group clearly depended on temperature. Resting generally means a lower basic metabolic rate and a decrease in the metabolic rate is a common response to extreme ambient temperatures, water deprivation, food shortage or starvation (Arnold et al., 2004). In captive Przewalski's horses, water intake was highest during hot and dry periods (Scheibe et al., 1998). In the Gobi regions Przewalski's horses seem to avoid thermal stress and thus conserve water and energy when resting during the hottest hours of the day.

Hot temperatures are often positively correlated with a high presence of insects. In Camargue horses feeding activity decreased during the summer months, apparently in response to the number in biting flies (Tabanidae and Ceratopogonidae; Duncan, 1992). Przewalski's horses in Takhin Tal have also shown to suffer from insect harassment (Ganbaatar, unpubl. data) and low feeding activity levels around noon may be additionally explained by high insect presence. Insect presence is especially dense near water and thermal stress in combination with insect avoidance might also be a reason why Przewalski's horses seem to preferably drink in the early morning or late afternoon (Klimov, 1988; Pereladova et al., 1999; Sinnmayer, 2003; Ganbaatar, 2003; Souris, unpubl. data).

4.2. Group synchronization

Many reintroductions fail because the stress associated with the re-introduction weakens social bounds thereby increasing the chance of group dissociation after release (Stanley Price, 1989). The disruption of social groups may result in increased inter-specific aggression and increased vulnerability to predation. The high synchronization of 87-91% shown between the individual of the study group was evidence of a very good social integration of all its members and is at the higher end of group synchronization reported from other studies (Van Dierendonck et al., 1996; Boyd and Bandi, 2002; Schöenpflug, 2004). The latter might be due to the small group size and the absence of foals (Boyd and Bandi, 2002). Interestingly, the good social integration did not prevent the emigration of two mares within the first three weeks of the release.

The immigration of a second stallion in the third week also did not reduce behavioral synchronization of the group. However, in contrast to the behavior of the initial stallion, the new stallion showed a significantly lower synchronization with the mares and kept doing so after the first stallion left the group. We never observed high levels of antagonistic behavior between the two stallions and never any serious fighting (Souris, unpubl. data). We believe that the initial harem stallion largely lacked typical stallion behavior, e.g. herding of mares, patrolling, marking, alert behavior (Klimov, 1988) and thus lost the group to the second stallion. The second stallion showed this behavior and therefore was automatically less synchronized with the mares than the initial stallion. A lower synchronization of the harem stallion with the rest of the group is probably the norm and has also been observed for an established harem stallion in Takhin Tal in 1999 (Sinnmayer, 2003).

5. Conclusion

Our data suggests that captive bred Przewalski's horses experience little behavioral and nutritional stress when being released into the desert steppe of the Gobi regions after one year in an adaptation enclosure. The adaptation process seems as smooth as in the more productive mountain steppe and suggests that Przewalski's horses are equally capable to adapt to the harsh conditions of the gobi. Correct timing appears critical and managers should aim to release naïve Przewalski's horses with the onset of the green-up and in the vicinity of a reliable water source. In order to detect possible problems and to see how different release protocols influence the adaptation process, the time budget and body score development of Przewalski's horses should be closely monitored.

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