The behaviour of foals before and after weaning in group

Föls beteende före och efter avvänjning i grupp

av

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Examensarbete 190

Swedish University of Agricultural Sciences
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English-Swedish dictionary

Adrenal cortex binjurebark
Adrenal glands binjure
Agonistic behaviour agonistiskt beteende, tex hot, attack, undvikande
Anterior pituitary hypofysens framlob
Arteriosclerosis åderförkalkning
Artificial artificiell, konstgjord
Auditory signal ljudsignal
Colt hingstföl
Diurnal pattern dygnsrytm
Domesticated domesticerad, tamform
Endogenous endogen, producerat i kroppen
Feral feral, domesticerad förvildad
Fillie stoföl
Forage söka efter föda
Gastric ulcers magsår
Gastrointestinal tract mag-tarmkanalen
Grooming putsning
Husbandry jordbruk
Hypertension högt blodtryck
Hypertrophy förstoring
Juvenile här; unghäst
Large intestine grovtarm
Lateral lateral, här; ligger platt på sidan
Multiparous här; sto som tidigare haft avkomma
Nocturnal nattlig
Olfactory signal luktsignal
Orphane föräldralös
Peer like, jämlike
Polyphasic polyfasa, här; sömn, sover flera korta perioder
Precocial välutvecklad unge vid födseln
Predator predator, rovdjur
Primiparous här; sto som ej tidigare haft avkomma, förstföderska
Recumbent liggande
Significant signifikant, betydelsefull
Small intestine tunntarm
Stereotypies stereotypier, typ av beteendestörning
Sternal här; bröstsida, ligger på bröstet
Sub-adult här; unghäst
Tactile signal taktil, känselsignal

Förord

Vi vill rikta ett stort tack till stuteriet med personal som har ställt upp med hästmaterial, information om hästar och rutiner samt husrum för observatörerna. Vår handledare Margareta Rundgren får också ett stort tack för sitt engagemang, intresse och otaliga intressanta diskussioner. Tack även till Malin Berggren, grafiker, för hjälp med redigering av bilder och layout.

Sara Muhonen & Maria Lönn
Maj 2003

Abstract

Weaning is a standard procedure at most studs, and the methods of weaning varies greatly. The method used at the stud in this particular study is supposed to decrease stress. The purpose of the study was to compare the behaviour of foals in group before and after stepwise removal of their mares.

Standardbred foals with their mothers were kept in three different groups at pasture (12, 11 and 11 foals, respectively, mixed sexes). They had free access to silage and the foals were fed concentrate in a creep-feeding area. By the time the foals were 5 months old, the mares were stepwise removed from the pasture. Every or every second day, 2-4 mares were removed, until all mares were gone. The mares were placed so that the foals could not hear or see them. The foals remained in their original group at the pasture throughout the whole weaning process.

Observations were performed daily in two hour-shifts from the day before the first removal until the day after the last removal of mares. The three groups were observed for 28, 26 and 20 hours, respectively. A total of 24 different behaviours were recorded, some continuously and others every second minute. Means for periods of 14 minutes were calculated and analysed by the GLM procedure, the Statistical Analysis System.

The time budgets of the three groups were very similar to each other. Also the time budgets before and after removal of mares were similar. This indicates that the foals adapted quickly to the new situation. Perhaps this quick adaptation was possible because of the otherwise familiar circumstances. On removal days, the foals without dams were both running and walking more and they were also more vocal than the foals with dams. Apparently, the foals were upset by the removal of their dams. Also on removal days, all foals, both with and without dams, spent less time resting and less time in a recumbent position. This shows that all foals in the group were disturbed on removal days. During days after removal days, the foals without dams spent less time resting alone and less time in lateral recumbency than foals with dams. This indicates that the foals without dams still had not adapted to the new situation. After removal of all mares, the total time of resting were no less than before the removal of mares, but the foals had changed their resting behaviour. Since the foals spent less time in lateral recumbency one might assume that they did not get enough of the important REM-sleep. While the foals still had access to their dams and were able to suckle, they ended the majority of the nursing bouts. This shows that the mares had not yet began to wean their foals themselves. Still twelve days after the first group had been weaned, we noticed that the foals were trying to suckle on each other. For a foal which is developing very rapidly at this age, the separation from it’s dam is a major psychological trauma. The traumatic experience may be irreversible, and will lay a foundation to the development of stereotypies.

The subject of weaning foals need more research. This study show that weaning by stepwise removal of the mares from pasture, leaving the foals in a familiar surrounding, is a good weaning method. However, the timing of the weaning, at the age of five months, is too soon for the foals. When and how to wean the foals should be based on knowledge of the horse’s natural behaviour and not tradition.

Introduction

Domestic horses are usually weaned at the age of 4-6 month. This age is chosen by traditional as well as practical reasons. The weaning methods differs greatly, but total and abrupt separation dominates the horse industry today. Feral horses wean their offspring at a much later stage and very gradually. The aim of this study was to compare the behaviour of foals, kept in group at pasture, before and after stepwise removal of their dams. This particular weaning method is supposed to decrease weaning stress.

Literature

Social structure

Wild or feral horses are non-territorial and usually live in family or bachelor groups. A family group is usually a single stallion with his harem that consist of mares, juveniles and foals. A group of horses with at least one adult male and at least one female, which normally move together is called a band. Multiple stallion bands exist. When two or several mature stallions live in a group with mares, juveniles and foals, usually one stallion is dominant over the others. Bachelor groups consist of males without any attached mares, males can also live solitary. A herd is a structural social unit made up of bands. (Miller, 1981; Berger, 1977; Feist and McCullough, 1976) Family groups also function without a stallion (Tyler, 1972). Studies have shown that both in feral and domesticated horses, the stallions are neither the dominant nor the most aggressive horses in all groups. (Houpt and Keiper, 1982)

In the age of 1-4 years most of the females and males move away from their mothers' bands. Females are incorporated into new bands by stallions or occasionally by bachelors, while young emigrating males are either ignored by other bands or chased by other stallions and bachelors. (Berger, 1986)

Mother-foal interactions

The bond between mother and offspring is most apparent in the close association of the two. Foals are precocial and remain close to their mothers’ side in the band during all movements. The mare is strongly protective of her foal, she will threaten other horses that come too close to the foal and she positions herself between the foal and an intruder. Dominant stallions also protect the foals, herd them with the band and will bring a foal back to the band if it becomes separated. The dominant stallion will also separate band members if the mother is unable to maintain the distance of other horses from her foal. In these cases the mother whinnies and the stallion moves the other horse away. Such protectiveness is important because lost or orphaned foals are attacked by other horses. (Feist and McCullough, 1975; 1976)

Tyler (1972) studied the amount of time that a foal and it's dam spent within 5 m of each other. Foals in their first week were observed for 94% of the time within 5 m from their mothers, 52% in their fifth month and about 20% in their eighth month. Crowel-Davis (1986) found very similar results, foals in their first week were observed for 85% of the time within 1 m from their mothers, 99% of the time within 5 m from their mothers and they were never recorded more than 10 m apart. By week 21-24, foals were observed for 26% of the time within 1 m from their mothers and 52% within 5 m. There were no significant differences between colts and fillies.

The increase in the distances between foals and their mothers with the foal's age was correlated with the foal's increasing ability to recognise their mothers from other ponies. There were no consistent significant differences found in the distances that colts and fillies were observed from their mothers. (Tyler, 1972)

The mares also play an important role in maintaining contact with their foals. This was shown by differences in the mares' behaviour when their foals were up and when they were lying down. Mares left their foals almost twice as many times per hour when their foals were up compared with when they were lying down, up to their foals' sixth month (Tyler, 1972). Crowell-Davis (1986) found that the mares, during the first weeks of the newborn foals' life, never wandered away if their foal was recumbent, as they often did when their foal was upright. Instead she stayed close to the foal either by grazing around it in circles or by standing beside it, often resting upright and sometimes with her head just above the foal. This recumbency response was very strong the first 8 weeks and then slowly declined.

Barber (1994) found that during the foals' first day of life, the mares spent 100% of their time within 5 m from their foal. With the foals' increasing age, the mares' spatial distance changed. For upright standing foals the time mares spent within 5 m from their foal decreased to 67% at the age of 4 weeks, and 46% at the age of 17 weeks. The figures do not decline as rapidly when the foals were recumbent. Here the time spent within 5 m were 76% during week 4, and during week 17, the mare still spent 76% of her time within 5 m from her recumbent foal.

