



**SOCIAL CHARACTERISTICS OF A STABLE AND A TEMPORARY
GROUP OF ICELANDIC HORSES.**

How do horses cope in new social circumstances?

Iiris Kallajoki



**Líf – og umhverfisvísindadeild
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SOCIAL CHARACTERISTICS OF A STABLE AND A TEMPORARY GROUP OF ICELANDIC HORSES.

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Research project in biology for foreign students (LÍF015M) - 20 units

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Social characteristics of a stable and a temporary group of Icelandic horses. How do horses cope in new social circumstances?

Social characteristics of two horse groups.

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Abstract

The social characteristics of one stable and one temporary group of Icelandic horses were studied altogether for 85 hours during autumn and winter 2009 - 2010. Seven horses were moved from the stable group (at Bær) to the temporary and special attention was paid to their behaviour. Two of those horses (22 and 20 years old geldings) had spent seven previous winters in the pasture where the temporary group was held (at Fell) and were familiar with some of the horses there. Two elderly geldings (20 and 19 years old) who had a long relationship were there for the first time and so were two of three young mares – the third had been born in the pasture and stayed there for the first 4 months of her life. Also, time budgets were estimated in the temporary group in order to study individual variation.

In both groups the dominance hierarchy was significantly linear and rank was positively correlated with age and aggression. In general the results support former findings of horses bonding more with familiar individuals, within the same sex and between horses of similar rank.

Analyses of the seven focal horses that were transferred between groups showed some interesting results. During the first two hours the leader (Lilli) protected his group, especially the geldings from the other horses and another gelding protected the young mares. Lilli was one of the two horses who had been in the temporary group earlier and was the highest ranking horse in the stable group and the second highest in the temporary group. These two horses were staying close to each other and were otherwise mainly socialising with quite high ranking horses in the temporary group. Being close to Lilli seemed to help two of the three geldings from Bær to gain a higher position in the hierarchy when moved to the new group. Lilli tolerated the presence of the six that came with him much better in Fell than he did at Bær. One of the geldings hardly ever approached Lilli but he was often in the company of the young mares from Bær. They bonded strongly with each other, and also created new bonds with individuals in the temporary group.

Aggression and allogrooming rates were both higher in the temporary group. Higher ranking individuals spent more time eating hay than those ranking lower. This has been reported earlier (Ingólfssdóttir and Sigurjónsdóttir, 2008) and shows how important it is to secure access for all horses to hay.

Útdráttur

Félagsgerð tveggja hrossahópa og hegðun hestanna í hópunum var könnuð aðallega í þeim tilgangi að fylgjast með hegðun sjö hrossa sem voru flutt á milli hópanna um áramót. Rannsóknin fór fram í Kjós í alls 85 klst frá október 2009 til mars 2010. Í þeim hóp sem hrossin voru í fyrir áramót þekkjast flest hrossin mjög vel og líta má á þann hóp sem stöðugan. Í þeim seinni er mun meira um breytingar. Fyrri hópurinn var í mun stærri girðingu á Bæ (130 ha) en hinn á Felli (30ha). Hrossin voru eingöngu á beit í fyrri hópnum en fengu hey í þeim síðari. Af hrossunum sjö höfðu tveir fullorðnir geldingar (22 og 20 vetra) verið saman í útigöngu í 8 ár á Felli. Hinir fimm voru tveir fullorðnir geldingar (20 og 19 v) og þrjár 2ja vetra merar. Í seinni hópnum var lagt mat á það í hvað tími hrossana fór til að athuga hvort staða í virðingaröð hafi áhrif á fæðunám.

Í báðum hópum var marktæk línuleg virðingarröð og reyndist aldur og árásargirni hafa marktæka jákvæða fylgni við stöðu. Hrossin tengjast (vinátta) mest hestum sem þeir þekkja vel, eru á svipuðum aldri, af sama kyni og á svipuðum stað í virðingarröðinni. Í ljós kom að hrossin sem voru flutt á milli hópanna höguðu sér á mismunandi hátt sem endurspeglar mismunandi hugsunarhátt og eðliseiginleika einstaklinga. Sá elsti í hópnum (Lilli) sem var efstur í virðingarröðinni á Bæ og næstefstur á Felli verndaði hrossin í fyrstu, einkum geldingana. Hann þoldi návist allra mun betur á Felli en hann gerði á Bæ og tveir af þremur geldingum héldu sig mikið nálægt honum. Báðir höfðu hærri stöðu á Felli, líklega vegna þess að þeir nutu þess að vera vinur Lilla. Tryppin héldu mjög saman en blönduðust öðrum töluvert, þó mismikið væri.

Árásargirnir var meiri í vetrarhópnum. Hátt settir einstaklingar eyddu meiri tíma í heyát en þeir lægra settu. Sú niðurstaða er sú sama og fannst í annarri rannsókn hér á landi (Ingólfssdóttir and Sigurjónsdóttir, 2008), sem sýnir hversu mikilvægt það er að tryggja að tryppi og huglítill hross hafi aðgang að fóðri.

Preface

I am a biology student in University of Turku in Finland. In the past I have spent some years taking riding lessons in Finland and after that the interest for horses has never ended. Icelandic nature and the Icelandic horse have fascinated me for a long time and finally I decided to become an exchange student here. I met my supervisor Hrefna Sigurjónsdóttir on another course she was teaching at the University and she offered me this possibility to help her with her research. I want to thank Hrefna for the opportunity to make this research project and all the advice and help she has given me throughout the study. I also want to thank Hrefna and Sigurður Snorrason for the experiences with horses. It has been great and educational.

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1. Introduction

Horses (*Equus caballus*) are social animals living in herds consisting of smaller groups/bands (families) of individuals. Family bands of feral horses normally have a stallion, about three mares and their offspring of recent years (Waring, 2003, p. 211-212). Icelandic horses are generally kept in herds consisting of both adult and immature horses of different ages (Sigurjónsdóttir *et al.*, 2003). Herd life increases safety because there are more eyes keeping lookout on predators, and a diminished chance for an individual of getting eaten upon attack (Dockery and Reiss, 1999, p. 69, 71). The relatively complex social structures of horse herds show adaptations to herd life formed during thousands of years of evolution (Sigurjónsdóttir, 2007). Horse's ability to learn is one important characteristic that has made it useful for humans as a domesticated species (Waring, 2003, p. 96).

Everyday life in horse herds is made easier by dominance hierarchies that reduce aggression between individuals. Usually only subtle threats are needed for a lower ranking horse to withdraw from a higher ranking individual. The rank order of a horse can be affected by many factors like age, weight, height, earlier experiences, physical condition, temperament, familiarity between individuals and proximity of other horses. Newcomers and young horses are usually low in the hierarchy but move higher in the rank when they get familiar with the group or mature (Waring, 2003, p. 211, 243, 247, 249, 250). The squeals of dominant and subordinate horses differ, such that the dominant horses can exhale air more forcefully indicating that they have better aerobic capacity which gives advantage in fights (Macdonald, 2009, p. 692). The social circumstances can have an effect on the rank status. Thus, individual A can be submissive towards individual B when A is alone, but B can be submissive to A when A is near a certain horse (McDonnell, 2003, p.22). Also horses may differ in persistency in certain situations, for example feeding versus drinking, being submissive to certain individuals while drinking but dominant over the same horses while feeding. Dominance hierarchies in horses are in general close to linear, but many times with some circular (A is dominant towards B, B is dominant towards C, who is dominant towards A) or equal relationships. Dominance hierarchy influences the social characteristics of the herd and therefore can affect the lives of individuals (Waring, 2003, p. 243, 247, 249). Furthermore, higher ranking individuals can have

more access to hay and get more shelter during bad weather than individuals lower in the hierarchy (Ingólfssdóttir and Sigurjónsdóttir, 2008). The high impact of dominance hierarchy on lives of individuals is to be taken into consideration when studying social behaviour in horses or time budgets of groups with limited access to resources.

Horses differ in temperament between breeds and individuals. Environment, training, use of the horse and genetic inheritance explain a big part of these differences but aggressive behaviour might also be at least partially learned (Bowling and Ruvinsky, 2000, p. 288-289). Young mares who have recently reached their full body size are known to act more aggressive. Once the rank position is acquired the need for aggressive acts diminishes (Waring, 2003, p. 246-247). In studies of groups of Icelandic horses the aggression rate has been found to be higher in temporary (Granquist, 2008) and bigger groups (Hrefna B. Ingólfssdóttir, 2004) than in more stable and smaller groups.

Social behaviour in horses starts developing soon after birth (Waring, 2003, p. 79). Bonds or peer attachments (friendships) are developed and maintained by mutual grooming (allogrooming) and playing, and close presence of preferred individuals is tolerated. Social bonds are often established within the same sex and age class, between horses of similar rank and related individuals are often preferred (Waring, 2003, p. 83, 158, 227-228; Sigurjónsdóttir *et.al.* 2003) Some individuals are more popular as playing and allogrooming partners than others (Sigurjónsdóttir, 2007).

Removing parasites from areas hard to scratch by oneself might be the reason why allogrooming has evolved. Nowadays it is also known to play part in bonding between individuals (Budiansky, 1997). Allogrooming is interactive nibbling of body parts not easily reached by horses themselves. Many horses have one or a few regular allogrooming partners while some horses rarely allogroom. Frequency of allogrooming varies daily and seasonally increasing for example when winter coat is shedding. Allogrooming is also found to reduce heart rate. Often allogrooming is ended by the horse higher in the hierarchy. (Waring, 2003, p. 157-159)

Playing helps developing motor and social skills and establishing or maintaining friendships, and is common among young horses. Play behaviour consists of running alone or in groups, play fighting, approach-withdrawal patterns and tossing or manipulating objects with mouth

(Waring, 2003 p. 83, 87). Playing among mature mares is rare and young colts play more and in a different way (more play fight) than fillies (Sigurjónsdóttir *et al.*, 2003).

Horses spend majority of their time feeding. Time spent feeding depends on the quality of the food but in general free-ranging equids have been found to spend 59-69% of their time feeding. Feeding and resting occur periodically throughout day and night. Individuals have different resting and eating patterns: some only sleep during night and others rest more at day time. Grazing activity is usually at its highest at dawn and late afternoon. Adult horses rest mostly standing so that they have their weight on three legs while one hind leg is being rested, but usually they lie down at least once a day. In free ranging Misaki-horses in Japan have been found to spend more time resting on winter days (27.3 %) than on summer days (19.7%) Allogrooming between horses can last from a few seconds up to 10 minutes, but lasts for three minutes or less in majority of the occasions (Waring, 2003, p. 117-118, 121, 128, 157).

