

Monitoring of agonistic behaviour and foal mortality in free-ranging Przewalski's horse harems in the Mongolian Gobi

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INTRODUCTION

Understanding the variables influencing natality and mortality is particularly important for the conservation of small populations (Hamon and Braude 2009). The re-introduced Przewalski's horse (*Equus ferus przewalskii*) population in Takhin Tal, in south-western Mongolia, has been naturally increasing since 2001 (Slotta-Bachmayer et al. 2004; Fig. 1). Samples from deceased animals are being collected following a standard necropsy protocol and post-mortem analyses were able to clarify the proximate and ultimate causes of death in several incidents (Robert et al. 2005). However, due to the large expanse of the study area and the presence of carrion eating vultures it is rather difficult to find the carcass of a missing Przewalski's horse and confirm the cause of death. Thus a large portion of Przewalski's horses just disappear without a trace, especially small foals.

In 2006 only twelve out of 33 (36 %) foals survived until winter, despite good pasture conditions. Whereas most foals just disappeared, three carcasses showing bite marks were retrieved. The bite marks were interpreted as signs of wolf predation by the local rangers and consequently wolf predation in general was blamed for the high foal losses. However, the wolf population in the area is heavily persecuted and wolf densities are believed to be low (Kaczensky et al. 2008). Furthermore, without a detailed necropsy the cause of death or the distinction between predation and scavenging are very hard to determine (Robert et al. 2005).

In feral horses reproductive success has been shown to correlate with harem stability (Cameron et al. 2009). In addition, mares in groups with more than one sexually active stallion had a lower fecundity and foals experienced a higher mortality (Linklater et al. 1999).

Furthermore, the killing of foals by conspecifics, especially by stallions, is well documented for Przewalski's horses and other equids under captive conditions (Ryder and Massena, 1988, Pluháček and Bartoš 2005). Whereas Feh and Munk-

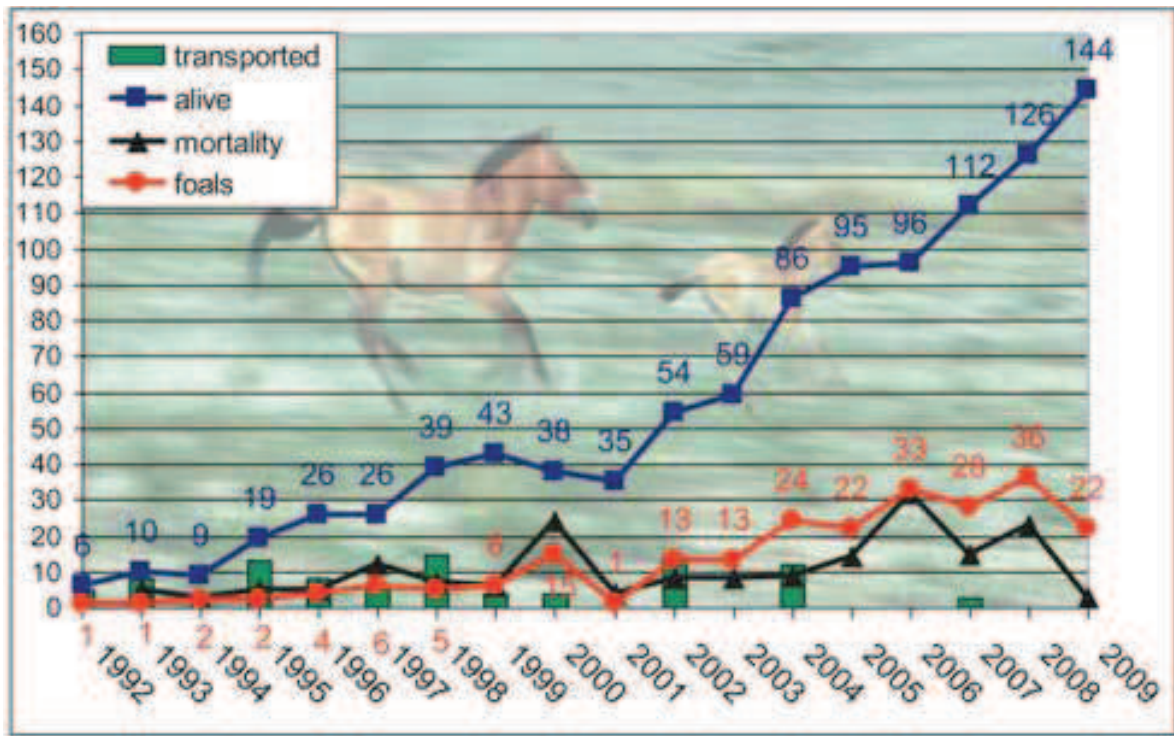


Fig. 1: Development of the Takhin Tal Przewalski's horse population in south-western Mongolia until December 2009.

htuya (2008) suggest that only zoo bred stallions which grew up in unnatural social groups are prone to infanticide, growing evidence from other areas suggests that infanticide is unlikely to be an artefact of captive condition or origin. Single observations of stallions killing foals of both sexes were independently made in the semi-reserve Pentezug in Hungary (W. Zimmermann, pers. comm.) as well as in free-ranging herds in Hustain Nuruu (N. Bandi, pers. comm.) and Takhin Tal (O. Ganbaatar, pers. comm.).

In the majority of the documented infanticide cases it was suggested that it was not the father, but rather an unrelated stallion that did the killing. But in contrast to other species like lions (*Panthera leo*, Packer and Pusey 1983) or brown bears (*Ursus arctos*, Swenson et al. 1997), the killing of young offspring in equids does not shorten the reproductive interval. Thus the unrelated stallion does not seem to increase his chances for reproduction by killing an unrelated foal. However the killing of a foal may result in a better body condition of the mare and thus increase the probability of a successful pregnancy. An alternative explanation might be the elevated testosterone level in a newly established harem stallion (McDonnell and Murray 1995, Sterregaard et al. 2002) and the reluctance of mares to accept a new breeding partner. Young foals might by accident become involved in quarrels and subsequently get wounded or act as a "punching bag" for a temporarily aggressive stallion.