After the eighth month, there was no significant change in the amount of time observed within 5 m from the mother, up to the end of a foal's first year. Up to the age of five month, foals were observed less then 10% of the time more than 45 m from their mothers. Even when a year old, the foals were observed at such a distance less then 35% of the time. Twelve and thirteen month old foals were observed for over 45% of the time within 25 m of their mothers. This reflect the long and close relationship between a mare and her foal. (Tyler, 1972)

The close relationship between a mare and her yearling, even when the mare has a new foal, continues until the young animal becomes sexually mature or leave the mother's group. Although the yearling or older offspring is weaned, it still rests near its mother, groom with her and follow her. A close association is also formed between the yearling and the new foal, this prolongs the relationship between the yearling and its mother. The older sibling graze near the younger one, which usually stays near the mother. But the reverse can also occur as sometimes the close association of two siblings encourage a greater independence of the younger one with regard to its mother. (Tyler, 1972)

Time budgets

In order to satisfy basic requirements of feed, water and rest, horses distribute their time between different activities. The way a horse is distributing it's time is here referred to as time budget. How much time a horse spend on each activity depends on it's age, sex and season of the year (Grub & Jewell, 1974). Despite some differences between the time budgets of for example mares and stallions, Duncan (1980) came to the conclusion that time-budgets of horses are generally very similar. This suggests that their time budgets are stable and very inflexible. However, the time budgets of new-born foals are very different from the time budget of older horses. (Boy and Duncan, 1979).

Boy and Duncan (1979) studied the time-budgets of Camargue-horses. The study showed that the younger horses, especially the new-born foals, spent a lot of time either standing alert, lying flat (lateral), lying up (sternal), or moving. On the contrary, the older horses spent a lot of time resting standing up or foraging. While the foals grow older, their time-budgets became more and more similar to the older horse's time-budgets. The foals increased the time spent foraging and resting standing up at the expense of other activities, especially lying flat and standing alert. Boy and Duncan (1979) concluded that age was the most important factor in the development towards a sub-adult time-budget. At the age of 5 months, the foals of Camargue spent their time distributed like this: resting 32%, foraging 36%, and activity (standing alert, walking, trotting and galloping) 19%. Very shortly after the weaning (age >9 months), time-budgets of the foals were similar to those of sub-adults (horses 1-2 years older than the foals) (Boy and Duncan, 1979).

It is known that the milk production of mares reaches a peak in the third months of lactation and then falls to a minimum at weaning (Waring *et a.,* 1975). The supply of milk allows the foals to invest time in sleep and movement. As the milk supply gradually decreases, more time is spent foraging. The decreasing milk production could be the factor that stimulates the foals to develop a sub-adult time-budget with its increased amounts of foraging (Boy and Duncan, 1979).

There is a difference between the time-budgets during summer compared to winter. Kaseda (1983) studied the daily activities of 12 Misaki horses (the Japanese native horse). The study showed that these horses spent more time grazing during summer than they did during winter (76,1% and 71,0%, respectively). The grasslands where the Misaki horses grazed were very poor in quality and quantity in the winter. The fact that the horses spent more time resting and less time grazing in winter, suggest that they have adapted to the environment with poor food by reducing energy expenditure due to grazing (Kaseda,1983). However, the Camargue horses studied by Duncan (1985) did the opposite; they spent more time foraging during winter, especially during the months February and March (66,2%), than during summer (in June 50,7%). This can be explained by the nutritional stress the horses went through during the winter. To maintain their condition, they increased their time foraging. They also changed the way they selected what to eat, being more selective during summer.

Feeding

Horses are herbivores and spend most of their time grazing. Adult free-ranging horses spend 50-75% of their day foraging (Berger, 1986. Sweeting *et al.*1985). In the summer, grazing is most common in the morning and late in the afternoon (Tyler, 1972).

As early as in their first day of life, foals can be seen “grazing”. In the beginning, they do not actually swallow the grass, but they nibble and chew on it, drop it, pick it up again and toss it up in the air. Young foals can also be seen nibbling and chewing uneatable objects, such as twigs and branches. Subsequently, they gradually spend more and more time grazing, in the beginning always side by side with their mother (Tyler, 1972). Duncan found that new-born foals spent 12% of their time “foraging”. This figure increased to around 36% by the time the foals were 5 months, and to 55% by the time they were 10 months. It is during the foals first year the gastrointestinal tract is developing. By the time of 12 months it is fully developed (Frape, 1998). Shortly after weaning the foals' time budget were similar to sub-adults; even more time is spent foraging and less time sleeping and moving than before weaning (Boy & Duncan, 1979).

Resting

Adult horses spend approximately 6 hours per day resting, included about 4 hours of sleep. Horses are polyphasic and divide their resting time into 5-7 periods. For stabled horses the rest is mainly nocturnal. (Dallaire, 1986). Also feral horses rests mostly at night, with exception for hot days in the summer, when resting occurs mostly at daytime (Kaseda, 1982). Adult horses mostly rests in a standing position (a protection to escape predators), but usually they lay down to rest at least once a day (Waring *et al.*, 1975). Young foals on the other hand, rests mainly lying down. Up to the age of 2 months they spend 70-80 % of their total resting time laying down, but this decreases while they grow older and by the time they are 8 months they spend around 14 % of the total resting time lying down. (Tyler, 1972)

The degree of wakefulness can be divided into four different stages by measuring the activity of the brain (EEG); Wakefulness, Drowsiness, Slow-wave sleep and Paradoxical sleep, also called REM-sleep. All four categories have several different characteristics. One of the characteristics is the EEG-waves, that decreases in frequency and increases in amplitude as the alertness is lowered, except for one of the categories, the paradoxical sleep. In this the EEG-waves resemble that of the wakefulness; high frequency and low amplitude, despite the fact that the horse is in deep sleep. There are also short series of so-called theta waves, which are seen when an animal is awake and has spotted something in the environment. (Dallaire,1986) Table 1 shows a survey of the four categories of wakefulness.

Table 1: The four categories of wakefulness

Wakefulness	EEG: High frequency, low amplitude. Rapid eye movements, no slow eye movements.
Drowsiness	EEG: Decreased frequency, increased amplitude. Usually occurs in standing posture. Slow, horizontal eye movements.
Slow-wave sleep	EEG: Low frequency, high amplitude. Usually occurs in sternal recumbency. Scarce eye movements, slow and horizontal. Mean duration: 6,4 minutes.
Paradoxical sleep (REM-sleep)	EEG. High frequency, low amplitude. Also short series of theta waves. Usually occur in lateral recumbency. May also occur in sternal recumbency if the head is leaning on the ground. Bursts of irregular rapid eye movements (REM). Various body movements, as if running, for example. Sometimes even whinnying. Mean duration: 4,2 minutes.

Sleep is not only a state of rest when the horse is immobile and doesn't respond to external environment. It has a biological value and is important for normal growth and behaviour. During REM-sleep, there is an increased cell division and an increase in output of growth hormone; two functions that is of great importance especially for foals. REM-sleep can only occur when the horse rests in lateral recumbency or in sternal recumbency with the head leaning against the ground. Sleep deprivation can lead to hyperirritability and learning deficits. If a horse is deprived of it's sleep, it will increase the time spent in paradoxical sleep after the deprivation. This further indicates the importance of sleep. (Houpt, 1980; Dallaire and Ruckebusch, 1974.)

Boy and Duncan (1979) found that new-born foals in Camargue spend 41% of their time resting. Of this time, 8% is resting standing up, 18% sternal recumbency and 15% lateral recumbency. By the time the foals were 5 months they spent 32% of their time resting, including 11% resting standing up, 12% in sternal recumbency and 9% in lateral recumbency.

Horses resting behaviour is much depending on the environment. For stabled horses, sleep is mainly nocturnal, but this depends on the activity in and around the stable. Also horses on pasture are strongly depending on a familiar environment, especially to rest in a recumbent posture. When the environment or other circumstances changes, they may avoid sleep for several days. However, if one horse lies down, the others often tend to follow (Dallaire, 1986).