Icelandic horses fed with hay on pastures in the wintertime have been found to spend 60-70 % of their time feeding and 17-27 % of their time resting (12-25% standing and 2-8% lying). In general most resting occurred in the mornings and at noon. Time spent allogrooming ranged from 0.5 % to 2.5 % in different groups on different winters. Time spent in other activities like walking and drinking was 6-12 % in different groups (Hrefna B. Ingólfssdóttir, 2004)

Animal intelligence is a hard subject to measure. What should always be remembered is that every species has its own type of intelligence. In order to survive in the wild horses had to be able to tell edible and poisonous plants apart, recognise danger before being eaten and get along with other herd members. As a prey species horses are very sensitive to pain and fear experienced, and can associate places or people with bad experiences for a long time. Horses are really good in discrimination tasks and their memory serves them better than that of many humans in a similar situations. Horses can discriminate between tiny environmental cues such as slight, unconscious changes in postures or expressions of humans (Morris, 1997, p. 85-87). Study from Proops, McComb and Reby (2008) suggests that horses are capable of recognising familiar herd members by combining auditory, visual and olfactory information (cross-modal individual recognition), and that their procession of social information about identity of herd members is cognitively complex. Urine and faeces help horses keep track on the whereabouts of herd members because the smell contains social information (Macdonald, 2009). Young horses do better in learning tasks (Waring 2003, p. 109) suggesting that ability to learn might

be greater in young horses. Social learning in horses has not been studied a lot (Nicol, 2002), but it is generally believed that younger horses learn from older ones (Murphy and Arkins, 2007; Sigurjónsdóttir, 2007). A study from E. Sondergaard and J. Ladewig (2004) also shows that horses that have opportunities to interact socially with individuals of the same species learn quicker than horses that are being kept more isolated.

The horse husbandry in Iceland supports a situation close to natural, for many horses are kept outside around the year in herds usually consisting of both adult and immature horses of different ages (Sigurjónsdóttir *et al.*, 2003), giving the immature horses a chance for social learning. The horses that are stabled spend 7 months of their year outside in groups and in the stable they are usually kept in a box with another horse (Sigurjónsdóttir, 2007).

The two study groups in this research were kept outside on pastures, one group grazing freely and the other fed with hay. Seven horses were moved from the first group to the second group which was kept 2 kilometres away. Two of the seven horses had been there previously (7 winters) and were familiar with some of the horses there but the other five were introduced into the group for the first time during the research. In addition to describing the social structure of the groups the aim of the research was to get some insight into social cognition of horses, such as social strategies of individuals by examining the behaviour of the horses first in a stable group, and then in the new group. In the second group time budgets for horses during the winter time were also estimated. This was done to study individual variation and relate that to rank, age and residence.

2. Methods

Two groups of horses were observed in Bær and Fell in Kjós, West-Iceland for total 85 hours, over a period of five months and four days during autumn and winter. From the first group seven horses were moved to the second group, and special attention was paid to their behaviour. All obvious interactions, both friendly and agonistic, between horses were recorded and nearest neighbour-measurements were taken in both groups by the method *all occurrences of*

some behaviour (Lehner 1996) (see below). In Fell also time budgets were estimated by instantaneous scanning (Lehner 1996).

2.1. Study Groups

The pastures of the two study groups had similar vegetation with grasses and hummocks, typical to Iceland. At Bær there were some old flat fields which are not cut for hay anymore. Both groups had access to water or snow and ice in the winter. The group at Bær had a bigger pasture (ca 130 ha) and was grazing freely, whereas the second group in Fell was on a smaller pasture (ca 30 ha) mainly foraging with supplementary hay. The group in Bær was smaller and more stable compared to the group in Fell. No horses are kept between January and May at Bær, while at Fell horses are kept throughout the year and given hay between 1st of January and end of May.



Figure 1. *Horses on the pasture at Bær.*

The group in Bær had a big and variable pasture with natural shelters against wind (Figure 1.) The group consisted of 25 horses, two of whom joined the group shortly after the observations had begun when a gate between two adjacent enclosures was opened. Otherwise no changes in group composition occurred during the observation period. In the group there were 15 geldings and 10 mares, three of whom were sub-adults. Many of the horses had already known

each other for years while a few were spending their first or second autumn in the group. Age and residence was known for the horses. (See Appendix 1.)

The pasture at Fell was smaller, flatter and less variable than at Bær but still marked by small tussocks. There was very little natural shelter from wind and no man-made structures. The horses were fed with hay all through the observation period (Figure 2). Usually two or three hay piles were available. The group was big and the group composition was changing a lot during the observation period. Altogether 38 horses were present at the observations, not all at the same time though. The group size varied from 29 to 35 horses. Four geldings and three mares were removed from the group during the observation period and once five geldings and one mare were added to the group. Of the 38 horses 23 were geldings and 15 were mares. There were nine 2 to 4 years old juveniles in the group. Some of the horses had lice and by the end of the observations many horses were infected by them, a few looking really bad. Information on age was available for most of the horses (Appendix 2).



Figure 2. *Horses eating from a hay pile on the pasture at Fell.*

The seven horses mentioned before, three sub-adult mares Embla (Em), Osk (Ok) and Þoka (Þo) and four old geldings Huginn (Hu), Léttir (Le), Lilli (Li) and Tandri (Td) were moved from the group in Bær to the group in Fell for the winter. Lilli and Léttir had stayed in Fell before and they were familiar with some of the horses there. Embla was born in Fell but had

only stayed there for four months after her birth because her mother died when she was three months old. A young mare Vinkona (Vi), an old mare Totoro (To) and a young gelding Freysi (Fr) that were in a subgroup including Embla at Fell when Embla became orphan were there during the observations. Freysi stayed in the group for the whole observation period, the young mare Vinkona left soon after the introduction between 12th and 18th of January, and Totoro joined the group a little before the observations were at half-way. On the first day at Fell more attention was paid on what the seven newly released horses were doing and no nearest neighbour- or time budgets measurements were taken.

2.2. Data sampling

Observations in Bær were made for 44.6 hours on 14 days during a time period from 13th of October until 27th of December. The group in Fell was observed for 40.5 hours on 15 days from 3rd of January when the seven horses from the first group were released into the second group, until 22nd of March. Colourful tapes were used to recognise the horses individually. Binoculars were used to help recognising horses from afar and to have a closer look on what they were doing.

Social interactions between the horses were recorded continuously in both groups by the principle “all occurrence of some behaviour” (Lehner, 1996, p. 197) by using behavioural definitions made by horse ethologists (McDonnel, 2003). The behavioural classes used were:

A. Positive

- Approach (a horse approaches another)
- Nose to nose (two horses touch each others noses, mutual)
- Nose to side (a horse smells the side of another horse)
- Nose to genitals (a horse smells the genitals of another horse)
- Play
- Allogroom (mutual grooming)
- Attempt to groom (a horse initiates allogrooming another horse)

B. Negative

Aggressive:

- Threaten with ears

- Threat to bite
- Threat to strike (threat to kick another horse with a foreleg)
- Threat to kick (threat to kick another horse with a hind leg)
- Bite
- Aggressive push (run/walk into another horse)
- Kick with hind legs
- Strike with forelegs (kick another horse with forelegs)
- Attack (run towards another horse with ears laid back and try to bite him)
- Aggressive chase (chase another horse away running)
- Fight upright
- Intervention (intervene two horses occupied in some behaviour)
- Push between two animals

Submissive:

- Flee
- Supplant (a submissive gesture without moving the feet)
- Move away
- No reaction

I definitely missed some of the aggressive and submissive acts because they were too discrete or because the horses were spread and I couldn't see them all at the same glance. This means that the average values calculated are too low. This applies especially to threaten with ears and supplant. The very distinct aggressive and submissive acts, like attack, aggressive chase, fight upright and flee were probably all noticed. In Fell where "push between two animals" occurred often when horses were getting close to the hay some of the occasions were not seen. From positive interactions probably every allogrooming was observed in Bær and most of them in Fell. Also majority of playing was noticed but some of the other positive behaviours were probably not seen.

Also nearest neighbour-measurements were taken every 20 minutes in both groups by noting for each horse which had its head closest to the head of the horse in question at the moment it was looked upon. At the same time it was noted if horses were on the edge of the group or alone. When a horse was four to six horse-lengths away from the nearest horse, it was said to be standing on the edge of the group, and when a horse was seven horse-lengths or more away from the nearest horse it was said to be standing alone (Appendices 5 and 6).

In Fell behaviour was recorded by instantaneous scanning to make time-budget estimates (Lehner 1996, p.205-206) at the same time as the nearest neighbour-measurements were taken. The behaviour classes used were: *eat hay*, *graze*, *stand*, *rest* (standing while resting one hind leg), *walk*, *lie*, *drink/eat snow/lick or eat ice*, *allogroom*, *play*, *autogroom* (nibble, bite, lick or rub a part of a body), *nose to side*, *nose to nose*, *rub head* (against an object), *pee* (urinate), *defecate*, *flee*, *run*, *flehmen*, *threat to strike*, *threat with ears*, *yawn*, *nose to genitals*, *attack and roll*. Eat hay, graze, stand, rest, walk and lie were used as the main behaviour classes and the other behaviours were usually combined under a title of “other” behaviour.

In Fell the nearest neighbour-measurements and the time budget recordings were made twice as often for the seven horses that had been in the first group, or every 10 minutes. More attention was paid on the behaviour of the seven horses.



Figure 3. *Me observing at Fell.*

2.3. Data analyses

Dominance hierarchies were calculated with MatMan© and preferred partners with *Chi-Quadrat-Test* (χ^2 -Test) by Hrefna Sigurjónsdóttir. T-tests were also performed by her to find out whether the differences in allogrooming rates between groups and different time periods were significant. Good indicators for friendships are allogrooming, playing and tolerating the closeness of each other (Waring, 2003, p. 83, 158, 227; Sigurjónsdóttir *et. al.*, 2003). This time staying close, that is to say data from nearest neighbours-measurements was used when calculating significant friends because too few allogrooming sessions were observed in Bær. When calculating aggression rate “kick” and “threat to kick” were not used, for they can be used as defensive behaviour (Sigurjónsdóttir *et. al.*, 2003). Observation periods were divided into smaller periods in both groups in order to see possible changes in time.

3. Results

3.1 Overview

Aggression rate per hour per horse was higher on average in Fell than in Bær (Appendices 3 and 4). Dominance hierarchies were mostly linear and significant in both groups. Horses higher in the rank order had higher aggression rates and were older compared to lower ranking individuals in both groups (see Figures 1, 2, 3 and 4). Average allogrooming rate per hour per horse was much higher in Fell than in Bær and grew towards the end of the observation period. Playing rates per hour per horse were similar in both groups and majority (95 %) of the play behaviour observed was performed by geldings. Horses had on average more friends in Fell than in Bær.