In summer 2006 group stability of Przewalski's horse harems in Takhin Tal had decreased due to the loss of several lead stallions. This resulted in new group formations and frequent shifts of animals among groups, which was likely asso-

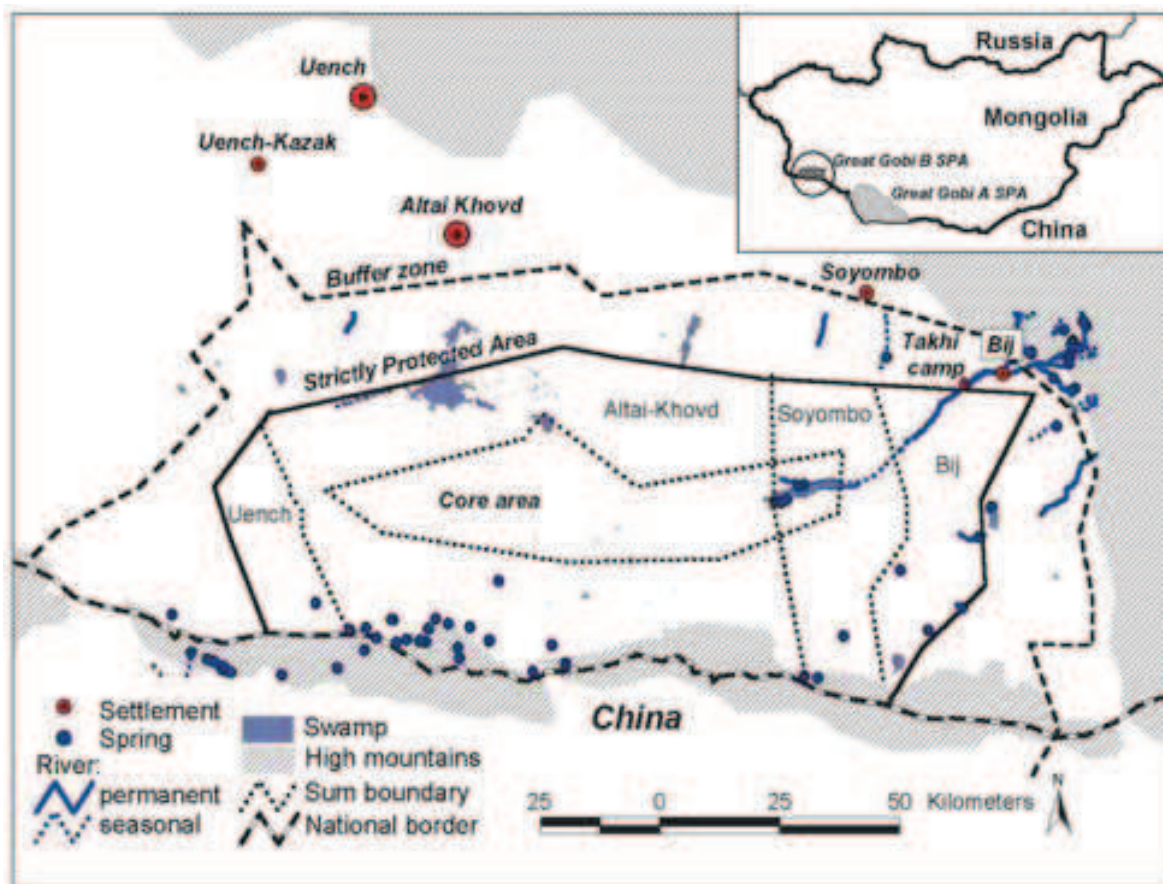


Fig. 2: Great Gobi B Strictly Protected Area in south-western Mongolia.

ciated with a higher level of antagonistic behaviour. In addition, multiple foals ended up in harems where the lead stallion was not their father, possibly making them more vulnerable to infanticide. In February 2007, another two lead stallions died, which again resulted in the formation of new groups. This situation provided a unique opportunity to investigate whether social unrest is coupled with an increased level of agonistic behaviour, which in turn results in high foal mortalities within the affected groups.

STUDY AREA

The Takhin Tal study area is located in the north-eastern corner of the Great Gobi B Strictly Protected Area in south-western Mongolia (Fig. 2). The SPA, was established in 1975 and encompasses some 9,000 km² of desert steppes and semi-deserts (Zhirnov and Ilyinsky 1986). The climate of the Great Gobi B, is continental with long cold winters and short, hot summers. Average annual temperature is 1 °C and average annual rainfall is 96 mm with a peak during summer. Average snow cover lasts 97 days. Rain and snowfall can be highly variable from year-to-year in space and time (Zhirnov and Ilyinsky 1986, Kaczensky unpubl. data).



Fig. 3: Tanja Nikowitz observing the Przewalski's horse harem Mondol.

The landscape of the area is dominated by plains in the east and rolling hills in the west. The Altai Mountains flank the park to the north, and the Takhin Shar Nuruu Mountains form the southern border with China. Elevations range from 1,000 to 2,840 m. Desert areas are widely dominated by Chenopodiaceae, such as saxaul *Haloxylon ammodendron* and *Anabasis brevifolia*. The steppe areas are dominated by Asteraceae, such as *Artemisia* and *Ajania*, and Poaceae like *Stipa* and *Ptilagrostis* (Von Wehrden et al. 2006).

The SPA is used by approximately 100 families with approximately 60,000 head of livestock (sheep and goats, horses, cattle and camels), predominantly in winter and during the spring and autumn migration (Kaczensky et al. 2007). In summer, human presence in the park is almost negligible. Other wild ungulates of the steppe areas are goitered gazelle *Gazella subgutturosa*, Asiatic wild ass and Przewalski's horse. The only large mammalian predator is the grey wolf *Canis lupus* (Kaczensky et al. 2008).

MATERIAL AND METHODS

We observed eight different harem groups, roaming in the vicinity of the Takhi camp, during 27 observation periods between 14 July and 23 September 2007 (Tab. 1; Groups are named after the lead stallion). An observation period normally started at midday of the first day and ended at midday the next day. Thus within two weeks each group was observed once and the investigation continued with the second observation of the first harem group.

Tab. 1: Observed Przewalski's horse harems in Takhin Tal 2007.