Recumbency response

Mares keep close to their foals, especially when the foals are recumbent. Barber and Crowell-Davis (1994) found that during the foal's first day of life, the mare spent 100% of her time within 5 m from the foal. While the foals became older, the spatial distance of the mares changed. When the foals were recumbent, the amount of the time the mares spent within 5 m had decreased from 100% from day 1 to 76% in week 4. In week 17, the mare still spent 76% of her time within 5 m from her recumbent foal. For standing foals the time the mares spent within 5 m from the foal decreased to 67% at the age of 4 weeks and 46% at the age of 17 weeks. Crowell-Davis (1986) found that Welsh Pony mares, during the first weeks after parturition, never wandered away if the foal was recumbent, as they often did when it was upright. Instead the mares stayed close to the foal either by grazing around it in circles or by standing beside it, often resting upright and sometimes with her head just above the foal. Crowell-Davis (1986) found that this recumbency response was very strong the first 8 weeks and then slowly decreased.

Suckling

In Tyler's study (1972) of free ranging New Forest ponies suckling occurred very frequent the first 24 hours after birth. The mean frequency of suckling, for first week foals was four bouts per hour. Foals in their fifth and sixth week suckled on average twice an hour. Fifth month foals suckled once an hour and eighth month foals suckled about once in every two hours. The average frequency of suckling then remained constant until weaning.

Carson and Wood-Gush (1983) found that nosing behaviour always occurred during a nursing bout and occasionally it occurred alone. They divided all nursing bouts into successful bouts, when the foal sucked, and unsuccessful bouts, when the foal nosed but did not suck. In the first week of life the foals had an average of seven nursing bouts per hour, five successful bouts and two unsuccessful ones. In week two the foals had an average of four bouts per hour, three successful bouts and one unsuccessful.

Barber and Crowell-Davis (1994) had very similar results in their study on Belgian mares. During the first week of life their foals had an average of eight bouts per hour, six successful ones and two unsuccessful ones. Week four the frequency had declined to four bouts per hour, 3.5 successful ones and 0.5 unsuccessful ones, the successful bout frequency was consistently higher than that for unsuccessful bouts. In week seventeen the mean rate of bouts was two successful bouts per hour.

In the first week of the foal's life the bout length varied from a few seconds to several minutes, the median length was 78 seconds. After the first week the median duration of sucking bouts decreased until the fourth month, then it increased again up to their ninth month. There was no significant difference between colts and fillies, nor of primiparous and multiparous mares but there was a large individual variation (Tyler, 1972). Carson and Wood-Gush (1983) found that in week one the total mean bout duration was 105 seconds and by week 24 it had decreased to 74 seconds and to one successful bout per hour.

The results of Barber and Crowell-Davis (1994) shows that total bout duration was a mean of 84 seconds on day one, peaked at week eight with a mean of 98 seconds and was lowest in week 17 at a mean duration of 78 seconds. There was no significant difference between colts and fillies in nursing rates or bout duration.

Duncan *et al.* (1984) found that in week 0-8 of the foals' life they spent a large but rapidly decreasing proportion of their time suckling, 8% down to 2.3%. From week 9 to week 29 the time spent suckling varied very little around 2%. After week 30 the time spent suckling again decreased rapidly.

Tyler (1972) concluded that suckling usually occurred when foals had found their mothers after a period of separation, after a foal had been resting, after a disturbance which resulted in the foal approaching it's mother and when a mare approached her foal. Sucking also acted as a comforting stimulus in itself. Several foals were observed sucking the nipples of older siblings, who had never had foals of their own and who cannot have had any milk. Carson and Wood-Gush (1983) also found that nursing commonly occurred after resting or after a disturbance, which caused the foals to approach their dams.

Suckling behaviour does not measure milk intake in horses. Cameron *et al.* (1999) failed to show a relationship between behavioural measures of suckling and milk energy intake. They found no significant linear relationship between milk energy intake and suckle bout duration, suckle bout frequency or proportion of scan samples during which the foals were sucking. They found no significant relationship between total time spent sucking and milk energy intake and none of mare age, mare weight, foal age, foal sex or foal weight was a significant predictor of milk energy intake. The most significant model they found used a single factor, number of butts, and it only approached significance ($P=0.063$). Therefore they suggest that studies using time spent suckling to predict milk energy intake are probably not accurate and may have led to misleading conclusions, particularly regarding different maternal investment.

Natural weaning

For the greater part of lactation the foals voluntarily terminate almost all suckling bouts. In the last month before weaning, the mothers terminate a large proportion of bouts and shows aggression in a third of all suckling interactions. The timing of weaning depends on the conflict over resources, non-pregnant mares continue to invest in their foals for a longer time than pregnant mares. Pregnant mares wean their foals about 15 weeks before the next birth, at the time when the nutrient costs of pregnancy become significant. (Duncan *et al.*, 1984)

Berger (1986) studying the feral horses of the Great Basin in Nevada, found no relationships between weaning age and foals sex, maternal condition, or band stability. The ages at which foals were weaned varied considerably, but 85% were weaned prior to their first birthday, and 79% of these were not observed suckling after nine month of age. About 90% of the lactating females were pregnant, many of them had had spring births and were facing the middle or end of winter, with food in short supply. Mothers weaned their offspring during winters, probably because of winter-related stresses and that the last trimester of pregnancy is the most nutritionally demanding. Among the horses of the Great Basin, prior reproductive status of mothers influenced the ages at which their young were weaned. Mothers without foals from the preceding year weaned their offspring at an average of 16 month of age, but mothers with yearlings and foals weaned their foals at an average of 8.5 month. Weaning was not aggressive or abrupt, it was a gradual process that took several months. Mothers with both yearlings and newborn foals never let the yearlings suckle, if they tried they were aggressively and soundly rebuffed by bites from their mothers. (Berger, 1986)

Tyler (1972) concluded that weaning usually occur when the foals are about one year old, a few days or weeks before their mothers give birth to a new foal. Non-pregnant mares can allow their yearlings to continue suckling until their second winter or spring. The foals' independence increases with age and that means that the contact with the mothers decreases. This is probably largely brought about by their mothers' behaviour. The mares move further away from their foals as they grow older and they sometimes avoids them when they approaches to suck. As the foals grow older mares also delays their foals' sucking bouts by more active methods, they can bite their foals rather than just moving away from them. Both mares and foals were responsible for maintaining their relationship and yet bringing about the foals' increasing independence.

Weaning methods

Several different systems of artificial weaning of foals are in use, but total and abrupt weaning is the most widely used method of weaning in the horse industry today. In many conventional weaning management systems, foals are vaccinated and de-wormed during weaning. Some management systems do not allow foals access to creep feed prior to weaning. (McCall *et al.*, 1985). In table 2 studies of different weaning methods are listed and they are also described in the following text.

Table 2: Studies of different weaning methods

Reference	**Gradually/ abrupt**	**Groups/ individually**	**Age of foals**	**Abbreviations**
Heleski *et al*., 2002	abrupt	groups of three and individually	4.5 month	
Hoffman *et al*., 1995	abrupt	pairs and individually	5-7 month	PHC=pasture, hay, pelleted concentrate; PH=pasture, hay
Holland *et al*., 1996	gradually and abrupt	groups	5-7 month	
Houpt *et al*., 1984	abrupt	pairs and individually	4-6 month	
McCall *et al.*, 1985	gradually and abrupt	in pairs or triplets	4 month	TS=total separation; PS=partial separation; C=preweaning creep feed; NC=no preweaning creep feed; CON=control group, no separation, creep feed
McCall *et al*., 1987	gradually and abrupt	in pairs or triplets	4 month	TS=total separation; PS=partial separation; C=preweaning creep feed; NC=no preweaning creep feed; CON=control group, no separation, creep feed

Time budgets

Heleski *et al*. (2002) studied the time budgets of foals weaned in two different ways. The study comprised twelve Quarter horse weanlings with an average age of 4.5 months. Six of them were housed in groups of three in a paddock (992 m^2) and six were housed individually in boxes (13.4 m^2) with solid partitions. The paddock-reared weanlings had an open, three-sided shelter. All weanlings in both treatments showed increased overall activity and vocalisation (whinnies, neighs) and decreased eating/drinking behaviour on day one post-weaning compared with day seven post-weaning ($P<0.01$).