In Bær horses were more commonly friends with familiar horses and individuals of the same sex. When seven horses from Bær were introduced to the group in Fell the dominant horse of Bær, Lilli, kept his group separated from the others the first 40 minutes. After that the groups mixed when horses gathered around the hay piles, but the horses from Bær still stayed close to each other. During the observations in Fell the horses from Bær maintained most of the bonds

between each other but also started to associate with other horses (figures 6, 7 and 8). Many of the friendships in Fell seem to be based on familiarity, sex, rank or the age of the horses.

Horses in Fell spent most of their time eating, resting (standing and recumbent) and standing. Other behaviours occupied on average under 20 % of their time. Horses higher in the hierarchy spent more time eating hay than horses lower in the hierarchy (see Figure 12).

3.2 Negative interactions

Average aggression rate per hour per horse was calculated based on all instances seen. Since I definitely did not see some interactions the following figures are minimal values. However it is safe to assume that similar errors were made in the two places allowing comparison between the two groups and also between individual horses. In Bær the average rate per hour per horse was found to be 0.46 - the highest and lowest values 2.71 and 0.04. In Fell the average aggression rate per hour per horse was 1.04 while the values for horses are between 0.02 and 8.29. The difference between aggression rates between groups is 0.59 aggressions per hour per horse. The difference between the highest aggression rates between the groups is 5.58 aggressions per hour per horse, and 0.02 between the lowest aggression rates between the groups. Horses in Bær spent more time alone and on the edge of the group than horses in Fell (Appendixes 5. and 6.).

The rank order can be seen in appendices 1 and 2 and figures 4 and 5. The calculated dominance hierarchies were very significant and mostly linear with some circular relationships in both groups (Bær: Landau improved linearity index $h' = 0,45$, $p < 0,001$, Fell: Landau linearity index $h' = 0,44$, $p < 0,001$). The ranks of the seven horses seem similar in both groups with some changes. Lilli (Li) was the highest in the hierarchy in Bær but in Fell one horse ranked above him. Huginn (Hu) and Tandri (Td) are both in the higher middle part of the hierarchy in both groups. In Bær Tandri has a higher position than Huginn while the opposite is true for Fell. Léttir (Le) ranks quite low in the hierarchy in Bær but higher, above the middle in Fell. Osk (Ok) and Embla (Em) are low in the hierarchy in both groups, but slightly higher in Fell than in Bær. Þoka (Þo) ranks lowest in the hierarchies of both groups.

Aggression frequencies for horses in relation to position in the hierarchy order in both groups are shown in Figures 4 and 5 (highest rank is to the left). A positive correlation between high

rank and high aggression frequency was found in both groups ($r = 0.59$ in Bær and $r = 0.53$ in Fell) and the results were significant ($P < 0.01$ in Bær where $n = 25$ and $P < 0.001$ in Fell where $n = 38$).

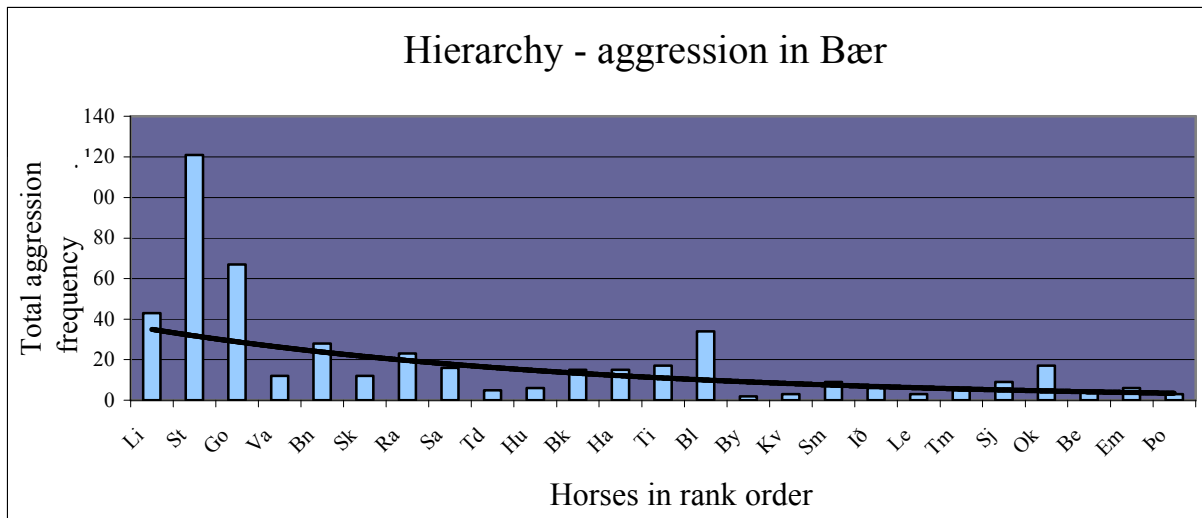


Figure 4. Total aggression measured for each horse in Bær shown with respect to rank. Li ranks highest.

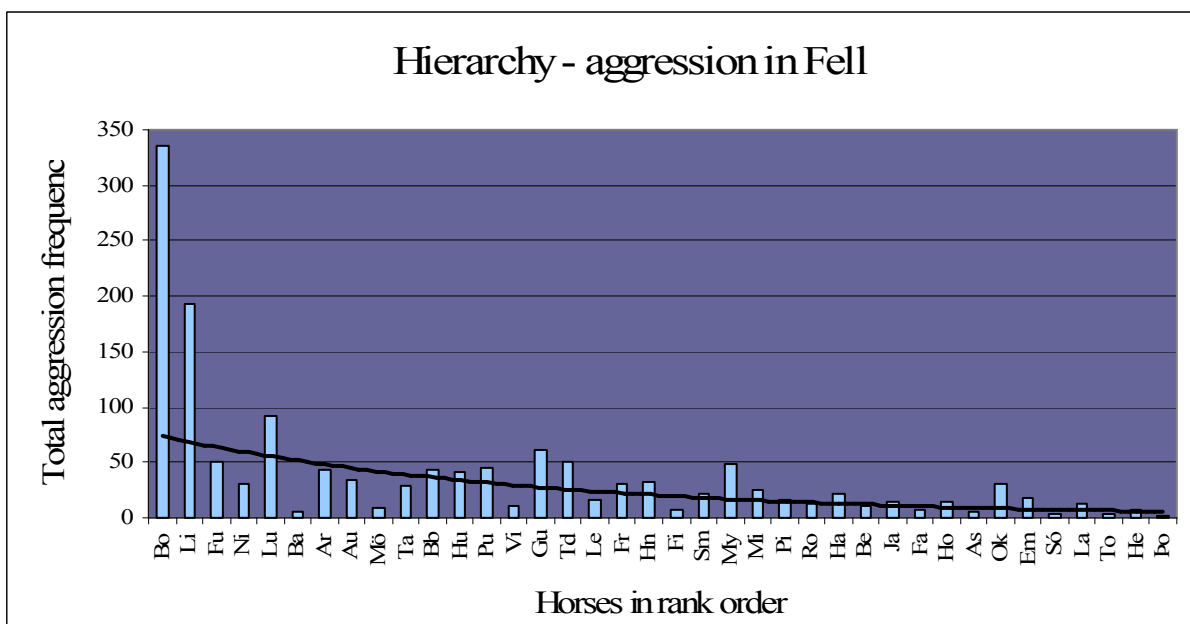


Figure 5. Total aggression measured for each horse in Fell shown with respect to rank. Bo-ranks highest.

The ages of almost all horses were known in both groups and it was possible to calculate if age and rank were correlated. A positive correlation between age and high rank position was found in both groups ($r = 0.40$ in Bær and $r = 0.55$ in Fell). The result just reaches signifi-

cance in Bær ($P = 0.05$, $n = 23$) and is very significant in Fell ($P < 0.001$, $n = 34$). See Figures 6 and 7 (highest ranking horse on the left).

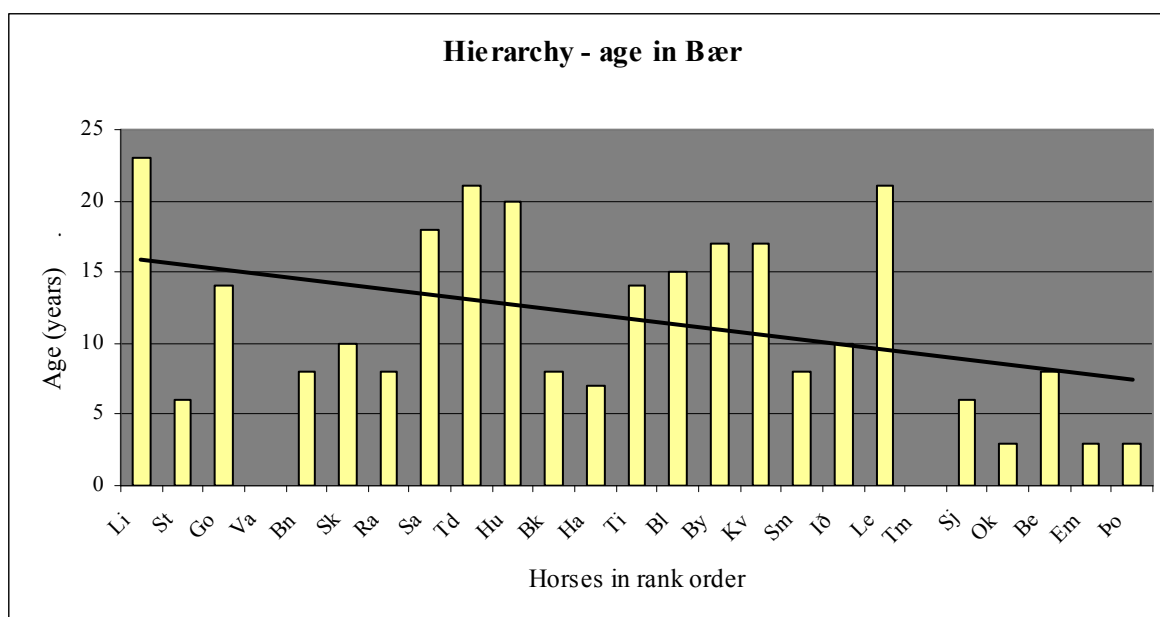


Figure 6. Relationship between age and rank order in Bær.