Individuals	Fx	sex	age	birth	sire	death	death cause
Mondol-group							
Mondol		stallion	10	10.05.97			
Tsgaadai		mare	11	06.06.96			
Imj		mare	13	02.08.94			
Dorothee		mare	8	06.06.99			
Dorothee's foal		mare	0	10.05.07	Mondol	20.05.07	disappeared
Khokhoo		mare	10	19.11.96			
Khokhoos foal	F10	stallion	0	20.06.07	Mondol		
Soir		mare	10	31.03.97			
Soirs foal	F11	mare	0	03.06.07	Mondol		
Telmen		mare	5	15.05.02			
Telmens foals	F12	stallion	0	20.06.07	Mondol	15.11.07	back leg broken
Sormuus		mare	3	13.06.04			
Buman		mare	2	29.04.05			
Azaa		stallion	2	21.05.05			
Khatan		mare	1	21.05.06			
Bokhoo		mare	1	03.06.06			
Sumber		stallion	1	24.06.06			
Tumen		mare	1	30.06.06			
Matar		stallion	1	02.07.06			
Zandan-group							
Zandan		stallion	9	28.05.98			
Misheel		mare	10	28.05.97			
Misheels foal	F6	stallion	0	03.06.07	Zandan		
Maral		mare	7	23.05.00			
Maral foal	F7	stallion	0	07.07.07	Tuulai		
Kherlen		mare	7	26.05.00			
Kherlen's foal	F8	mare	0	Begin of July	Zandan		
Orkhon		mare	7	15.07.00			
Orkhon foal	F9	mare	0	02.07.07	Tuulai		
Oroo		mare	5	24.05.02			
Erdene		mare	9	19.02.98			
Erdene's foal				10.07.07	Tuulai	10.07.07	disappeared
Zorgol		mare	7	20.05.00			
Saran		mare	4	09.04.03			
Saran's foal		mare	0	26.05.07	Tuulai	29.05.07	disappeared
Bars		stallion	2	09.05.05			
Burd		stallion	2	25.05.05			
Taij		stallion	1	09.05.06			
Jiguur-group							
Jiguur		stallion	15	12.06.92			
Sogoo		mare	14	01.12.92			
Sogoos foal	F3	stallion	0	31.05.07	Jiguur		
Gurguul		mare	12	07.05.95			
Gurguuls foal	F2	stallion	0	26.04.07	Jiguur		
Od		mare	13	23.04.94			
Ods foal	F1	mare	0	22.04.07	Jiguur		
Itgel		mare	11	12.06.96			
Itgels foal	F4	stallion	0	09.05.07	Jiguur		
Taikhar		stallion	3	12.05.04			
Agsam		stallion	2	24.06.05			
Naran		mare	2	01.09.05			
Maizii		mare	1	24.04.06			

Moogii's group

Moogii		stallion	8	08.10.99			
Tschandaga		mare	16	11.05.91			
Tschandaga's foal	F17		0	30.08.07	Pas (Khowch)		
Toot		mare	20	11.05.97			
Toot's foal			0	25.07.07	Pas (Khowch)	25.07.2007	disappeared
		stallion					
		mare					
		mare					
		mare					

Myangan's group

Myangan		stallion	7	01.05.00			
Zuram		mare	5	02.06.02			
Zuram's foal	F15	mare	0	12.07.07	Myangan		
Ners		mare	5	10.06.02			
Ners foal	F14	mare	0	08.06.07	Tayan	29.08.07	unclear, found
Udam		mare	5	15.05.02			
Udam's foal		mare	0	03.06.07	Myangan	06.07.07	disappeared
Borkhul		mare	3	28.04.04			
Borkhul's foal		stallion	0	04.05.07	Tayan	12.05.07	disappeared
Huvhar		mare	3	06.06.04			

Nomkhon's group

Nomkhon		stallion	5	07.05.02			
Bulga		mare	12	07.05.95			
Ugan		mare	15	02.09.92			
Nuden		mare	3	20.05.04			
Holog		mare	2	30.06.05			
Ugans foal	F13	mare	0		Pas (Khowch)		

Khuchit's group

Khuchit		stallion	8	16.06.99			
Ugan		mare	15	02.09.92			
Nuden		mare	3	20.05.04			
Holog		mare	2	30.06.05			
Ugans foal	F13	mare	0		Khowch		

Selenge-group

Selenge		stallion	7	28.08.00			
Yyl		mare	13	17.04.94			
Sonja		mare	7	13.06.00			
Sonjas foal	F5	stallion	0	31.05.07	Jiguur	22.11.07	disappeared

1 mare

Bulga		mare	12	07.05.95			
Bulga's foal	F16	mare	0	20.07.07	Pas (Khowch)	12.08.2007	wolf predation likely

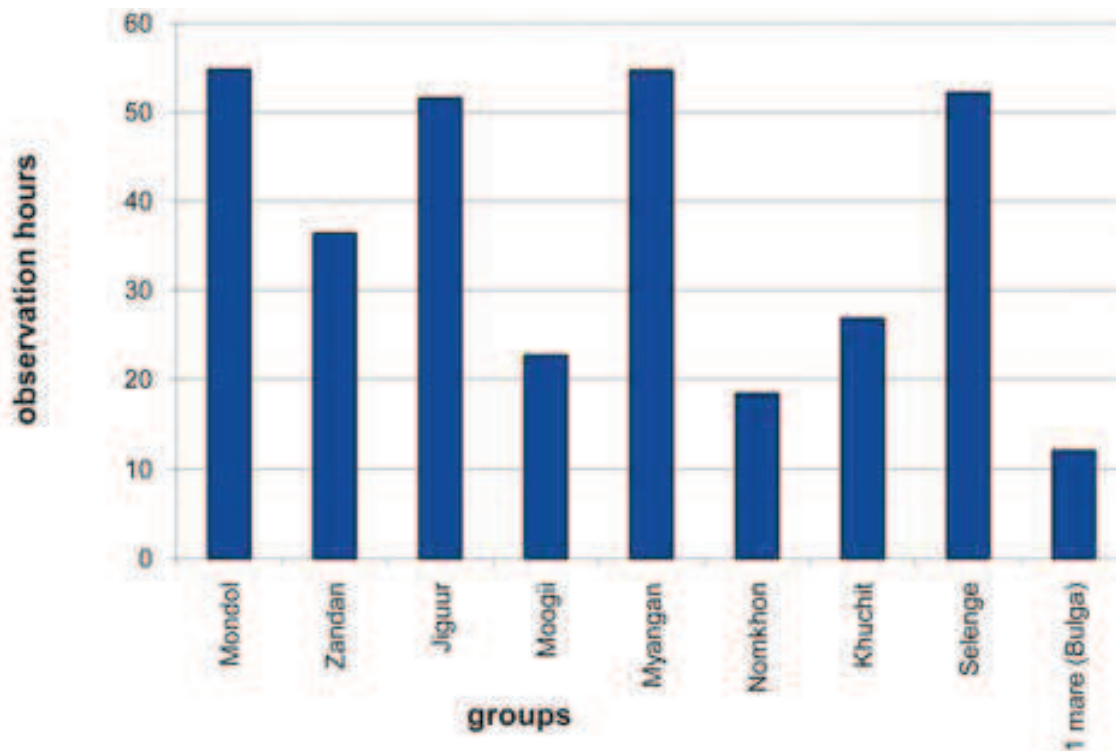


Fig. 4: Observation time for the different harem groups.

We completed four observation periods for the harems Mondol, Myangan, Selenge, Jiguur and Zandan, two for the harems Khuchit, Nomkhon and Moogii, and one of the mare Bulga and her foal (Tab. 1). The shorter observation periods were due to the timing of social changes:

- The Khuchit harem was taken over by the stallion Nomkhon half way through our investigation.
- The first foal in Moogii's group died before July and the second foal was not born before the second half of our investigation period.
- The mare Bulga and her foal separated from their harem group and were observed additionally to the harem observation schedule.