There was a significant difference in time budgets of the two treatments ($P< 0.0001$). The stabled weanlings were lying more frequently ($P< 0.003$) than the paddock-reared weanlings. Stabled weanlings were more engaged in aberrant behaviours ($P< 0.03$) such as licking or biting the stall wall, kicking the wall, pawing repeatedly and bucking/rearing bouts than the paddock-reared weanlings. All stalled foals engaged in some degree of aberrant behaviour and the frequency tended to increase ($P< 0.1$) over the observation period. All the foals were observed for 56 days. (Heleski *et al*., 2002)

The paddock-reared weanlings were within 10 m of their peers during 89.1% of the time. Paddock-reared foals were engaged in actual contact social interactions 3.3±1.2 times per hour. This included friendly interactions, play biting, mutual grooming, mutual fly swatting and aggressive interactions. The paddock-reared foals grazed 18.5% of observed time. Stabled weanlings could not graze but tended to spend more time investigating ($P< 0.1$) than did paddock-reared weanlings. Heleski *et al*. (2002) concluded that the paddock-reared weanlings had more optimal welfare than the individually stabled weanlings.

Vocalisation and locomotion

The most characteristic call of the horse is the whinny or neigh. This is a call of high amplitude and varies in length between 0.5 and 2.8 sec. The whinny is a characteristic call of isolation from conspecifics, particularly social partners for example stable mates or mother from young. There is usually locomotion during a period of whinnying and other various activities such as scratching, chewing and pawing can also occur. It appears that the animal is ‘excited’ when a whinny is produced. (Kiley, 1972)

McCall *et al.* (1985) compared four different weaning systems on four month old Quarter Horse foals: TSNC -abrupt, total separation of mare and foal and no pre-weaning creep feed, TSC - abrupt, total separation and pre-weaning creep feed, PSNC –partial separation allowing visual, auditory and olfactory contact and no pre-weaning creep feed, PSC –partial separation and pre-weaning creep feed and CON –control group, no separation and pre-weaning creep feed.

Vocalisations (whinnies) of the weaned foals were affected by separation method ($P< 0.001$). The total-separation foals vocalised more frequent than the partial-separation foals. The partial-separation foals did not vocalise significantly more than the control-foals, which were not weaned. Access to pre-weaning creep feed did not affect number of vocalisations ($P> 0.05$). (McCall *et al*., 1985)

The first 5 hours after separation from their dams the total-separation foals spent more time walking and less time standing still ($P< 0.01$) than the partial-separation foals. Foals without pre-weaning creep feed spent more time walking and less time standing still ($P< 0.01$) than the foals with pre-weaning creep feed. Simple correlation coefficients between total vocalisations and time spent moving show that vocalisations were negatively correlated to time spent standing still ($r = -0.67$, $P< 0.001$) and positively correlated to time spent walking ($r = 0.66$, $P< 0.001$) and trotting ($r = 0.48$, $P< 0.05$). These relationships suggest that upset foals vocalising frequently also show an increased locomotor activity. (McCall *et al*., 1985)

Holland *et al.* (1996) experimented with foals, five to seven month of age, weaned gradually and abrupt. Twenty foals were kept on pasture with their dams divided into four groups. Two groups had access to an all forage diet and the other two groups were fed forage and a pelleted concentrate diet. One group on each diet was weaned abruptly, as all mares were removed at the same time and the foals stayed on pasture. The other group on each diet was weaned gradually, one to two mares were removed every second day and the foals stayed on pasture. The gradually weaned foals were more vocal the day of weaning ($P= 0.01$) than the abruptly weaned foals. The abruptly weaned foals walked more on day one and two after weaning ($P<0.0001$) than gradually weaned foals. Abruptly weaned foals cantered more on day one ($P= 0.0002$) than gradually weaned foals. Gradually weaned foals grazed more ($P= 0.0002$) than abruptly weaned foals. They concluded that foals weaned in groups, where all mares were removed at once were more stressed than groups where a few mares were removed at a time. The foals did not show the expected stress responses to weaning and this may be related to the fact that they were kept on the familiar pasture instead of removed into stalls.

Houpt *et al*. (1984) studied twenty-two Shetland-type ponies, four to six month old, weaned singly or in pairs. Eight ponies were weaned singly and fourteen were weaned in pairs. They were placed in stalls of 9 m^2. All foals could hear and presumably smell, but not see, foals in other stalls. All the foals neighed significantly more ($P< 0.05$) after weaning than before weaning and the foals weaned singly neighed significantly more ($P< 0.05$) than the foals weaned in pairs. All foals were also more active after weaning ($P< 0.05$) than before weaning but there was no significant difference between foals weaned singly and foals weaned in pairs. Weaning a foal with another foal as a stall companion appears to be less stressful than weaning the foal singly.

Lying down

In the study of McCall *et al*. (1985) time spent lying down was not significantly affected by treatment, but differences in lying postures were observed. The foals on PSNC (partial separation, no creep feed), PSC and CON treatments spent much of their lying time in lateral recumbency. The TSNC (total separation, no creep feed) and TSC foals spent their lying time in sternal recumbency and were not observed for any length of time in lateral recumbency. These differences may reflect different levels of relaxation or anxiety in the foals.

Non-nutritional sucking

McCall *et al*. (1985) observed non-nutritional sucking of other foals in all the treatments, except the unweaned control foals. The non-nutritional sucking started within two hours after the separation of mare and foal and was observed up to two weeks post-weaning. For unweaned foals non-nutritional sucking acts as a comforting stimulus (Tyler, 1972) and it may be an indicative of weaning stress (Wood-Gush *et al*., 1975).

Aggression

McCall *et al*. (1985) found that foals in all treatments, except the unweaned control foals, exhibited aggression to other foals. Aggression began during the first hour after mare and foal were separated. Sex of foal did not influence the incidence of agonistic behaviour towards other foals.

In a study by Hoffman *et al*. (1995) four groups of Thoroughbred foals on two diets and two weaning methods were compared. Each group comprised nine foals with mares in each group; the PHC group was fed a diet of pasture supplemented with hay and a pelleted concentrate, the PH group was fed pasture and hay. The foals in each group were five to seven month old and included both colts and fillies. They were abruptly separated out of sight and hearing range from their dams all at once and placed into stalls. In each dietary group four foals were weaned in pairs and five foals were weaned singly but all foals were within sight of another foal. The single housed foals had stalls of 14 m^2 and the paired foals had stalls of 19 m^2. All paired weanlings had spent time together before weaning, but after weaning they exhibited aggressive behaviour toward each other. According to the authors there was a tendency for the paired foals to be less vocal ($P= 0.276$), other behavioural observations indicated that the foals were less vocal because their stall companions were engaged in aggressive behaviour. According to the authors pairing foals at weaning seemed to have little or no advantage in this study.

Play

After mares and foals had been separated, McCall *et al*. (1985) only observed play behaviour in the control group (not separated). The foals were observed for 5 hours after the separation of mother and foal. However, two weeks post-weaning play behaviour was seen in all treatments.

Defecation and urination

Houpt *et al*. (1984) found that the foals defecated significantly more frequent the first fifteen minutes after weaning than just before weaning (before= 0 times/15 min; after= 0.7±0.2 times/15 min; $P< 0.05$). The foals also urinated significantly more frequent the first fifteen minutes after weaning (before= 0 times/15 min; after= 0.6±0.2 times/15 min; $P< 0.05$) than just before weaning. For both defecation and urination, there were no significant differences between foals weaned singly and foals weaned in pairs.

Diet

Holland *et al*. (1996) found that the foals on a forage and pelleted concentrate diet walked more on all days after weaning (P= 0.0004) than foals on an all forage diet. The foals on an all forage diet grazed more (P= 0.0003) than the foals on a forage and pelleted concentrate diet. This may indicate that the foals on an all forage diet were less stressed than the foals on the forage and pelleted concentrate diet. On the other hand, the fact that the foals on an all forage diet grazed more may just be a reflection of their dietary need and the foals on the forage and pelleted concentrate diet were not necessarily more stressed.

In the study of McCall *et al.* (1987) the partly separated foals had higher feed intakes during the first week postweaning than those abruptly weaned. Over the preweaning period the creep-fed foals gained more weight (P< 0.03) than the foals without creep-feed. Foals without preweaning creep-feed had higher initial postweaning feed intakes than the ones with preweaning creep-feed. This is very likely related to compensatory weight gain for the foals without preweaning creep-feed.

Hoffman *et al*. (1995) found that the foals fed pasture, hay and concentrate vocalised less (P= 0.028) than the foals fed only pasture and hay. They also tended to stand less (P= 0.117) and according to the authors, tended to spend more time eating (P= 0.243) than the foals on a pasture and hay diet. These behavioural differences suggest a trend toward better adaptation to weaning for foals fed pasture, hay and concentrate than for foals fed only pasture and hay.