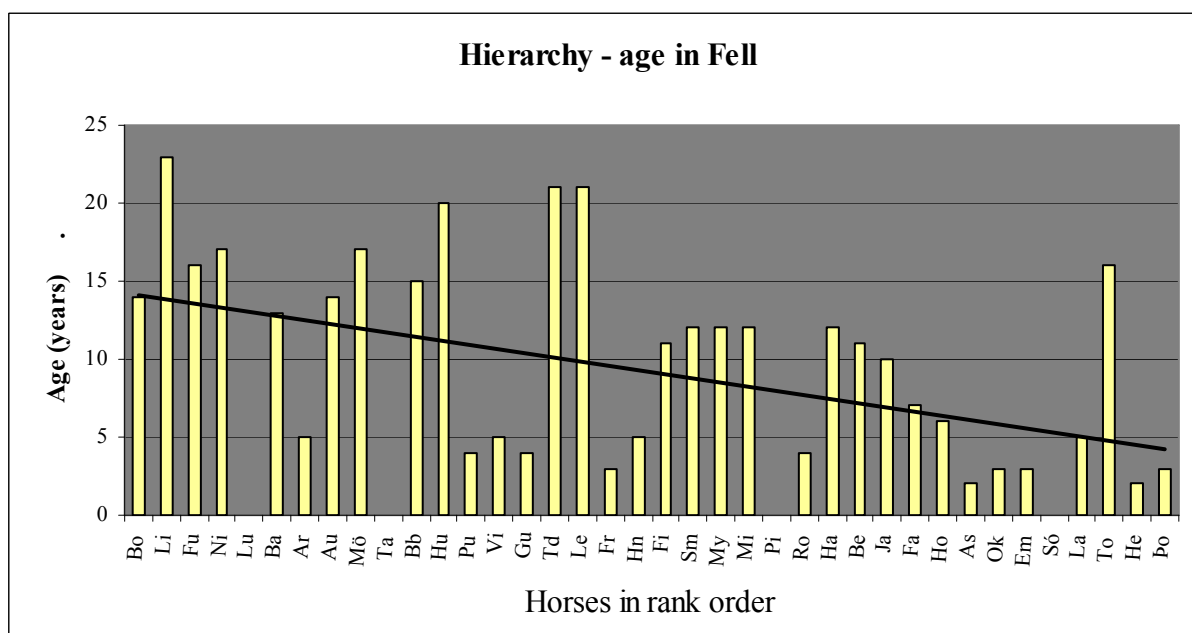


Figure 7. Relationship between age and rank order in Fell.

3.3 Positive interactions

3.3.1 Allogrooming and playing

Average allogrooming rate per hour per horse was 0.03 in Bær and 0.43 in Fell and the difference between the two places is very significant ($P < 0.001$). In Fell allogrooming rate changes from 0.10 at the beginning (3.-12. of January, 11.85 hours), to 0.30 in the middle (5.-17. of February, 9.3 hours) and 0.82 in the end of the observation period (24th of February - 22nd of March, 7.7 hours) (Appendix 4.). The allogrooming rate was significantly lower in Fell for the beginning of observations than for all observation hours. Difference between allogrooming rates in Fell in the beginning and end of the observations was very significant, as it was also between the beginning and middle of observations in Fell. Playing rate per hour per horse was 0.24 in Bær and 0.21 in Fell (Appendices 3 and 4). Geldings played more than mares, altogether 95% of the playings observed were performed by geldings. Average number of friends was 3,32 friends per horse in Bær and 5.01 in Fell.

3.3.2 Friendships in Bær

From the friend map of the whole observation time (Figure 8) the overall picture of the social network in Bær can be seen. The arrows show significant friends, that is to say horses who stay close to each other significantly more often than by chance. The direction of the arrow shows to whom the horse in question stays significantly often close to (is the closest neighbour), but if the arrows do not point in both directions it is not clear who seeks the company of whom. Horse A may for example seek the company of horse B and therefore horse B might have horse A as their nearest neighbour even though horse B would really prefer staying closest to horse C. The thickness of the arrow indicates the strength of the bond (reflects the value of the Chi- square). Solid lines represent more significant bonds ($P < 0.001$) than dotted lines ($P < 0.05$).

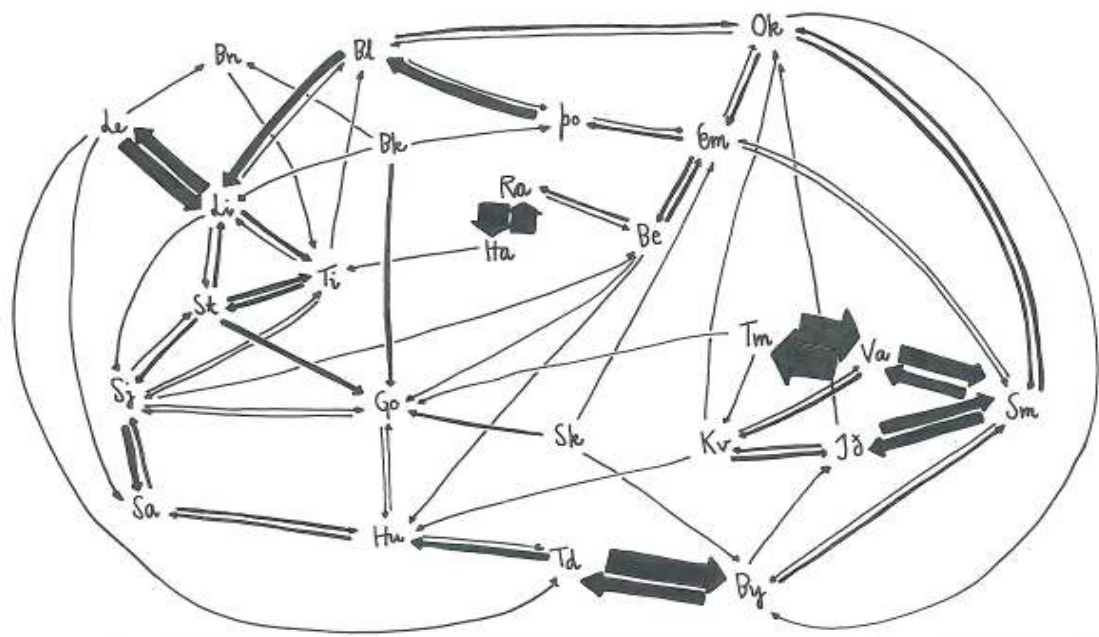


Figure 8. *Friendships and social networks in Bær. Abbreviations in Appendix 1.*

Geldings associate most with geldings and mares with mares but some strong mare-gelding relationships are also found. Familiarity definitely has an affect on friendships and age also at least in some cases (information on horses can be seen in Appendix 1) Lilli (Li) and Léttir (Le) have a strong bond and associate with horses, mostly geldings, from the same owner and other horses previously pastured with the group. Lilli has four mutual relationships: Léttir, Bil (Bl), Tigull (Ti), Stjarni (St) and also associates with Brunka (Bk) and Skjóni (Sj). Léttir has only one, mutual relationship, i.e. with Lilli but also stays close to Tandri (Td), Spaði (Sa) and Brunn (Bn). Tandri has a strong bond with Brynja (By), whom he has known for a long time and with whom he spent the last winter on the same pasture. Also Huginn (Hu) and Tandri, who have been stabled together for many years, have a mutual relationship. Besides Tandri, Huginn is friends with Spaði and Goði (Go) and associates with Blesi (Be), Kvik (Kv) and Brynja. The young mares Osk (Ok), Embla (Em) and Þoka (Þo) and an older mare Bil seem to have formed a quadrate, where Embla and Bil associate with Osk and Þoka, but not with each other. Osk and Embla are both friends with Smyrla (Sm). Osk also stays close to Kvik, Iða (Ið) and Brynja. Besides Osk and Þoka. Embla also associates with Skumur (Sk) and her best friend seems to be the gelding Blesi. In addition of being friends with Embla and Bil, Þoka also stays close to Brunka. Blesi, Rauður (Ra) and Hálfur (Ha) who are all from the same

owner and stay together. Especially the bond between Hálfur and Rauður is strong. Some mares from the same stable (Kvik, Iða and Smyrla) form an open sub-group with two new horses Vanhus (Va) and Tamma (Tm). Iða and Smyrla have only been in this group for a short time. Vanhus and Tamma have the strongest bond in the whole group. They stayed together on another pasture for the whole summer and were introduced to the group after one day of observations, when a gate between the pastures was opened. Skjóni, a gelding spending his first autumn in the group, has integrated well into the group and associates with geldings that have been in Bær for many years.

3.3.3 Introducing horses from Bær to Fell

Three young mares Osk, Embla and Þoka, and four old geldings Lilli, Léttir, Huginn and Tandri were moved from Bær to Fell. The horses were introduced to the group in Fell on 3rd of January. A video was recorded in parts (not when the seven horses were far from the other horses in order to save battery) for total of 35 minutes in order to get a more precise picture of what was happening.

On the release Þoka and Osk were first together and meet two new horses (Ronji (Ro) and Bossy (Bo)). Embla stayed the first minute or so near Lilli and Huginn, separated from the new group. Embla then joined Osk and Þoka and met horses from the new group (Bossy, Ronji and Luke(Lu)). Lilli, Léttir, Huginn and Tandri then kept together as a tight group, not socialicing with the other horses. Embla ran after Lilli and the others and met her old friend Vinkona on the way. Vinkona tried to follow them but was driven away twice by Lilli and Huginn. Lilli led his companions away from the other horses. Some horses from the new group started following them and eventually the whole herd followed. The most curious horses tried to approach the group but were always driven away by Lilli. Of the five horses only Lilli was meeting some horses from the new group while keeping them away from the other four.

Meanwhile Osk and Þoka were spending the whole time together near the gate but then joined the five horses from Bær running. Osk then left the familiar horses approaching the unfamiliar group and Þoka and Embla followed her. They met Merry (My) and Aragorn (Ar) shortly and then returned back to the geldings from Bær. Ronji and Pushy (Pu) followed and interacted with Embla, Lilli and Osk. Tandri protected the three young mares from some of the new

horses. Then the horses from Bær divided into two groups. Osk, Embla and Poka kept tightly together and approached the hay piles. Ronji followed them. Lilli, Léttir, Tandri and Huginn stayed behind grazing and moved further away from the hay, keeping tightly together. Other horses in Fell followed them, Gullý (Gu) in the front.

Between 40 minutes and an hour after the release, the groups blended a little when everyone went to eat hay. Still the old geldings from Bær stayed close to each other. The three young mares kept tightly together and were often in the proximity of the old familiar geldings. The hay piles were crowded and sometimes the mares clearly approached Lilli and others “in order to” get to the hay. Ronji and Gullý were socialising a lot with the mares, Ronji in a friendly way whereas Gullý in a more aggressive manner. Huginn seemed to protect Osk from Gullý once. Tandri was definitely acting more aggressive than seen in Bær, taking his place in the dominance hierarchy. Huginn and Tandri were inseparable and Léttir stayed at Lilli’s side all the time. Lilli seemed to tolerate all the horses from Bær showing much less aggression towards them than he did normally in Bær.