Once located, we observed a harem continuously using eyesight, binoculars or a telescope. During observations we were situated in a Jeep, on the flat desert-steppe or on a hill. Because flight distances of the individual harem groups varied quite strongly, our search effort was also quite variable, resulting in differences in the actual time harems were available for observations (Fig. 4).

We distinguished seven main behavioural categories (Tab. 2) and additionally recorded: start and end of observation, initiator and target of antagonistic behaviour, comments, other disturbances, location, distance, direction and observer. We further recorded the condition of each individual horse using the grading chart of Rudman and Keiper (1991; 0 = very skinny, 1 = thin, 2 = fair, 3 = good, 4 = fat, 5 = very fat). However, due to long observation distances, we were not always able to record condition. Any horse found dead was investigated following a necropsy protocol and documented with pictures.

Tab. 2: Ethogram coding used for our investigation.

category		behaviour
A	aggressive interaction	attacking biting chasing fighting kicking playfighting threatening
D	disturbance by external source	alert fleeing moving running scared
Fx	foal × drinking	drinking (F1, F2... F17)
F?	unknown foal drinking	drinking
I	interruption of observation	approaching by car moving by car to a better spot
N	main behaviour of whole group (>50% of adult animals)	drinking grazing moving resting
O	other interesting behaviour	drinking attempt mating attempt observation condition other group smelling, tasting wallowing earling drinking hardly visible not visible partly visible
P	positive interaction	grooming playing



Fig. 5: The mare Khokhoo and the three foals of Mondol harem.

To compare aggression within the harem (intra-aggressive interactions) and account for differences in group size, we divided the time any harem member spend involved in antagonistic behaviour and the number of times antagonistic behaviour was observed by the total observation time (duration – expressed as minutes per hours and horse) and the number of non-foal horses in the individual harem (frequency – expressed as N per hour and horse). To compare aggression between harems (inter-aggressive interactions) we calculated the average number of aggressive encounters per hour (duration – expressed as minutes per hours) and the average number of aggressive encounters per hour (frequency – expressed as N per hour). For visualisation we used program EXCEL and sorted harems from the larges to smallest groups on the x-axis.

RESULTS

1. Fate of individual Przewalski's harem groups

Mondol

The Mondol group counted 15 adults and three foals (Fig. 5). Mondol was the father of all the foals in his harem. Dorothee's foal had already disappeared before the start of our observation. In July all foals were in good condition, playing with and grooming each other. Telmen's foal (F12) got severely injured on the right hind leg at the beginning of August. It was hardly able to put weight on the affected leg, mostly walking on three legs (Fig. 6). The leg could have been broken. Although the foal survived until the end of our observation period, it became rather skinny and subsequently disappeared in November. Aggressive interactions in the group were numerous (total 123 times). Especially the yearlings were frequently involved (total 51 times). Interactions with other Przewalski's horse



harems happened only once. During the last observation period Mondol and Zandan groups were grazing close to each other. The yearling stallion Sumber even moved from Mondol's to Zandan's harem where he groomed with another yearling stallion and then moved back. First Mondol play fought with Sumber and then Zandan chased him. Sumber then fled about four kilometers away from the group in the evening. The next day he was back in Mondol group.

Zandan

The Zandan group consisted of twelve adults and four foals. Two of the four foals were the offspring of the deceased stallion Tuulai. Another foal of Tuulai and Saran had died before the observation period. The foal of Tuulai and Erdene either died during birth or was killed shortly thereafter. All of the observed foals were in good condition (Fig. 7). During the first observation period foals often ventured quite far from their mothers. During the second observation period they stayed very close to their mothers without grooming or playing with each other. But during the third and fourth observation period the foals were again very active; they played, groomed and ran a lot. Zandan was grooming with the foals and mares, including those foals of which he was not the biological father. Zandan once had to chase away three bachelors (Fig. 8), who mixed into his group and started to fight with the young stallions. Otherwise the group seemed quite excluded from any interactions with other groups.

Jiguur

The Jiguur harem group consisted of eight adults and four foals. The foals, all of them the offspring of Jiguur, seemed to be in a very good condition. They grew well, groomed each other, played a lot and often stayed quite far away from their mothers. No losses of foals were recorded during the monitoring time. We only observed one interaction of Jiguur group with other groups, which involved fighting off several bachelors.



Fig. 6: Telmen's foal with its injured leg couldn't flee at the same speed as the rest of the harem.



Fig. 7: The foal of Orkhon F9 in a good healthy condition.



Fig. 8: Zandan chasing away a bachelor who mixed into his group.



Fig. 9: Myangan group resting in the midday heat.



Fig. 10: Myangan group stampeding after drinking.

Moogii

Moogii group consisted of seven adults and one foal. The foal was born at the beginning of September and had been sired by the deceased lead stallion Pas. The tiny foal stayed close to its mother most of the time. We did not document any conflicts with other Przewalski's groups.

Myangan

The harem group of Myangan consisted of six adults and two foals (Fig. 9 and 10). The mares Borkhul and Udam had already lost their foals before the onset of our observations. One of the two remaining foals, Zuram's foal (F15), seemed weak with some older wounds on shoulder and muzzle. Ner's foal (F14), on the other hand, seemed very strong. However, Ner's foal was found dead due to unclear circumstances at the end of August (Fig. 14). In total three out of four foals died; two of the deceased foals were the offspring of the deceased harem stallion Tayan, one was the foal of the present harem stallion Myangan. However, we never observed any aggressions of Myangan towards the unrelated foals. Inter-aggressive behaviour could only be observed once when Myangan had a short fight with Jiguur.

Khuchit / Nomkhon

Khuchit group consisted of four adults and one foal. Ugan's foal originated from the deceased lead stallion Pas. We did not observe any aggressive behaviour towards the foal from the new harem stallion. The foal was in good condition and usually stayed close to its mother (Fig. 11). In July Khuchit had to fight off a bachelor group which included the stallion Nomkhon, from whom Khuchit had taken over the harem in May 2007.

At the beginning of September Nomkhon managed to reclaim his harem from Khuchit. He additionally recruited the mare Bulga. The new Nomkhon group consisted of five adults and one foal. Like Khuchit, Nomkhon did not show any aggressive behaviour towards the unrelated foal. The mare Nuden was missing during the last observation and was later found to have joined Myangan's group.