Physiological responses to weaning

A stressed animal release adrenocorticotropic hormone (ACTH) from the anterior pituitary. ACTH regulates cortisol secretion by the adrenal glands. The pituitary-adrenal response is stimulated typically by emotional stress such as uncertainty or social dislocation. Excessive weaning stress may affect appetite, metabolism and immune competence (Dantzer and Mormède, 1985; Hart, 1985).

Plasma cortisol concentrations can be measured before and after weaning. An ACTH response test can be conducted at 48 h after weaning to evaluate the degree of stress that the foals are experiencing. In general, animals experiencing mild stress may have relatively high concentrations of plasma cortisol before the ACTH challenge and a large rise in plasma cortisol in response to the challenge. This reflects hypertrophy and increased secretory function of the adrenal cortex. Animals experiencing moderate stress may have higher concentrations of plasma cortisol before the ACTH challenge and a less marked response to the challenge. This reflects partial depletion of the adrenal cortex by endogenous ACTH. Animals experiencing severe stress may have either high or low concentrations of plasma cortisol before the ACTH challenge and a poor response to the challenge. This reflects exhaustion of the adrenal cortex and resultant inability to secrete more cortisol. (Beech, 1987) As cortisol is a metabolic hormone it is also affected by the nutritional status of the horse. (Erickson, 1993)

Different weaning management regimens cause different physiological responses in foals. Foals weaned by an abrupt, total separation weaning method exhibited higher cortisol responses than foals weaned by partial separation of mare and foal allowing visual, auditory, olfactory and tactile contact in an experiment by McCall *et al.* (1987).

Table 3: Typical signs of stress observed in stalled weanling foals (Hoffman *et al.*, 1995)

Eustress	**Mild distress**	**Severe distress**
Whinnies occasionally	Whinnies frequently	Silent
Alert, attentive	Inattentive, distracted	Depressed, unresponsive
Stands well	Paws, weaves, chews wood	Stands head lowered
Walks calmly	Walks nervously or trots	Immobile
Seeks company	**Avoids company**	Ignores company
Gives care and attention	Agonistic (aggressive)	Apathetic
Eats well	Eats poorly	Refuse to eat

Hoffman *et al.* (1995) assigned a behavioural score to each foal (table 3). A foal that exhibited three or more signs of severe distress was assigned a behavioural score of 1. One or two signs of severe distress justified a score of 2 or 3, and foals with signs of mild distress got a score of 4, 5 or 6. Foals with signs of eustress were assigned a score of 7, 8 or 9, foals with no signs of agitation and that remained calm and alert got the score 10. The behaviour scores were positively correlated with the rise of plasma cortisol in an ACTH response test. This correlation illustrates the relationship between behavioural observations and physiological responses. In another study Malinowski *et al.* (1990) found that postweaning plasma cortisol concentrations were elevated in both mares and foals.

Stereotypies

Many stressors can cause profound and long-lasting effects on behaviour. Stereotypical behaviour is a such effect. Other effects are depression and "behavioural despair", where the useful spontaneity of behaviour is lost. These effects may result from the stress-induced release of ACTH, which acts on the brain. As in humans, animals seem to respond to social stresses with such pathological changes as hypertension, arteriosclerosis and gastric ulcers. If the animal can change the situation through appropriate behaviour, the physiological response declines. If the animal cannot cope with the situation, behaviour may become stereotyped or may be suppressed (so-called learned helplessness). (Klemm, 1993)

The majority of equine stereotypies start within one month after weaning when both the nutritional and social environment of the foal is substantially altered. Many circumstances change at weaning. The mare foal bond is broken, but housing and feeding practices are often changed at the same time. It is not clear which or what combination, of these factors is primarily responsible. (Nicol, 1999)

Waters *et al*. (2002) studied the risk of developing behavioural problems by horses weaned in different housing systems. The methods rewied were box-weaning; abrupt, with complete separation and isolation from conspecifics, barn-weaning; abrupt weaning carried out with small groups of foals kept together in a loose housed situation (n=6-20), paddock-weaning; abrupt weaning, usually with groups of weanlings being kept together in a field situation (n=2-20, in 50% of cases, 1-2 ‘nanny’ mares were left with the groups) and natural weaning; gradual weaning of foals by mares. The rate of development of stereotypic and redirected behaviour was greatest during the first 9 month of life. Weaned foals were observed frequently attemting to redirect sucking behaviour towards the genital regions of conspecifics.

The risk of developing behavioural problems increased more than 2-fold ($p= 0.015$) when box-weaning and barn-weaning was compared to paddock-weaning. Horses that were barned or stabled after weaning were at significantly higher risk than the ones that were pastured ($p< 0.01$). The fact that the risk of developing abnormal behaviour was equally high in barn-weaned and box-weaned horses suggests that the presence of companions is not sufficient to reduce the impact of weaning. The paddock-weaned horses had a lower risk. The presence of other calm, grazing horses may have reduced the stress of weaning for the foals in this study. According to the authors age at weaning was not significantly associated with the development of abnormal behaviour, the weaning technique used appeared to be far more important. (Waters *et al*., 2002)

Aim of our study

The purpose of this study was to compare the behaviour of foals, kept in groups at pasture, before and after stepwise removal of their dams.

Material and methods

The study was carried out on a large stud farm in the Lake Malar Region of Sweden during the autumn 2001.

Animals

The study comprised three groups (referred to as group A, B and C) including 12, 11 and 11 Standard bred foals, respectively. The composition of the groups had been the same since the beginning of the summer. They were arranged according to the age of the foals, so that the oldest foals with mares formed the first group and so on. The sexes were mixed. All the foals were born between April and June.

Pastures and feeding

The foals with there dams where kept on pastures with free access to silage. In June, a creep-feeder (fig. 1) containing a commercial concentrate (Krafft Grov 9,0 MJ/kg, 90 g digestible crude protein) were introduced to the foals. The months before weaning the foals consumed an average of 3 kilos per foal and day. After weaning the concentrate were restricted to an amount of approximately 2,6 kilos per foal and day. The purpose of feeding a smaller amount than before weaning was to increase the intake of silage. Before weaning, group A and B were moved to pastures where they had access to a shelter. When all mares had been moved away, the foals in group A and B were fed concentrate in cribs in the shelter. Group C had no access to a shelter during the period of weaning. All pastures were in the size of at least 3 hectare.

Figure 1. Only the foals could enter the creep-feeder containing concentrate.

Weaning method

The weaning was performed when the foals were approximately 5 months. The youngest foal were 142 days and the oldest 162 days when the dam was removed. Average age of the foals when their dams were moved away were for group A 149 days (min 142, max 155), group B 149 days (min 145, max 152) and for group C 155 days (min 151, max 162). The weaning procedure was carried out by the removal of three or four mares at a time from the group. It was always the mares with the oldest foals that were removed. The removed mares were placed so that they and the original group could not hear or see each other. The foals that had been deprived of their dams stayed with their original group. Gradually, mares were removed from the group until there were only foals left. The whole weaning procedure took 8 days for group A, 9 days for group B and 7 days for group C. The intention was that removal of mares should not occur two days in a row, but for different reasons this was not always possible. Six mares in group B and eight mares in group C were removed in a period of two days, respectively. The remaining three mares in group C were removed five days later. Table 4-6 and figure 11-13 in appendix shows detailed schedules of the removal of the mares from the different groups.

Foals which dams had not yet been removed from the group are hereafter referred to as “Foals with dams”. Foals that have had their dams removed from the group are hereafter referred to as “Foals without dams”. The foals without dams were marked with tape on the tail and the mane in order to distinguish them from the foals with dams.

Table 4. Group A; dates, age of foals when their mothers were removed and other remarks

Group A. 12 foals; 9 colts and 3 fillies.				
Date	Day of observation	Number of mares removed	Age of their foals, days	Other remarks
11 sept	1	0		Moved to adjacent pasture with shelter. Rainy.
12 sept	2	3	155, 154, 154	
13 sept	3	0		Cloudy
14 sept	4	3	155, 153, 151	Deworming. Sunny weather.
15 sept	5	0		Sunny weather.
17 sept	6	3	150, 147, 143	Cloudy
18 sept	7	0		Sunny weather.
19 sept	8	3	143, 143, 142	Cloudy.
20 sept	9	0		Rainy.