3.3.4 Friendships and their development in Fell

Familiarity is known to affect bonding and that can be seen not only in the friendships between the horses from Bær, but also friendships between other horses from the same owners. The ownership doesn’t explain all the friendships though because for the horses might have known each other for different lengths of time, they can be of different sex, age or rank or they can be kept in different company (e.g. some stabled for a part of the year and some in the pasture around the year). The Figures 9, 10 and 11 (below) show friend maps from the beginning, middle and the end of the observation period in Fell. The horses from Bær keep mostly close to each other (in small groups) through the observation time, but towards the end their band becomes somewhat looser when they form more bonds to the other horses in Fell. In the beginning the young mares and Tandri stick together whereas Léttir and Lilli pair up associating a little with other horses they are familiar with. It is worth noting that Léttir stays much more with Lilli than in Bær and is rarely seen being on the edge or standing alone which was often the case in Bær (see Appendices 5 and 6). Huginn stays at first both with Lilli and Tandri linking the seven horses from Bær together but in the end associates mainly with Tandri and other horses.

The three young mares Osk, Þoka and Embla form a triangular friend circle that lasts for the whole observation time but getting a little weaker towards the end of the observations. They also associate with Tandri and Léttir from Bær. In the beginning Þoka and Embla associate a little with the gelding Aragorn. In the middle of the observations Þoka associates with geldings Aragorn and Faramir (Fa) and Osk with mares Pippin (Pi) and Audrey (Au). In the end of the observations Þoka seems to stay close to a young mare Hobbit (Ho), Osk to the gelding Merry and Embla seems to prefer the company of the gelding Bob (Bb).

Léttir and Lilli stay close to each other during the observations, but their bond is stronger in the beginning than in the end. They both associate with Luke, more in the beginning of the observations than in the end. In the beginning Lilli stays a little with Bossy (Bo) and Huginn, in the middle with the gelding Leia (La). In the end Lilli associates a little with Huginn and has strong bond with Fusi (Fu), who is next to Lilli in rank order. Apart from staying close to Lilli, Léttir associates a little with Huginn and Mörki (Mö) and seems to have many preferred individuals in the end (Tandri, Huginn, Osk, Bob, Luke and Fusi)

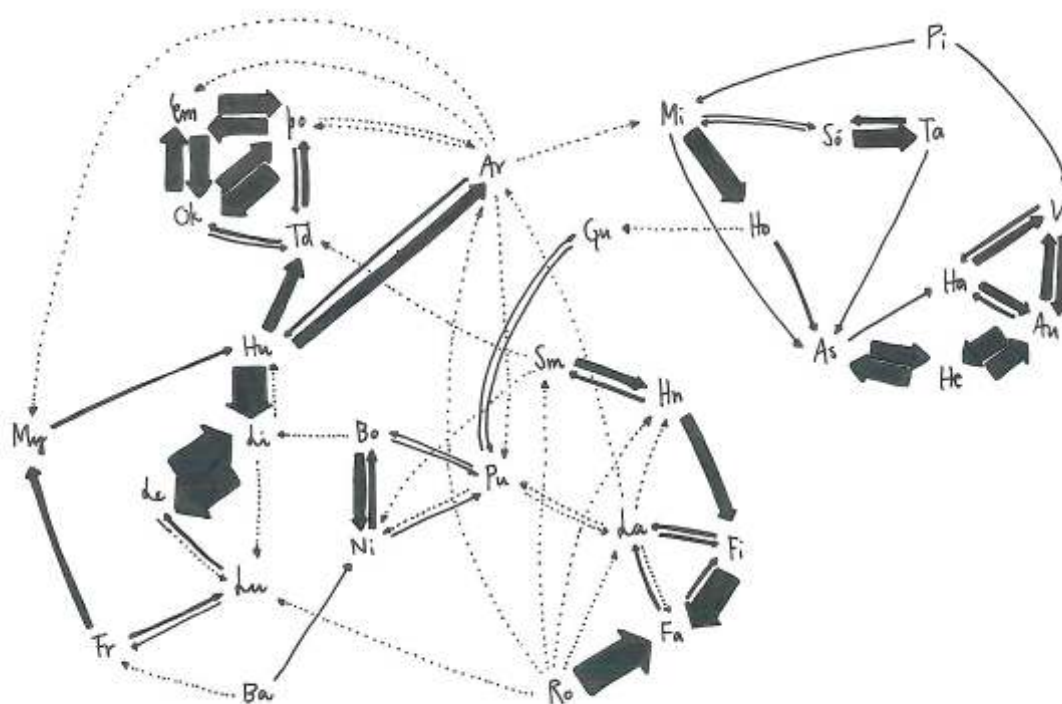


Figure 9. Friendships and the social network in Fell in the beginning of observations (3rd - 12th of January). See Appendix 2 for abbreviations.

All horses from one owner (group i , see Appendix 2.) expect one are clearly staying together a lot before some of them are taken away. Fusi and Mörki from the same owner (group o in Appendix 2) are friends but don't associate much with Nick (Ni) (also group o). Nick apparently spends more time in Fell than they do and has formed a strong bond with Bossy, the highest ranking horse in the dominance hierarchy of the herd. Audry and Hepburn (He), a dam and daughter still suckling, have a really strong bond in the beginning of the observation period when Audrey is in the group.

In the beginning Huginn stays close to Lilli but their proximity is reduced when the observations proceed. When time spent with Lilli diminishes a strong bond between Huginn and Tandri becomes evident. Huginn seems to have a relatively strong bond with Aragorn the whole time Aragorn stays in the group. Other horses Huginn associates with are Merry (My), Leia, Audrey, Léttir, Lilli and Taurus (Ta). Tandri associates at first with Osk and Þoka and a little with Smoky (Sm) but in the end just stays close to Huginn, Léttir and Han (Hn).

In the beginning some mares of different ages (Mimosa (Mi), Hobbit, Skjóna (Só), Taurus, Assa (As), Hepburn (He), Audrey, Vinkona and Pippin) form a distinct sub-group only attached to the main group by two weak bonds (Hobbit-Gullý (Gu) and Mimosa-Aragorn). Some of the bonds inside the group last throughout the observations but the sub-group eventually breaks and blends more with the rest of the herd as some individuals are taken away from the group and new bonds are being formed.

3.4 Time budget in Fell

Horses in Fell spent most of their time eating. Hay is the preferred forage but some grazing also occurs. Standing, resting and lying seem to occupy another major part of the day. On average 12 % of the time seems to include walking, allogrooming and other activities. The time budget for the whole observation period is presented in Figure 12.

The average hay-eating time per horse was 44 % and increased from 41 % to 48 % during the observation period. When grazing is taken into account the average feeding time per horse goes up to 48 %, increasing from 45 % to 41 % during the observations. Time spent eating hay varies a lot between individuals, from 27 % to 64 %. Figures 13 and 14 show the time budgets in Fell in the beginning of the observation period (3.-12. of January, 11.85 hours) and in the end of the observation period (24th of February - 22nd of March, 7.7 hours). There is a significant positive correlation ($r=0.34$, $P<0.05$) between time spent eating hay and the rank of the horse. Horses higher in the rank order spent in general more time eating hay compared to the horses with lower ranks (Figure 15, highest rank on left).

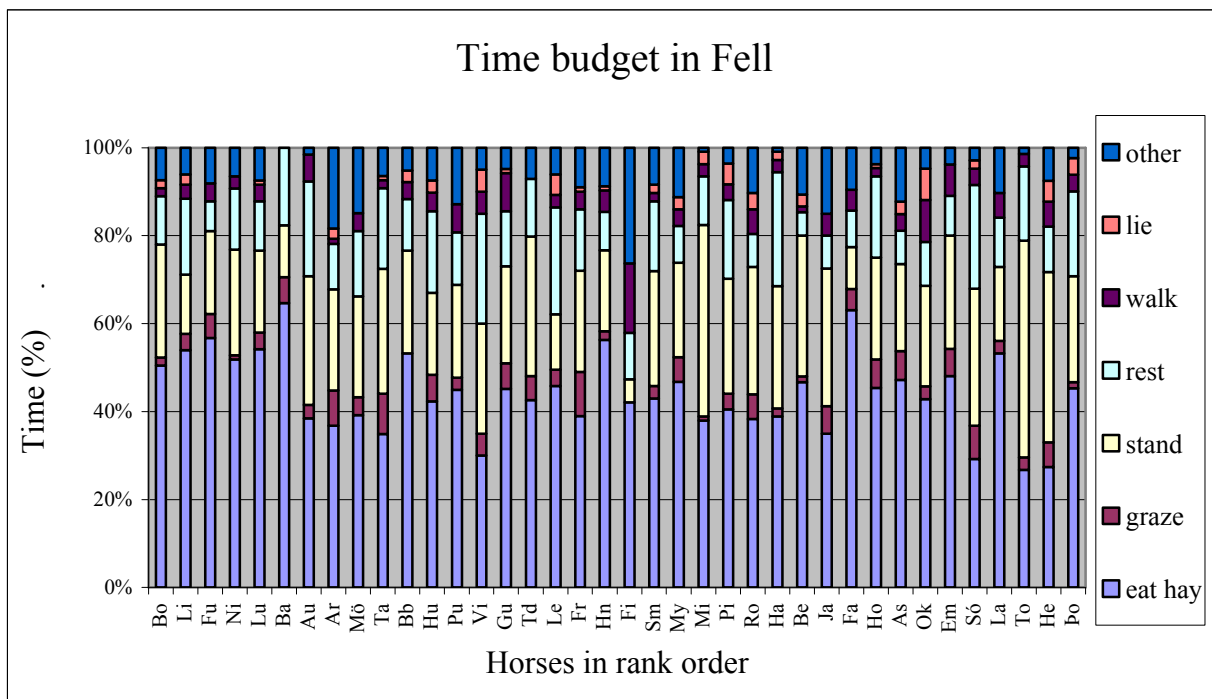


Figure 12. Time budget in Fell for the whole observation period. Based on measurements taken during daylight hours in the wintertime (mostly between 10.30 and 15)