Selenge

Selenge harem group comprised of only three adults and one foal. The mare Sonja and her foal (F5, Fig. 12) originated from Jiguur's harem, who was also the sire of the foal. F5 stayed close to its mother during the first observations, later it groomed and associated with all adults. Although Sonja's foal survived throughout the observation period, it disappeared in November and the mare Sonja moved back to Jiguur group. Selenge carried out four attacks against bachelors.

Bulga

At the beginning of August Bulga, a mare originating from Moogii's group, was observed alone with her foal (F16). The foal's father was the deceased stallion Pas. Her foal seemed to be in a good condition but was found dead two weeks later. Because a wolf showed up at the hill with the corpse and the foal showed extensive bite marks, we assume it was killed by a wolf (Fig. 13). Later Bulga was found to have joined Nomkhon group.



Fig. 11: Ugan, her foal F13 and the two other mares of Khuchit group Holog and Nuden



Fig. 12: Sonja's foal F5 was sired of Jiguur and stayed with his dam in Selenge harem. Here in the Bij river flood plain..

Body condition

In general all horses increased in body condition from July to September (Tab. 3).

2. Mortality of foals

Bulga's foal (F16)

The dead female foal was discovered on 12. 08. 2007 with the mother still standing traumatized next to it. While we observed the situation at a distance of 1 km with the telescope, a wolf appeared to be trying to eat or get the foal. After a few minutes he left, probably because of our human smell due to a strong backwind. When we approached the foal two hours later, the first vultures had arrived by which scared the mother was scared away. The foal was well preserved; we were able to examine the death cause of death (Fig. 13a, with spotlight on the abdomen). It had bite marks on the neck and head and the oesophagus was bitten through (Fig. 13b). In addition, there was a big open wound on the abdomen

Tab. 3: Body condition development for the observed harems from mid July to mid September 2007.

	Jiguur	Selenge	Zandan	Mondol	Khuchit	Myangan	Moogii	Nomkhon
Mid July								
ad female+foal	2.00	2.00	2.00	2.00	2.00	2.00	g.f.	g.f.
ad female	2.00	2.00	2.00	2.00	2.00	2.00	g.f.	g.f.
ad male	2.00	2.00	2.33	2.50	2.00	2.00	g.f.	g.f.
yearling female	2.00	-	-	1.67	-	-	g.f.	g.f.
yearling male	-	-	1.00	1.50	-	-	g.f.	g.f.
Begin of August								
ad female+foal	2.50	2.00	m.	2.33	2.00	2.50	g.f.	g.f.
ad female	2.00	2.00	m.	2.40	2.00	2.33	g.f.	g.f.
ad male	2.50	2.00	m.	2.50	3.00	3.00	g.f.	g.f.
yearling female	2.00	-	m.	2.00	-	-	g.f.	g.f.
yearling male	-	-	m.	2.00	-	-	g.f.	g.f.
End of August								
ad female+foal	m.	m.	2.50	2.67	g.f.	m.	m.	2.00
ad female	m.	m.	2.75	2.67	g.f.	m.	m.	2.33
ad male	m.	m.	2.33	2.50	g.f.	m.	m.	2.00
yearling female	m.	-	-	2.00	g.f.	-	-	-
yearling male	-	-	2.00	2.00	g.f.	-	-	-
Mid September								
ad female+foal	2.50	2.00	2.75	2.33	g.f.	3.00	3.00	3.00
ad female	2.00	2.00	2.75	2.60	g.f.	2.75	2.67	2.50
ad male	3.00	3.00	2.33	2.50	g.f.	2.00	2.50	3.00
yearling female	2.00	-	-	2.00	g.f.	-	-	-
yearling male	-	-	2.00	2.00	g.f.	-	-	-

m. = missing

g.f. = no observation due to group formation

with some organs coming out (Fig 13c). Around the location of the dead foal we found tracks that looked to be from a hunting scene. Following these signs we concluded that F16 had been killed by a wolf.

Ner's foal (F14)

The carcass of the female foal of Myangan group was found on 29. 08. 2007, already half eaten. Only little of the head was left to recognize the foal (Fig. 14). Four vultures and several smaller birds were feeding on the carcass when we arrived. One leg was found at a distance of six meters from the body. We discovered two wounds on the neck (Fig. 15), which looked similar to the wounds on the head of F16. However, the oesophagus did not show any injuries. On the very dry ground some tracks were visible, but were not really recognizable.

3. Agonistic behaviour

Intra-aggressive interactions occurred most often in Myangan's group, followed by Jiguur's, Mondol's and Zandan's harem and less frequently in the small harems of Khuchit, Moogii, Nomkhon and Selenge (Fig. 16a). The time spent on aggressive behaviour differed from the frequency of aggressions occurring in most groups (Fig. 16b). For example for Khuchit's group we documented seven aggressive encounters that lasted for 30 minutes whereas for Myangan's group we documented 68, but very short aggressive encounters.

The smaller groups like Khuchit and Selenge were involved in more aggressive interactions with other groups than the bigger groups (Fig. 17a).



Fig. 13 a-c: Based on the observation of the wolf near the scene of death place and the bitten through oesophagus, we assume Bulga's foal (F16) was killed by a wolf.

Foals were only involved 12 times out of a total of 370 in aggressive interactions within groups. We mainly documented aggressive interactions in Jiguur's, Myangan's and Selenge's harem (Fig. 18). However, for the most part it seemed that foals were just accidentally involved. We never observed any intentional attack on a foal.

Discussion

We are fully aware that our study cannot provide final answers to the causes of foal mortality or the very complex issue of infanticide in equids. The study duration was limited to two months of one particular year and we were only able to observe different groups during a maximum of four observation days. Therefore our study can only provide information on a very limited temporal subset of be-





Fig. 14: Through the presence of carrion eating vultures it is rather difficult to find the carcass of a missing Przewalski's horse and confirm the cause of death (Tab. 1).



Fig. 15: The two wounds on the neck of Ner's foal; (F14) the oesophagus was still complete.