Table 5. Group B; dates, age of foals when their mothers were removed and other remarks

Group B. 11 foals; 7 colts and 4 fillies.				
Date	Day of observation	Number of mares removed	Age of their foals, days	Other remarks
1 oct	1	0		Cloudy.
3 oct	2	3	150, 152, 152	Sunny weather.
4 oct	3	3	148, 150, 151	Sunny, little cloudy.
5 oct	4	0		Sunny weather.
8 oct	5	3	145, 150, 151	Cloudy.
9 oct	6	0		Rainy the night before. Muddy.
11 oct	7	2	145, 146	Cloudy.
12 oct	8	0		Rain.

Table 6. Group C; dates, age of foals when their mothers were removed and other remarks

Group C. 11 foals; 3 colts and 8 fillies.				
This group remained at summerpasture the whole weaningprocess. There was no shed. Very wet and muddy.				
Date	Day of observation	Number of mares removed	Age of their foals, days	Other remarks
29 oct	1	0		Deworming and vaccination.
30 oct	2	4	156, 158, 161, 162	Windy.
31 oct	3	4	153, 153, 154, 157	Heavy rain and very windy.
1 nov	4	0		Cold and windy.
5 nov	5	3	151, 152, 152	Windy.
6 nov	6	0		Cloudy.

Behaviour observations

Some behaviours were recorded instantaneously with 2 min interval, others continuously (Table 7). Means for periods of 14 minutes were calculated and analysed. The observations of foals without dams were separated from observations of foals with dams. Each period of observation lasted for two hours. Each group were observed for two periods the day before the removal of the first mares, one period at each occasion when mares were removed, starting immediately after the mares had been led away, and two periods the day after mares had been removed. When mares were removed two days in a row, there was only enough time for one period of observation until the next occasion of removing mares. Total time of observation were 28 hours for group A, 26 hours for group B and 20 hours for group C.

Table 7. Ethogram of the registered behaviours

Behaviour	**Definition**	**Interval (2 min) or frequency**
Suckling	The foal was seen with it's nose under the mare's abdomen. Short breaks (< 10 sec.) when the foal changed side or fetched some breath are included.	Interval and frequency
Play	Running around, bucking, or kicking, rearing or mounting. Short breaks (< 10 sec.) are included.	Interval and frequency
Grooming	Mutual grooming with it's mother or another foal. Short breaks (< 10 sec.) are included.	Interval and frequency
Drinking	The foal was seen at a watertank with it's head down and the nose in or near (within 0,1 metre) the watertank. Short breaks (< 10 sec.) are included.	Interval and frequency
Eating commercial concentrate	The foal was inside the creep-feed or, when they were fed at the cribs in the shelter, was standing within 0,5 metre from a crib.	Interval
Grazing	Standing/walking with nose in the grass. Grazing overrides walking if both occur simultaneously.	Interval
Eating silage	Standing within 0,5 metre from the silage.	Interval

Lateral recumbency, alone	Lying laterally with the head immobile on the ground and the legs extended, more than 5 metres from another foal or mare.	Interval
Lateral recumbency, in group	Lying laterally with the head immobile on the ground and the legs extended, within 5 metres from another foal or mare.	Interval
Sternal recumbency, resting, alone	Lying with the sternum on the ground and legs folded under the body, eyes partly or wholly closed, head held low, ears relaxed, more than 5 metres from another foal or mare.	Interval
Sternal recumbency, resting, in group	Lying with the sternum on the ground and legs folded under the body, eyes partly or wholly closed, head held low, ears relaxed, within 5 metres from another foal or mare.	Interval
Sternal recumbency, active, alone	Lying with the sternum on the ground and legs folded under the body, head raised and ears pricked, more than 5 metres from another foal or mare.	Interval
Sternal recumbency, active, in group	Lying with the sternum on the ground and legs folded under the body, head raised and ears pricked, within 5 metres from another foal or mare.	Interval
Standing active	Standing with head raised, ears pricked and eyes fully open.	Interval
Standing passive	Standing immobile. Usually with one hind-leg relaxed and the weight carried by the other; eyes partly or wholly closed, head held low, ears relaxed, not pricked. Ears and tail may move.	Interval
Walking	Walking with head held up.	Interval
Running	Trotting or galloping.	Interval
Attempt to suckle another mare	Nose within 0,5 metres from another mare's udder.	Frequency
Nonnutritional suckling	The foal was seen with it’s nose under the abdomen of another foal. Short breaks (< 10 sec.) are included.	Frequency
Aggressive behaviour	Biting, bite threatening, chasing, kicking or kick threatening towards another foal. Aggressions in the creep-feeding are not recorded.	Frequency
Submissive behaviour	Avoidance when receiving aggressive signals from another foal.	Frequency
Defecating	Self explanatory.	Frequency
Urinating	Self explanatory.	Frequency
Vocalisation	Whinnies.	Frequency

Statistical analysis

The statistical analyses were performed using the General Linear Model (GLM) procedure of SAS (SAS, 1989).

Comparisons of timebudgets the first and the last day were analysed with the following model:

$Y_{ijk} = \mu + g_i + d_j + (gd)_{ij} + e_{ijk}$

Y_{ijk} = the ijk^{th} observation
μ = general mean
g_i = effect of the i^{th} group (i = 1, 2, 3)
d_j = effect of the j^{th} day (j = 1, 2)
$(gd)_{ij}$ = the interaction between the i^{th} group and the j^{th} day
e_{ijk} = residual random term $N \sim (0, \sigma_e^2)$

Group = group of foals (1-3)
Day = 1: day before weaning process started, 2: day when all mares had been removed

All other comparisons were analysed with the following model:

$Y_{ijkl} = \mu + g_i + t_j + w_k + (tw)_{jk} + e_{ijkl}$

Y_{ijkl} = the $ijkl^{th}$ observation
μ = general mean
g_i = effect of the i^{th} group (i = 1, 2, 3)
t_j = effect of the j^{th} daytype (j = 1, 2, 3)
w_k = effect of the k^{th} with/without dams (k = 1, 2)
$(tw)_{jk}$ = the interaction between the j^{th} daytype and the k^{th} with/without dams
e_{ijkl} = residual random term $N \sim (0, \sigma_e^2)$

Group = group of foals (1-3)
Daytype = 1: day before weaning process started, 2: removal days, 3: days after removal days
With/without dams = 1: foals which dams has not yet been removed, 2: foals which dams has been removed

Two way interactions were tested and excluded when not significant or useful for the results of this study.

Results

Comparisons between the first and the last day

Time budgets

The time budgets of the three groups were very similar with a few exceptions (Table 8 and fig. 2a-c). The foals in group C rested significantly more on the first day, before any dams had been removed, compared to the other groups ($p = 0.005$) and group A were more active than group B and C ($p = 0.035$). There was an interaction between the groups considering resting, group A and B rested more on the last day, when all the dams had been removed, and group C rested more on the first day ($p = 0.033$). In group A and B the foals played and groomed the first day but not the last whereas group C did the opposite ($p = 0.026$), but to a lower extent.

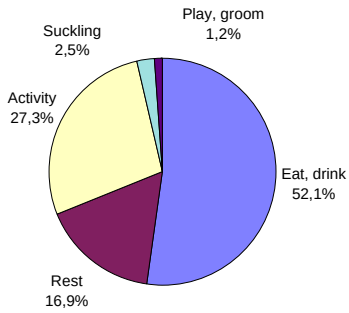
Table 8. Timebudgets of the three groups before and after removal of the dams (lsmeans)

Behaviour (% of observations)	**Group**						***p*-values**		
	A		**B**		**C**		Group	Day	Group * Day
	First day[1]	Last day[2]	First day	Last day	First day	Last day			
Eating or drinking	52.1	57.4	61.1	61.1	45.0	58.4	0.30	0.22	0.55
Resting[3]	16.9[a]	18.9[a]	13.3[a]	24.9[a]	42.9[b]	21.3[a]	0.005	0.62	0.033
Activity[4]	27.3[a]	23.7[a]	20.4[ab]	14.0[b]	10.6[b]	20.0[ab]	0.035	0.96	0.13
Suckling	2.5	0	3.2	0	1.5	0	0.091	<0.001	0.09
Playing or grooming	1.2	0	2.0	0	0	0.2	0.072	0.003	0.026

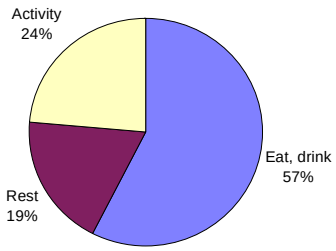
[1]Before removal of mares, [2]After all mares had been removed, [3]Recumbency and standing passive, [4]Running, walking and standing active.

a.