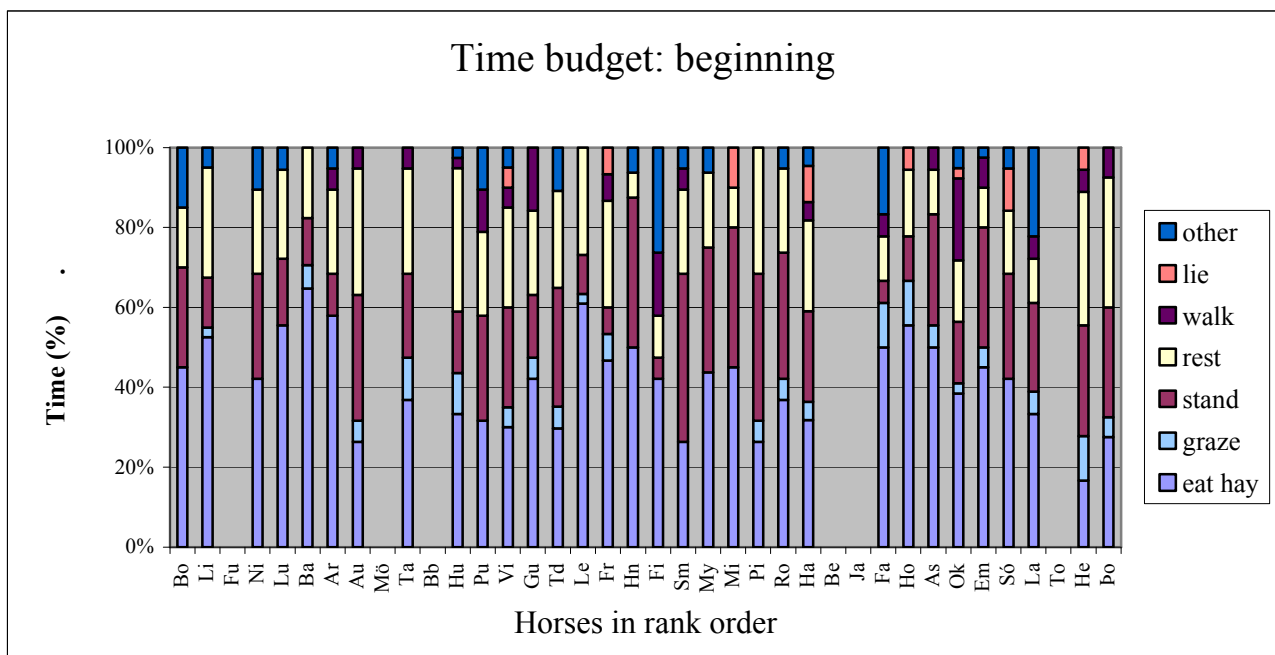


Figure 13. Time budget in Fell for the beginning of the observation period.

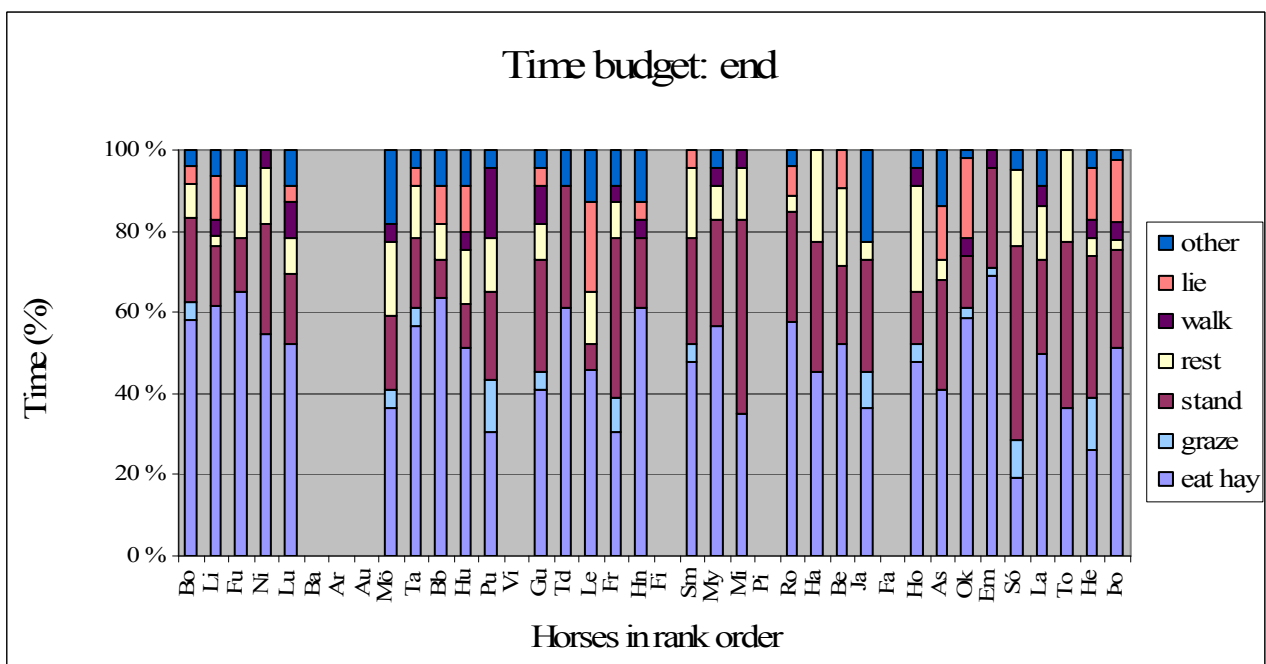


Figure 14. Time budget in Fell for the end of the observation period.

During the whole observation period average time per horse spent resting was 16 %, when both resting standing and resting recumbent are taken into account. Average resting time per horse changes during the observations being 22 % in the beginning and 16 % in the end. Av-

average time spent recumbent per horse is higher in the end of the observations (4.8 %) than in the beginning (1.7 %).

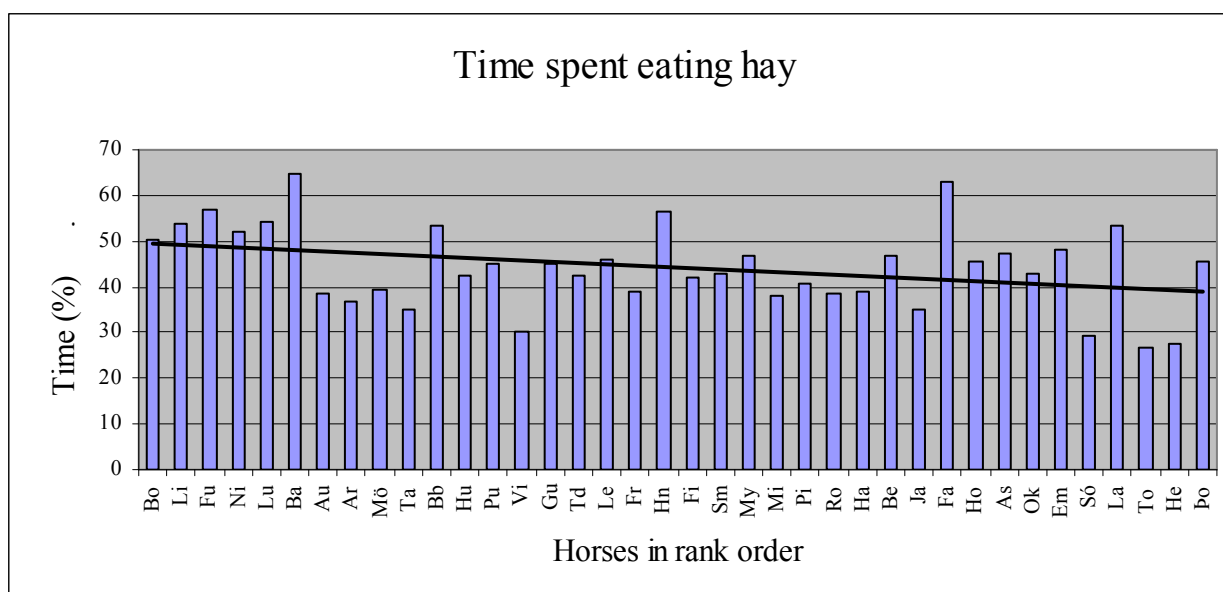


Figure 15. Time spent eating hay by each horse in relation to position in the hierarchy order.

Apart from the most common behaviours of eating hay, grazing, standing, resting and lying down, horses featured other maintenance and social activities like walking, drinking, allogrooming and playing which took on average 12 % of the time. Drinking, eating snow or licking or eating ice was most commonly observed of these infrequent behaviours. Also allogrooming, playing and autogrooming were observed relatively often. All the behaviours observed and categorised as “other” in the Figure 12 can be seen in Figure 16.

Horses in Fell stayed more tightly together than horses in Bær (Appendices 7 and 8). From the seven horses especially Léttrir was a lot more alone and on the edge of the group in Bær than Fell.

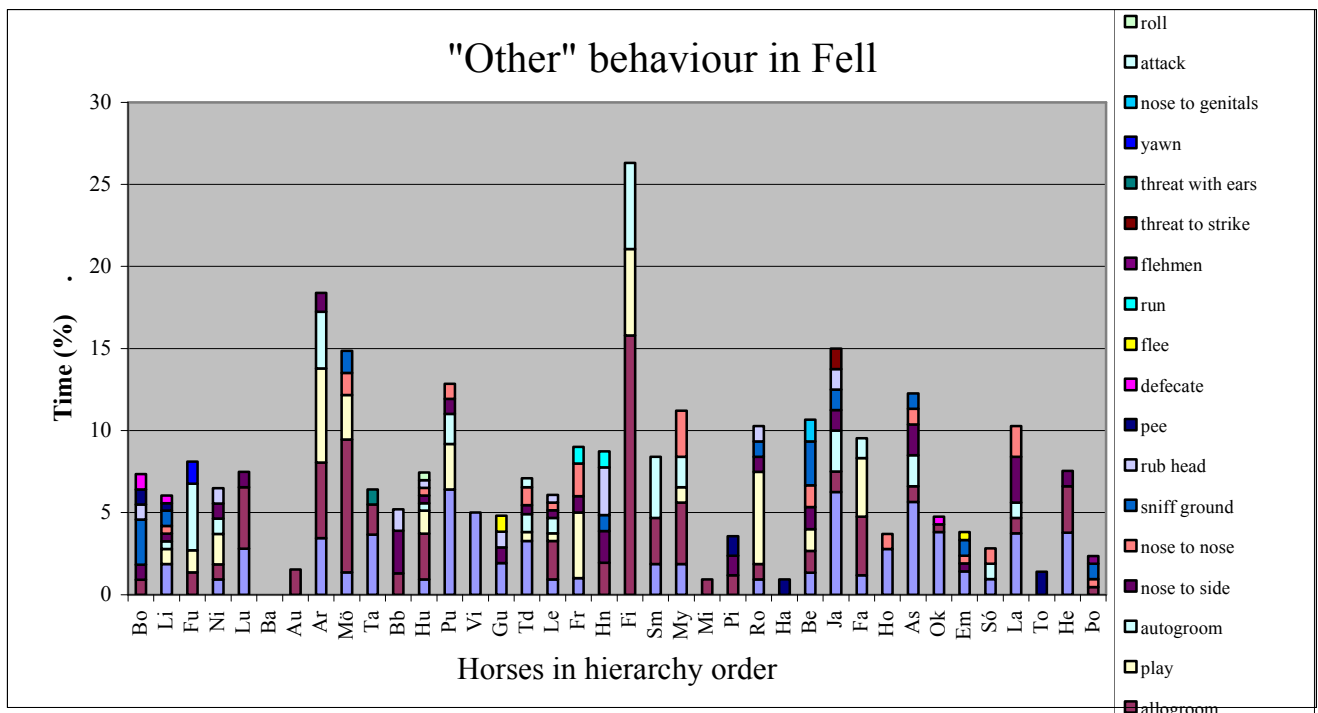


Figure 16. Time budget for behaviours that didn't occur so often during the whole observation period

4. Discussions

4.1 Negative interactions

The average aggression rate per hour per horse in Bær (0.46) is similar to those found in another study with groups of Icelandic horses, where the aggression rates have been 0.35 - 0.90 between different groups (Hrefna B. Ingólfssdóttir, 2004). The aggression rate in Fell is quite high (1.04) but still similar to that among mares in one group (1.18) in the same study. In groups of Icelandic horses containing stallions the aggression rates have been lower, between 0.03 and 0.08 aggressions per hour for each horse, probably because the presence of stallion has an effect on the interactions between other horses (Granquist, 2008).