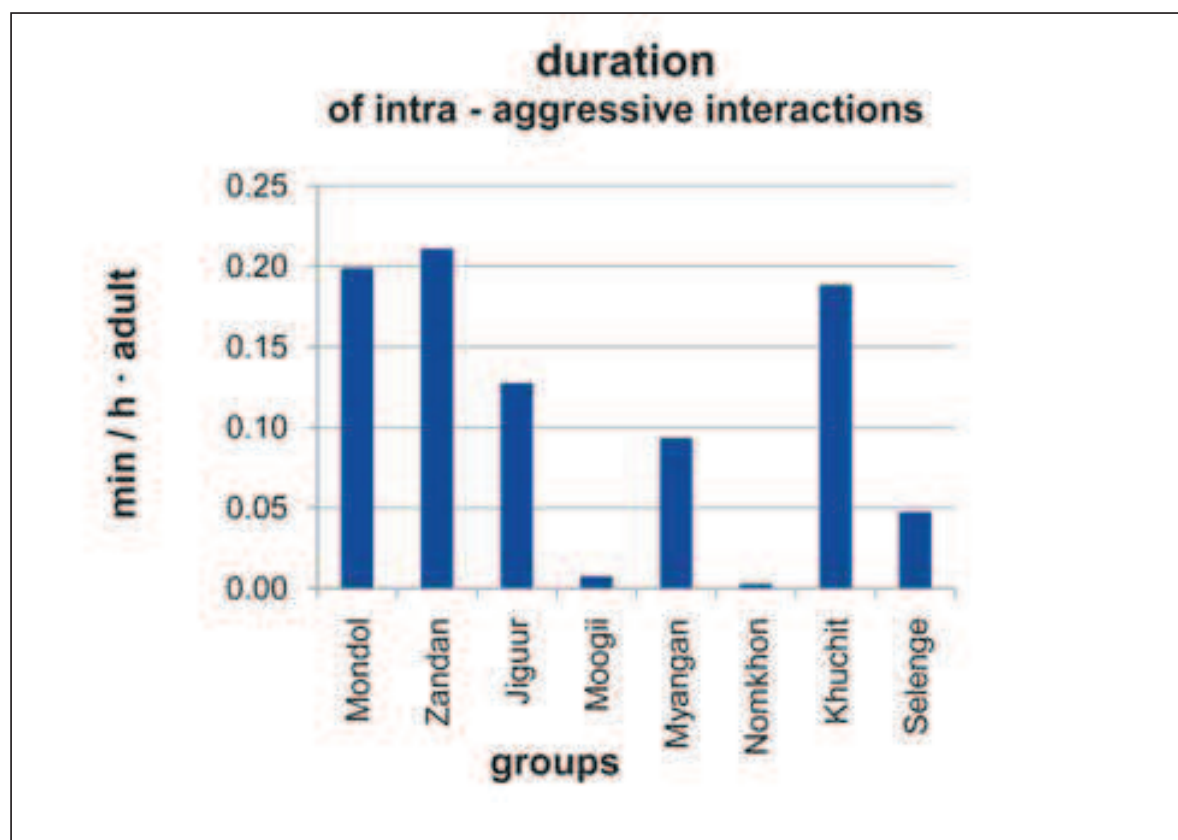
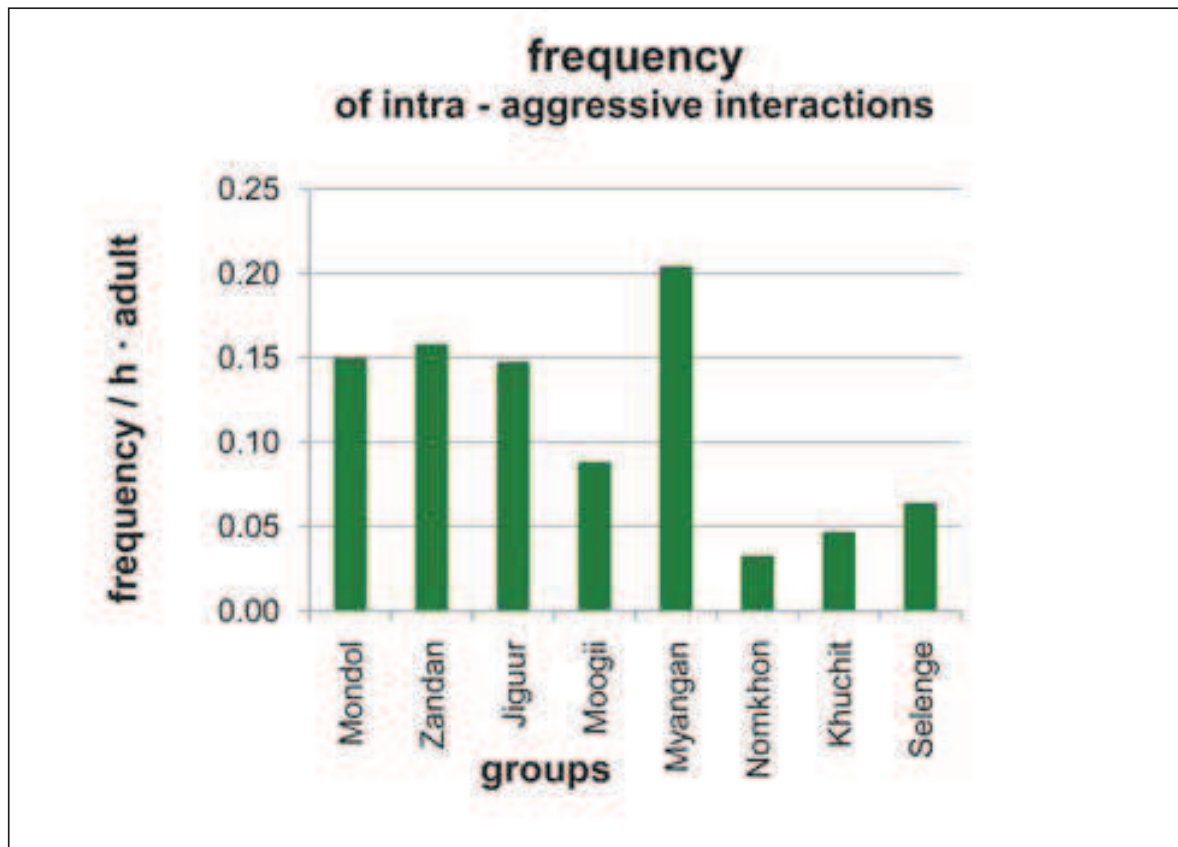


Fig. 16a & b: Averaged frequency and duration of intra-aggressive behaviour per adult and hour in the eight harem groups.