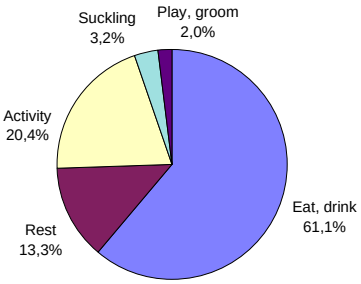
First day

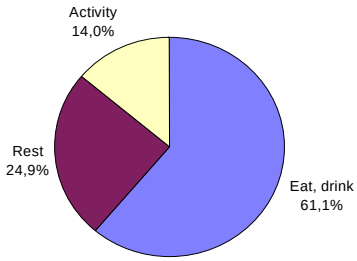


Last day

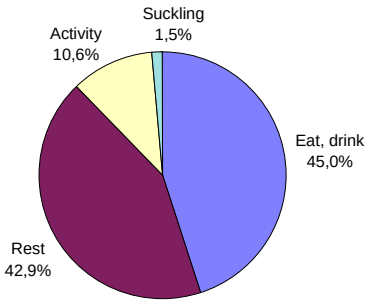


b.





c.



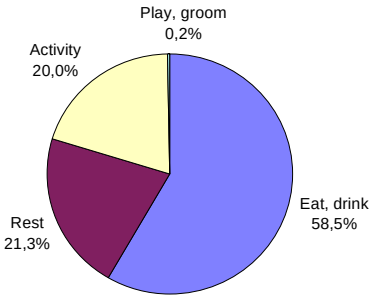


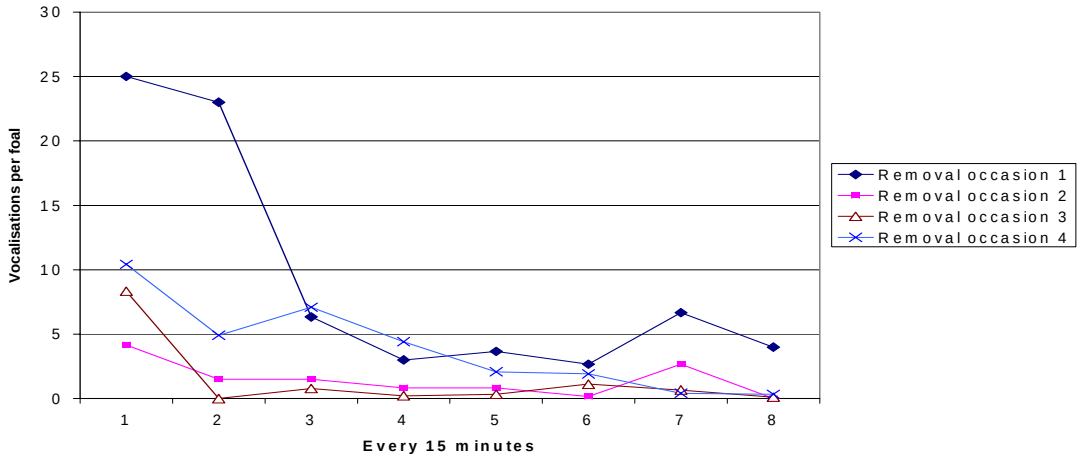
Figure 2. Time budgets of the groups A, B and C, the first and the last day, a= group A, b= group B and c= group C.

Comparisons between the removal days and days after removal days and between foals with and without dams

Locomotion and vocalisation

Locomotion involves running (trotting or galloping) and walking. The vocalisations the foals produced were whinnies. Neither the amount of running nor the number of vocalisations differed significantly between groups. However there were interactions between days and foals ($p < 0.001$) for both these behaviours. On removal days the foals without dams were both running/walking and whinnying more than the foals with dams. Days after removal days the foals without dams had calmed down and there was no longer a significant difference in either locomotion or vocalisation between those with and those without dams. The following figures (3a-c) show vocalisations of the foals without dams the first two hours after dams had been removed.

a.



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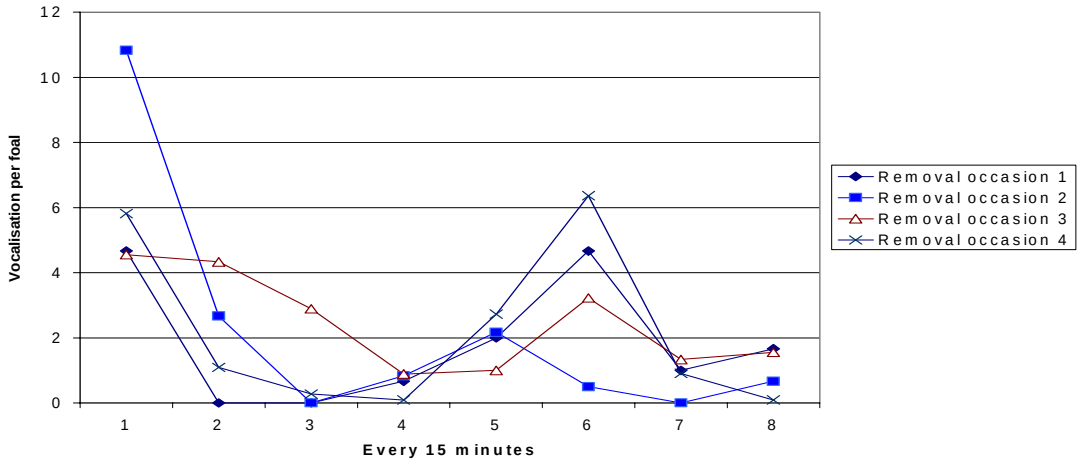


c.

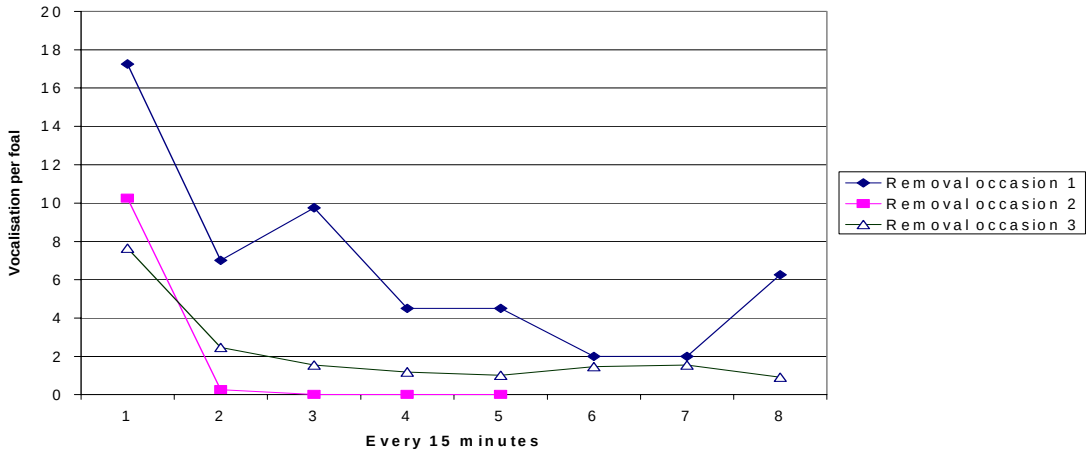


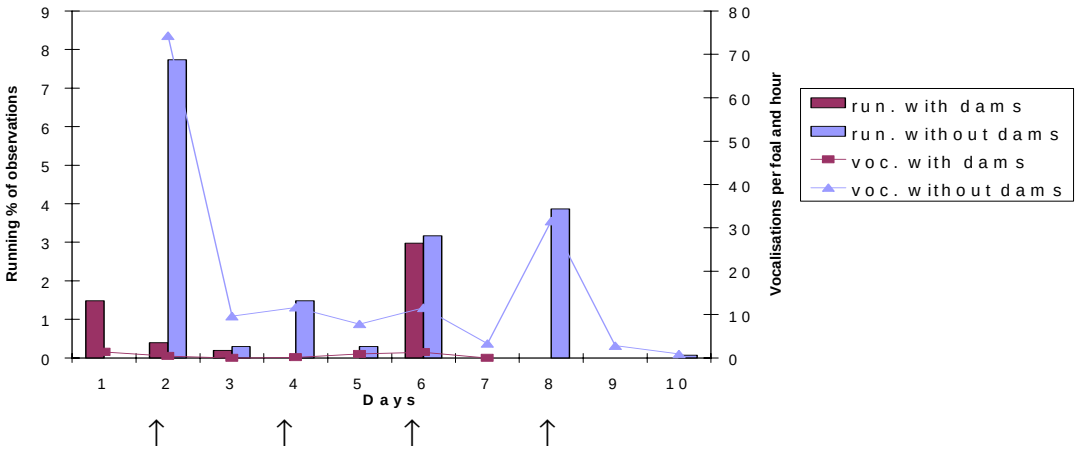
Figure 3. Vocalisations of the foals without dams in the three groups, the first two hours after dams have been removed, a= group A, b= group B and c= group C.