Higher aggression rate in Fell compared to that in Bær is probably due to differences in the stability and size of the groups. An already established dominance hierarchy order reduces the need for aggressive acts (Waring, 2003, p. 246-247). In studies of groups of Icelandic horses the aggression rate has been found to be higher in temporary groups (Granquist, 2008) and bigger groups (Hrefna B. Ingólfssdóttir, 2004). In Bær the dominance hierarchy order had

already been formed for the most part before the observations started and therefore the need for aggressive acts wasn't as high as in Fell. In Fell the group composition was changing all through the observation period and the new horses had to establish their place in the dominance hierarchy which explains the higher frequency of aggressive act. Also the group in Fell ($n = 29-35$) was bigger than the group in Bær ($n = 25$).

The ranks of the seven horses moved from Bær to Fell were similar in both groups. Proximity of other horses can have an effect on the rank of individuals (Waring, 2003, p. 250) and Léttir probably ranks higher in Fell than in Bær because in Fell he spent more time with Lilli, who is high in the hierarchy. In Fell Huginn has a higher position in the rank order than Tandri, while the opposite is true to Bær. The explanation for this might be that Huginn stayed closer to Lilli in Fell than in Bær, whereas Tandri didn't stay close to Lilli or other higher ranking horses in Fell.

Horses higher in the rank order were more aggressive than lower ranking horses in both groups. This supports previous results stating that rank order can be affected by temperament (Waring, 2003, p. 249). Older horses ranked higher than younger ones in both groups. Similar results have been found in the only other study on Icelandic horses done in the winter time (Hrefna B. Ingólfssdóttir, 2004) as well as in other studies in Iceland (Hrefna Sigurjónsdóttir and Anna G. Thórhallsdóttir 2006).

4.2 Positive interactions

4.2.1 Allogrooming and playing

Average allogrooming rates (per hour per horse) found in other studies on Icelandic horses have been 0.08-0.63 between different groups in the winter time (Hrefna B. Ingólfssdóttir, 2004), 0.05 - 0.39 in groups studied in May - June (Sigurjónsdóttir *et. al.*, 2003) and 0.028 - 0.60 between groups containing stallions (Granquist, 2008). Average allogrooming rate in Bær (0.03) was relatively low compared to previous research but the average allogrooming rate in Fell (0.43) was similar to what has been found previously. The time spent allogrooming in Fell increases towards the end of the observation period and a similar trend has been found before in a study on Icelandic horses in the wintertime (Hrefna B. Ingólfssdóttir, 2004). Allogrooming rates are higher in Fell than in Bær because more new bonds are being formed,

density of parasites is higher (Budiansky, 1997) and the winter coats are shedding (Waring, 2003, p. 159). Time spent allogrooming increases in Fell towards the end of the observation period because the nearing spring increases the shedding of the winter coat and parasites (lice) increase in density and more horses get infected by them.

Playing was of similar frequency in both groups. Playing among mature mares is rare (Sigurjónsdóttir *et al.*, 2003) which can also be seen in the results (Appendices 3 and 4) where most of the play behaviour observed happened among geldings.

4.2.2 Social structures of the groups in Bær and Fell

Social bonds are often established within the same sex and age class as well as between horses of similar rank and related individuals (Waring, 2003, p. 227-228; Sigurjónsdóttir *et al.* 2003). This was also true in many cases in both study groups of this research. In Fell familiarity seemed to determine most of the friendships in the beginning of the observations. When time passed and group composition changed, also new bonds, many times between the same sex and age groups were established. The average number of friends was higher in Fell probably because the group was unstable (Sigurjónsdóttir *et al.*, 2003) with many new horses and new friendships were made whereas in Bær most of the bonds were already established and there wasn't so much need to make new friends.

Even though Lilli doesn't associate with most of the seven horses in Bær, he tries to keep them together as a group when released into Fell. He is the alpha male in Bær and probably wants to protect "his horses". I think Léttir follows him because they are really good friends and the others keep with him because horses prefer familiar company, and they also get protection from aggressive encounters with other horses. Feeding is an activity taking most of horses' time and the hay piles probably made the mixing of the two groups of horses faster than it would have been without supplementary food.

Even though Huginn (Hu) and Lilli (Li) have known each other for many years, Huginn was not staying close to Lilli in Bær but in Fell he did so, especially in the beginning. Huginn might have benefited of Lilli's higher rank status in establishing his position in the rank order because in Fell he ranks higher than Tandri (Td) whereas the opposite was true in Bær. Results don't show that Huginn would have eaten more hay in the beginning of the observations

in Fell when he was staying closer to Lilli, but actually show the opposite, that is to say Huginn spent more time eating in the end of the observations when he did not stay near Lilli that much (Figures 13 and 14). That might though just be because the average hay eating time increased in general towards the end of the observations.



Figure 17. *Embla, Osk and Þoka resting behind Lilli and Léttir on 8th of January.*

I have a feeling that Tandri (Td) was scared of Lilli because he always reacted highly submissive when Lilli showed some agonistic behaviour towards him, and usually didn't try to come close to Lilli once driven away. Tandri and Huginn have known each other for many years and have always been together during that time except last winter when Tandri was on a pasture with Brynja (See p. 15). In Fell Huginn and Tandri spent much more time together once Huginn reduced the time spent near Lilli (Figures 9, 10 and 11), which might be because Tandri was scared of staying near Huginn when Lilli was near.

The three young mares moved from Bær to Fell probably befriended each other because they were of same age and sex and of similar rank. In the new environment their relationship got tighter and then loosened up a little when bonds to other horses were formed. During the first days of observations the mares looked for Lilli's company from time to time but he didn't really seem to enjoy their company and often threatened them away (see Figures 17 and 18).



Figure 18. *Embla and Poka approaching Lilli and Huginn (looking into the camera) at the hay. Lilli threatening the mares, they supplanting. Osk behind Embla and Poka but not visible. Picture taken 8th of January.*

4.3 Time budgets in Fell

The average time spent feeding was lower (45-51 %) than what has been found previously in other studies. Icelandic horses fed with hay in the winter time have previously been found to feed 60-70 % (Hrefna B. Ingólfssdóttir, 2004) and free ranging equids in general to graze 59-69% of their time (Waring, 2003, p. 128). The difference in values might be because the horses in this research were only observed during noon and early afternoon which is known to be a resting period for horses. The really big difference between individuals spending the most and the least time feeding could be due to different individual feeding and resting patterns (Waring, 2003, p. 121).

Higher ranking individuals had more access to hay than individuals lower in the dominance hierarchy, which has been found to be true also in another study with Icelandic horses (Ingólfssdóttir and Sigurjónsdóttir, 2008). All the horses still seemed to get enough food and seemed not to be losing too much weight. When looking at the time budget of individuals feeding less than average they also seem to stand and rest more than average (Figures 9, 10 and 11). The lower ranking horses might feed more while the more dominant horses are rest-

ing. Also, young horses rank lower and they might not need as much forage as older horses due to their smaller body size.

Average times spent resting (16-22 %) and on other behaviours like walking and drinking (12%) are similar to what has been found in other groups of Icelandic horses in similar conditions in the winter time (17-27 % and 6-12 %) (Hrefna B. Ingólfssdóttir, 2004). Time spent resting decreases when time spent feeding increases which is a natural pattern for horses. The increase in resting recumbent towards the end of the observation period is probably due to warmer weather when approaching spring.

4.4 Possible social strategies of the horses moved from Bær to Fell

Lilli and Léttir, who had been in Fell before, were mainly associating with each other and some other horses they knew before. After the first 1-2 hours after the introduction Lilli didn't care much about the other horses that had been in Bær, except for Léttir. He had been in the group before and seemed to associate with familiar horses and horses of similar rank. Huginn stayed near Lilli in the beginning of the observations, perhaps trying to get advantage of Lilli's high rank. He also associated quite a lot with other horses and seemed to make new friends easily. Tandri stayed mainly near familiar horses, first with the young mares and then mainly with Huginn. He seemed like a lonely type, not making friends easily but not needing many of them either. For me Osk seemed brave, Þoka shy and Embla somewhere in between. They had a natural base for mutual friendship already knowing each other and being the same age and sex. They associated mostly together but also established new friendships. From time to time they seemed to seek the company of the older and higher ranking horses from Bær and sometimes seemed to benefit from their proximity by getting protected against aggressive encounters and getting access to hay.

5. Conclusions

In a new social situation horses seem to prefer the company of familiar individuals. When time passes new bonds are created, many times within the same sex and age group or with horses of similar rank. This research suggests that individuals may have different social strategies according to their social status and/or personality. High ranking horses associate with horses of their liking and they may or may not tolerate the presence of familiar lower ranking individuals. Lower ranking individuals may benefit from staying close to familiar higher ranking individuals by gaining a higher rank position, getting protection from aggressive encounters and having more access to resources (e.g. food). Some individuals don't seem to care or dare staying near familiar higher ranking individuals even though there might be some benefits, but still associate with other familiar horses. More research is needed to know more about the social cognition and individual social strategies of horses.

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Appendices

Appendix 1. Horses in Bær. The seven horses that were moved to Fell are marked with blue colour.

Rank	Horses in rank order	Code	Age (years)	Mare(m) / Gelding(g)	Sub-group	Time spent in Bær (years)
1	Lilli	Li	23	g	a	8
2	Starni	St	6	g	b	2
3	Goði	Go	14	g	a	7
4	Vanhus	Va	unknown	g	e	1
5	Brunn	Bn	8	g	d	4
6	Skumur	Sk	10	g	c	2
7	Rauður	Ra	8	g	d	3
8	Spaði	Sa	18	g	a	8
9	Tandri	Td	21	g	a	8
10	Huginn	Hu	20	g	a	8
11	Brunka	Bk	8	m	d	4
12	Hálfur	Ha	7	g	d	1
13	Tigull	Ti	14	g	a	8
14	Bil	Bl	15	m	a	5
15	Brynja	By	17	m	a	6
16	Kvik	Kv	17	m	a	7
17	Smyrla	Sm	8	m	a	2
18	Iða	Ið	10	m	a	2
19	Léttir	Le	21	g	a	8
20	Tamma	Tm	unknown	m	e	1
21	Skjóni	Sj	7	g	f	1
22	Osk	Ok	3	m	b	2
23	Blesi	Be	8	g	d	2
24	Embla	Em	3	m	b	2
25	Þoka	Þo	3	m	b	2

Sub-groups:
a = from the same stable, been together for many years
b = same owners as in the group a, been with the group for a shorter time
c = same owner as in the group a, first summer with the group
d = all horses from the same owner, many stayed in Bær before
e = from the same owner, spent the summer together, first autumn with the group
f = first autumn with the group, no familiar horses in the group

Appendix 2. Horses in Fell. The seven horses from Bær are marked with blue colour.