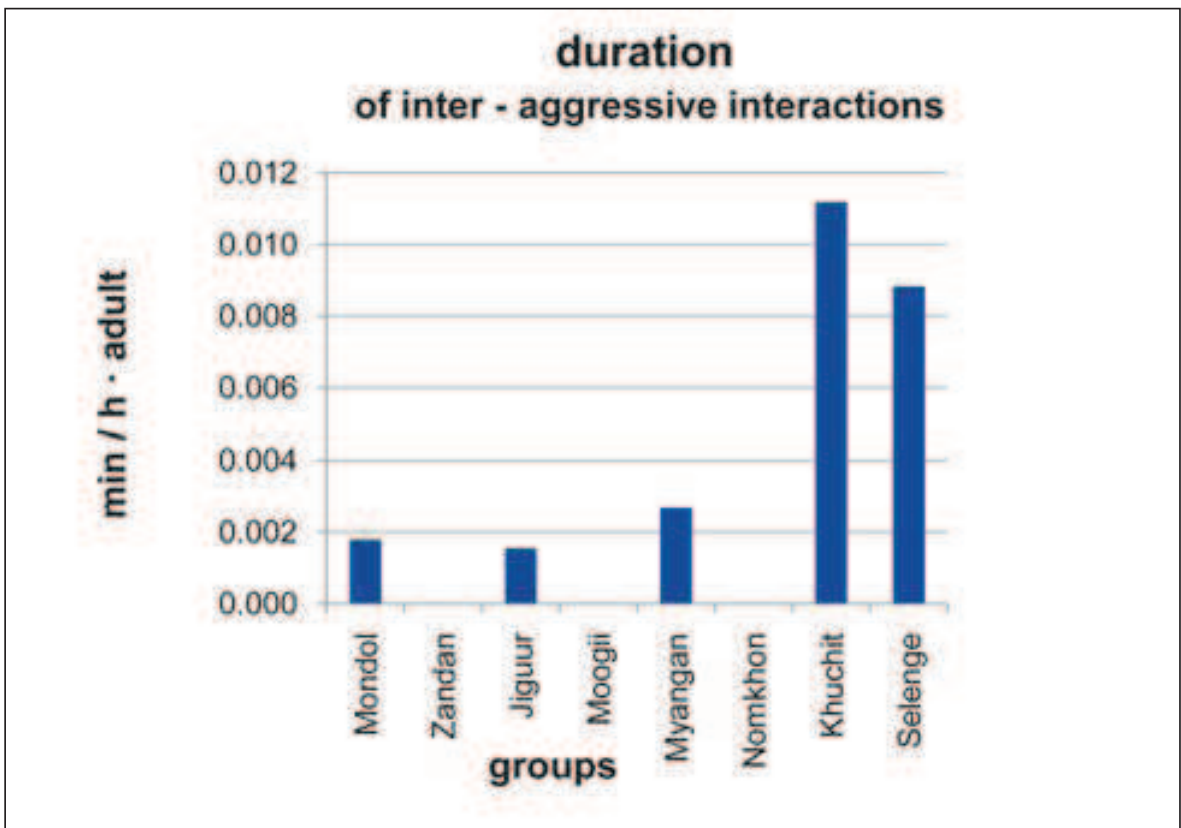
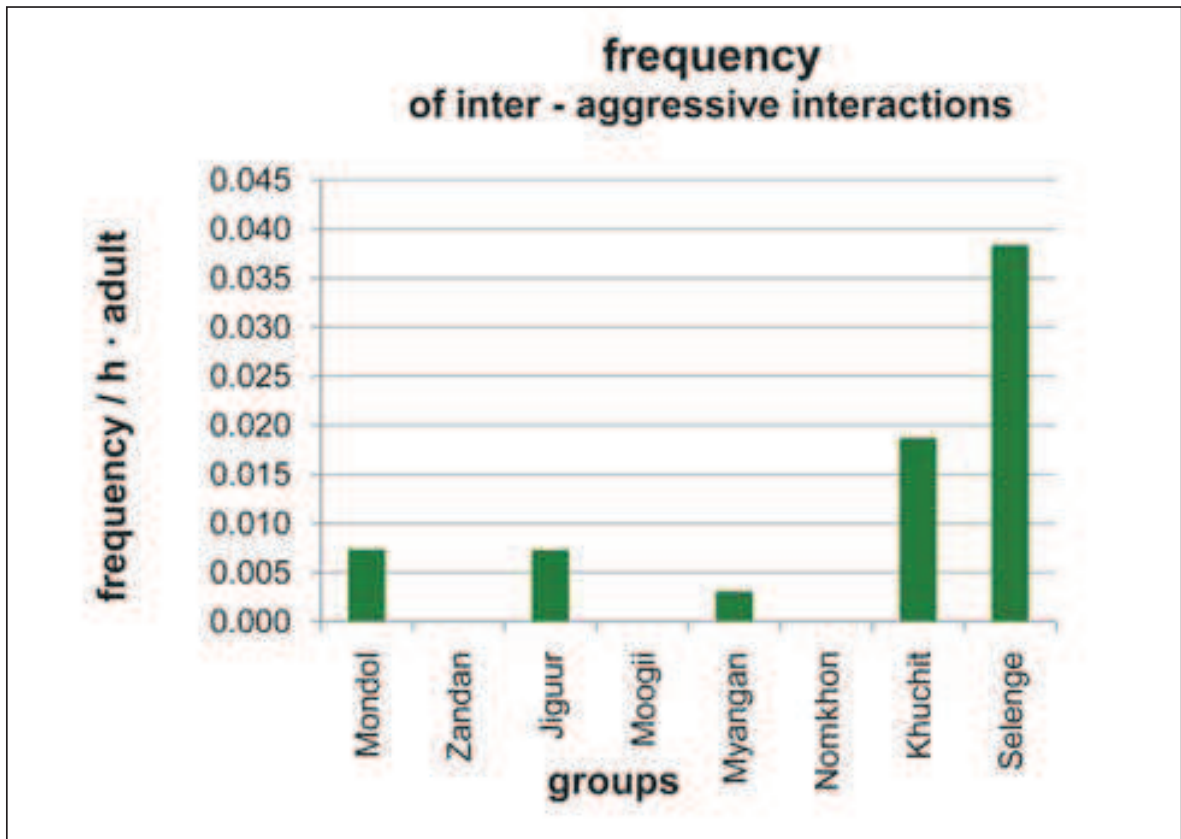


Fig. 17a & b: Averaged frequency and duration of inter-aggressive behaviour per adult and hour in the eight harem groups.

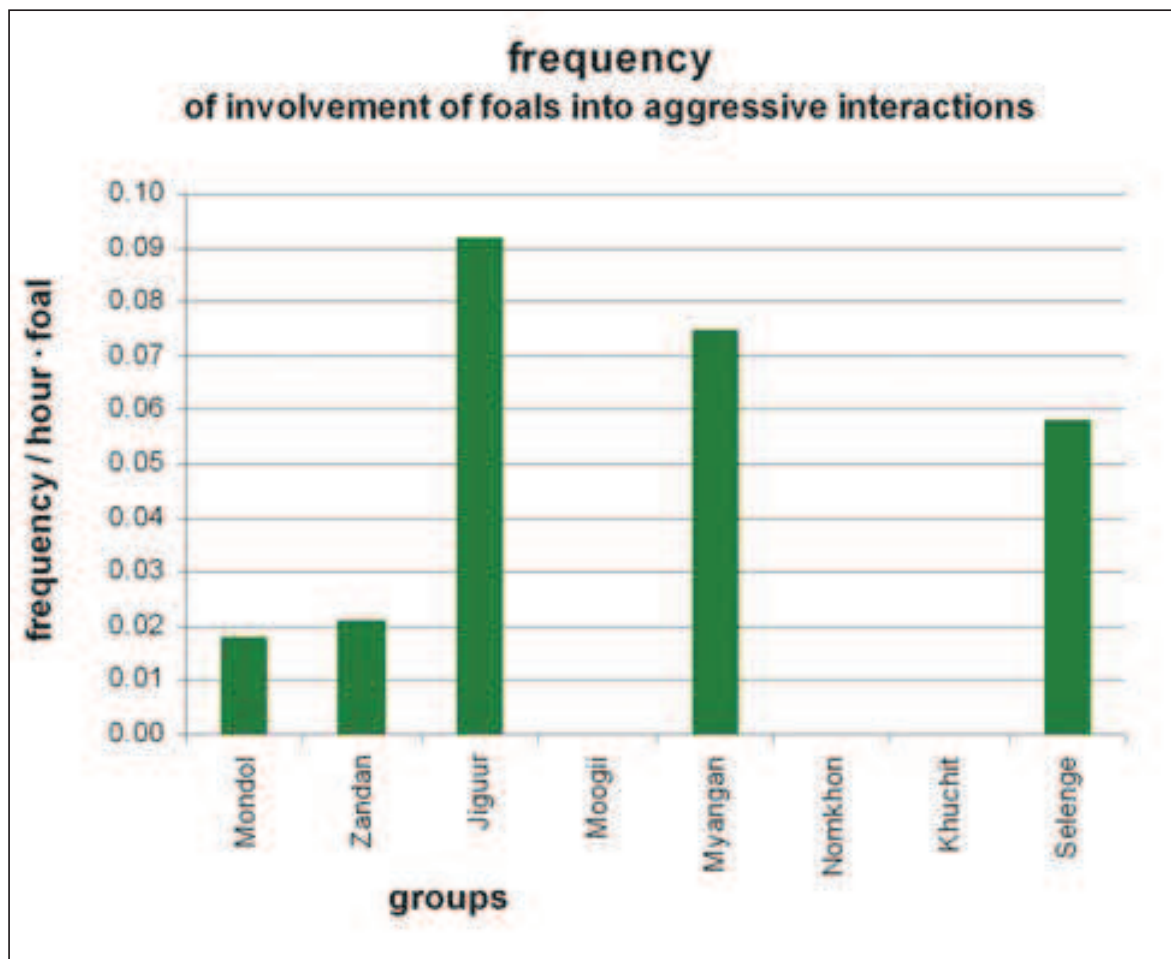


Fig. 18: Averaged frequency of foals involved in intra-aggressive behaviour per foal and hour in the eight harem groups.

havioural interactions in free-ranging Przewalski's horses. Rather than over-interpret these patterns, our pilot study should help to design future, more detailed, and longer-lasting field studies.

Agonistic behaviour

During the 2007 observation period, aggression within or among the Przewalski's groups could not be identified as a key factor explaining foal mortalities in Takhin Tal. Aggressive behaviour towards foals was rare, never resulted in any serious injury and in the group where it occurred most often, no foals were lost. Furthermore, groups with new harem stallions did not show higher levels of aggressive encounters, neither within the group, nor with other groups. However, of the 14 deceased foals in 2007 eight died before, three after and only three during our observation period. In the latter case, one disappeared immediately after birth before we had a chance to observe it. Thus our observations may have missed most of the relevant intra- or inter-group aggressions.

Although we have no direct evidence, social unrest may indirectly contribute to the loss of foals. The harem of Myangan for example was highly alert, ran a lot, and frequently shifted its grazing area. This may have resulted in less grazing time and a higher stress level and would be a possible explanation why this group lost

one foal during the observation period and two others previous to our observations. In addition, it looks like small groups are more prone to aggressive encounters with other Przewalski's groups, particularly bachelor stallions. Whether small groups are more prone to foals losses than large ones could not be resolved in this study, but should be investigated in the future.

Infanticide

In 2007, several foals were born into groups where the lead stallion was probably not their biological father. However, parentage in Takhin Tal was not confirmed by genetic analysis, but rather stallions are assumed to have sired a foal when they had been observed to have mated with the mare, or had been in possession of the mare during the previous breeding season. Assuming known parentage, our observations do not suggest that stallions treat unrelated foals any differently from related foals. In one harem with a stallion change, the mare Bulga left just after her foal's birth, which could be interpreted as an attempt to avoid infanticide. However, the opposite also happened. The mare Sonja and her foal left the harem of the foals' sire (Jiguur) and joined a harem of an unrelated stallion (Selenge group). Thus our observations support the findings from other areas which also show that an unrelated lead stallion can, but by no means has to be, a risk for the life of foals (Feh and Munkhtuya 2008, W. Zimmermann pers. comm.). In equids the killing of young offspring does not shorten the reproductive interval and thus benefits of male infanticide have to be more subtle (e.g. higher likelihood of having a foal the next year).

Wolf predation

Due to the difficulty of finding and retrieving the carcasses of small foals, causes of mortality in foals of free-ranging Przewalski's horses are poorly documented. There is no doubt that wolves can kill Przewalski's horses, particularly foals (Kaczynsky et al. 2008, Van Dyne et al. 2009). However, without careful examination of all circumstances, other causes of mortality may easily be overlooked. This was the case in the winter 2000/1 when wolf predation was believed to dramatically reduce the Przewalski's horse population in Takhin Tal. However, post-mortem necropsy revealed an infection with strangles as the proximate cause for Przewalski's horses becoming weak. They only subsequently fell prey to or were scavenged by wolves (Robert et al. 2005). During our observation period we were able to investigate two foal carcasses. In one case wounds and circumstantial evidence make predation by wolves the most likely cause of death. Why the mare chose to leave the safety of her harem with a small foal in the first place remains unsolved. In the second case bite marks could also have been inflicted by other animals (e.g. dogs or horses), or inflicted post-mortem. Thus wolf predation as a reason for the majority of foal losses could be neither rejected nor confirmed.

CONCLUSIONS

No final conclusions can be drawn from this investigation. The survey of the groups over two months is a very limited time period. Several foals had already disappeared and others vanished without us being able to observe the circumstances. Thus further investigations should be carried out throughout the

whole reproduction period. Less time-intensive and more systematic methods, like monitoring of groups positions with high temporal resolution to document the timing and frequency of interactions among groups, would be desirable.

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All pictures were taken by Tania Hoesli in the Great Gobi B Strictly Protected Area in south-western Mongolia 2007.



Fig. 19: Zandan group moving through the Great Gobi B Strictly Protected Area

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