Rank	Horses in rank order	Code	Age (years)	Mare(m) / Geld-ing(g)	Sub-group	Time spent in Fell
1	Bossy	Bo	14	g	h	2
2	Lilli	Li	23	g	a	2
3	Fusi	Fu	16	g	o	unknown
4	Nick	Ni	17	g	o	2
5	Luke	Lu	unknown	g	s	3
6	Beauty	Ba	13	g	r	unknown
7	Aragorn	Ar	5	g	i	unknown
8	Audrey	Au	14	m	q	unknown
9	Mörki	Mö	17	g	o	unknown
10	Taurus	Ta	unknown	m	s	3
11	Bob	Bb	15	g	k	unknown
12	Huginn	Hu	20	g	a	1
13	Pushy	Pu	4	g	r	unknown
14	Vinkona	Vi	5	m	r	unknown
15	Gullý	Gu	4	m	p / t	3
16	Tandri	Td	21	g	a	1
17	Léttir	Le	21	g	a	2
18	Freysi	Fr	3	g	h / t	3
19	Han	Hn	5	g	i	unknown
20	Finni	Fi	11	g	i	unknown
21	Smoky	Sm	12	G	i	unknown
22	Merry	My	12	G	i	unknown
23	Mimosa	Mi	12	M	n	unknown
24	Pippin	Pi	unknown	M	s	unknown
25	Ronji	Ro	4	G	h?	unknown
26	Harpa	Ha	12	M	p	2
27	Blesi	Be	11	G	h	unknown
28	Jarpur	Ja	10	G	h	unknown
29	Faramir	Fa	7	G	i	unknown
30	Hobbit	Ho	6	M	n	unknown
31	Assa	As	2	M	r / t	3
32	Osk	Ok	3	M	a	1
33	Embla	Em	3	M	a	1
34	Skjóna	Só	unknown	M	s	3
35	Leia	La	5	G	i	unknown
36	Totoro	To	16	M	h	unknown
37	Hepburn	He	2	M	q / t	3
38	Þoka	Þo	3	M	a	1

Sub-groups:

a = horses from Bær
h = Sigríður's horses
i = Þorður's and Svavar's horses
k = Ingibjörg's horse
n = Einar's horses
o = Ólafur's horses

<p>p = Aðalheiður's horses</p> <p>q = dam and daughter</p> <p>r = horses from different owners, not kept together expect now on the pasture</p> <p>s = horses whose owner is unknown</p> <p>t = horses that have spent their entire youth in Fell</p>
<p>Time spent in Fell:</p> <p>1 = first winter</p> <p>2 = two or more winters</p> <p>3 = permanent resident</p>

Appendix 3. Aggression, allogrooming and playing in Bær. Rates are per hour per horse.

Horse	Aggression	Allogrooming	Play
Li	0,96	0,02	0,65
St	2,71	0,04	0,34
Go	1,50	0,04	0,27
Va	0,69	0,18	0,03
Bn	0,63	0,02	0,40
Sk	0,27	0,00	0,22
Ra	0,52	0,02	0,22
Sa	0,36	0,00	0,07
Td	0,11	0,00	0,02
Hu	0,13	0,07	0,04
Bk	0,34	0,02	0,00
Ha	0,34	0,00	0,18
Ti	0,38	0,02	0,90
Bl	0,76	0,00	0,04
By	0,04	0,00	0,02
Kv	0,07	0,02	0,02
Sm	0,20	0,00	0,00
lð	0,13	0,02	0,00
Le	0,07	0,03	0,54
Tm	0,29	0,00	0,00
Sj	0,23	0,04	1,06
Ok	0,38	0,04	0,07
Be	0,09	0,04	0,74
Em	0,13	0,02	0,04
Þo	0,07	0,00	0,07
average	0,46	0,03	0,24

Appendix 4. Aggression, allogrooming and playing in Fell. Rates per hour per horse.

Horse	Aggression	Allogrooming				Play
		all hours	beginning	middle	end	
Bo	8,29	0,25	0,17	0,22	0,39	0,12
Li	4,76	0,25	0,00	0,11	1,17	0,35
Fu	1,98	0,62	not present	0,32	1,70	0,39
Ni	0,74	0,44	0,08	0,22	0,91	0,20
Lu	2,27	0,91	0,08	0,22	1,96	0,17
Ba	0,42	0,00	0,00	not present	not present	0,25
Ar	1,34	0,88	0,00	0,22	not present	0,70
Au	1,28	0,19	0,08	0,00	not present	0,00
Mö	0,35	1,32	not present	0,65	3,65	0,43
Ta	0,72	0,40	0,08	0,54	1,17	0,00
Bb	1,71	0,43	not present	0,32	1,04	0,19
Hu	1,01	0,84	0,00	0,54	0,65	0,12
Pu	1,11	0,64	0,08	0,11	0,91	0,49
Vi	0,93	0,17	0,00	not present	not present	0,00
Gu	1,53	0,12	0,00	0,11	0,52	0,02
Td	1,23	0,15	0,00	0,00	0,78	0,02
Le	0,39	0,69	0,00	0,75	2,48	0,10
Fr	0,74	0,30	0,00	0,22	0,52	0,86
Hn	0,81	0,52	0,17	0,43	0,65	0,25
Fi	0,68	1,18	0,84	not present	not present	0,17
Sm	0,54	0,86	0,08	0,54	1,17	0,02
My	1,18	0,69	0,25	0,86	0,39	0,79
Mi	0,62	0,20	0,00	0,65	0,26	0,00
Pi	0,52	0,33	0,08	0,65	not present	0,09
Ro	0,32	0,30	0,08	0,11	0,13	0,54
Ha	0,54	0,05	0,00	0,00	0,26	0,00
Be	0,43	0,12	0,00	0,22	0,13	0,54
Ja	0,54	0,31	not present	0,43	0,52	0,08
Fa	0,24	0,81	0,42	1,08	not present	0,46
Ho	0,35	0,25	0,00	0,00	1,04	0,07
As	0,15	0,37	0,34	0,11	0,65	0,07
Ok	0,74	0,07	0,00	0,00	0,26	0,02
Em	0,44	0,05	0,00	0,11	0,13	0,02
Só	0,07	0,25	0,08	0,11	0,00	0,02
La	0,30	0,72	0,25	0,43	1,04	0,27
To	0,12	0,04	not present	0,00	0,13	0,00
He	0,20	0,40	0,00	0,32	0,39	0,05
Po	0,02	0,05	0,00	0,00	0,26	0,02
average	1,04	0,43	0,10	0,30	0,82	0,21
beginning = 3.-12. of January, 11,85 hours middle = 5.-17. of February, 9,3 hours end = 24th of February - 22nd of March, 7,7 hours						

Appendix 5. All the instances that were observed of horses standing alone or on the edge of the group in Bær.

Horse	Alone	On the edge
Li	8	12
St	2	2
Go	3	5
Va	1	3
Bn	2	4
Sk	8	16
Ra	8	16
Sa	16	25
Td	2	9
Hu	4	12
Bk	11	19
Ha	3	7
Ti	0	5
Bl	3	7
By	4	13
Kv	2	13
Sm	0	7
lø	5	9
Le	21	30
Tm	3	12
Sj	1	2
Ok	1	2
Be	4	5
Em	1	6
po	1	2
sum	114	243

Appendix 6. All the instances that were observed of horses standing alone or on the edge of the group in Fell.

Horse	Alone	On the edge
Bo	3	4
Li	1	3
Fu	0	0
Ni	2	2
Lu	3	4
Ba	0	0
Ar	0	3
Au	0	1
Mö	0	0
Ta	2	6
Bb	0	0
Hu	3	4
Pu	2	4
Vi	0	0
Gu	6	6
Td	0	6
Le	2	6
Fr	1	2
Hn	0	0
Fi	0	0
Sm	2	3
My	0	1
Mi	1	1
Pi	1	2
Ro	0	0
Ha	0	1
Be	0	1
Ja	0	0
Fa	0	0
Ho	1	3
As	3	3
Ok	1	2
Em	3	11
Só	0	5
La	0	0
To	2	4
He	4	4
Þo	1	6
sum	44	98

Appendix 7. Time horses stay alone or on the edge of the group in Bær.

Horse	Alone (%)	On the edge (%)
Li	5,5	8,3
St	1,4	1,4
Go	2,1	3,5
Va	1,0	3,0
Bn	1,4	2,8
Sk	5,1	10,3
Ra	5,5	11,0
Sa	9,9	15,5
Td	1,3	6,0
Hu	2,6	7,8
Bk	6,8	11,8
Ha	2,1	4,8
Ti	0,0	3,5
Bl	2,1	4,9
By	2,5	8,0
Kv	1,3	8,2
Sm	0,0	4,6
lð	3,4	6,2
Le	12,7	18,1
Tm	2,7	10,9
Sj	0,9	1,7
Ok	0,7	1,5
Be	2,8	3,5
Em	0,7	4,2
Þo	0,7	1,4

Appendix 8. Time horses stay alone or on the edge of the group in Fell.

Horse	Alone (%)	On the edge (%)
Bo	2,6	3,5
Li	0,4	1,3
Fu	0,0	0,0
Ni	1,8	1,8
Lu	2,6	3,4
Ba	0,0	0,0
Ar	0,0	3,3
Au	0,0	1,4
Mö	0,0	0,0
Ta	1,6	4,9
Bb	0,0	0,0
Hu	1,3	1,7
Pu	1,7	3,4
Vi	0,0	0,0
Gu	5,5	5,5
Td	0,0	2,7
Le	0,9	2,7
Fr	1,0	2,1
Hn	0,0	0,0
Fi	0,0	0,0
Sm	1,9	2,8
My	0,0	0,9
Mi	0,9	0,9
Pi	1,2	2,3
Ro	0,0	0,0
Ha	0,0	0,9
Be	0,0	1,3
Ja	0,0	0,0
Fa	0,0	0,0
Ho	0,9	2,6
As	2,8	2,8
Ok	0,4	0,9
Em	1,3	4,9
Só	0,0	4,5
La	0,0	0,0
To	2,6	5,1
He	3,7	3,7
Po	0,4	2,7