Vocalisations were often performed in connection with locomotion (running and walking). The correlation coefficient (Pearson) between locomotion and vocalisation was 0.5 ($p< 0.001$) for group A and B and 0.6 ($p< 0.001$) for group C. The correlation coefficients between running and vocalisation and between walking and vocalisation were also significant (Table 9). Figure 4a-c show running and vocalisation for the foals with and without dams in the three groups.

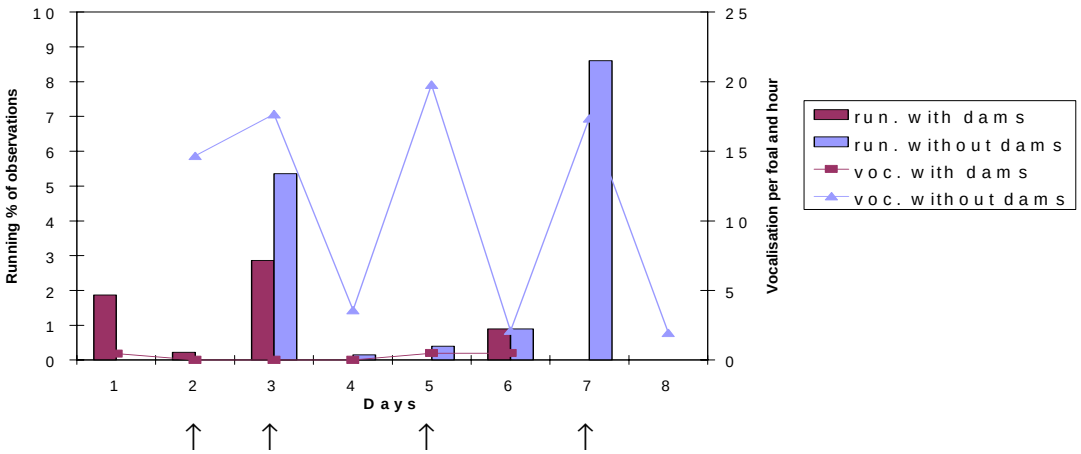
Table 9. The correlation coefficient (Pearson) and *p*-value between vocalisation and locomotion/running/walking for the three groups

	Vocalisation					
	A		**B**		**C**	
	Correlation coefficient	*p*-value	Correlation coefficient	*p*-value	Correlation coefficient	*p*-value
Locomotion	0.5	<0.001	0.5	<0.001	0.6	<0.001
Running	0.7	<0.001	0.5	<0.001	0.6	<0.001
Walking	0.3	<0.001	0.4	<0.001	0.5	<0.001

a.



b.



c.

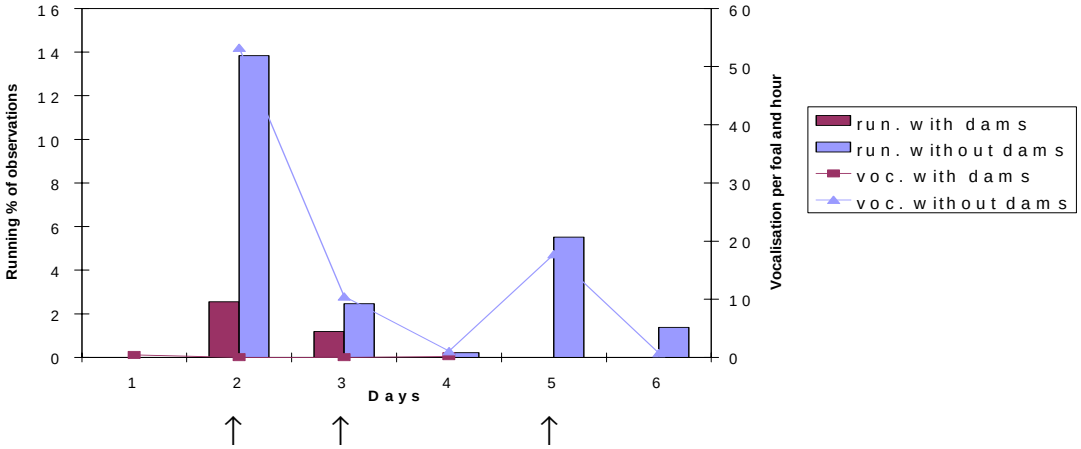


Figure 4. Vocalisation and running in the groups, a= group A, b= group B and c= group C. Days with arrows are removal days.

Resting

The different resting behaviours, ("standing passive" and all "recumbent"-observations) are here summarized and called ”resting”. No significant differences between the three groups were found in the amount of time they spent resting ($p= 0.076$). However group C rested less recumbent ($p< 0.001$) and more standing passive ($p= 0.0075$) than the other groups (Table 10 and 11). There were also differences between the groups in how much the foals rested in groups (fig. 5) or alone and in lateral or sternal recumbency (Fig. 6a-c). There was no significant difference between the foals with and without dams, in any of the groups, in how much they rested ($p= 0.42$), but they all rested less on removal days ($p<0.001$). Both foals with and without dams spent less time in a recumbent posture on removal days ($p< 0.001$). All foals rested less alone on removal days ($p= 0.026$) and the foals without dams rested less alone ($p= 0.0016$) than foals with dams on days after removal days. Both foals with and without dams rested less in lateral recumbency ($p< 0.001$) on removal days and the foals without dams rested less in lateral recumbency ($p= 0.039$) than foals with dams on days after removal days.

Figure 5. Foals resting in group with a mare standing over them.

Table 10. Resting behaviour of the three groups (lsmeans)

Behaviour (% of observations)	**Group**					
	A		**B**		**C**	
	With dams[1]	Without dams[2]	With dams	Without dams	With dams	Without dams
Resting	31.5	25.6	22.7	22.0	25.0	18.1
Standing passive	8.4	9.8	8.6	10.8	21.6	14.5
Recumbency	23.0	15.8	14.1	11.2	3.4	3.6
In Groups	18.3	14.1	10.7	9.5	2.1	3.0
Alone	4.7	1.7	3.3	1.7	1.3	0.6
Lateral	10.8	5.2	3.3	2.1	0.9	0.4
Sternal	12.2	10.6	10.7	9.1	2.5	3.2

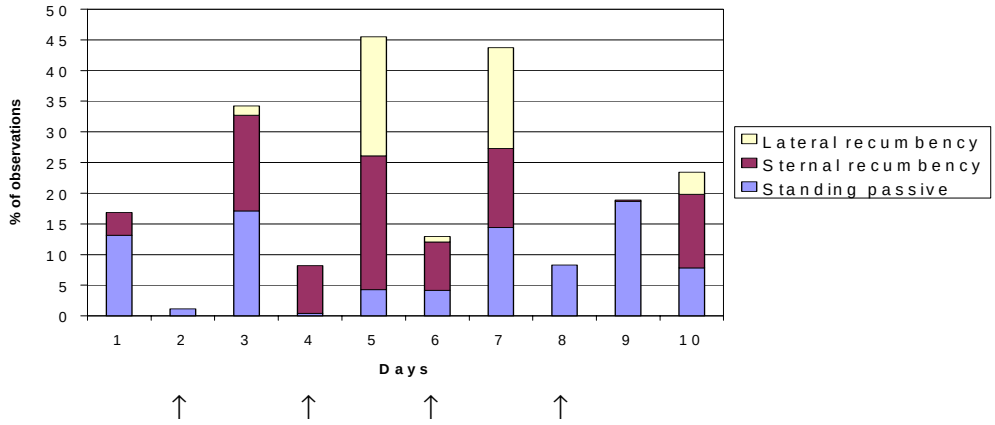
[1]Foals with dams, their dams had not yet been removed, [2]Foals without dams, their dams had been removed from the group.

Table 11. *p*-values for the different resting behaviours

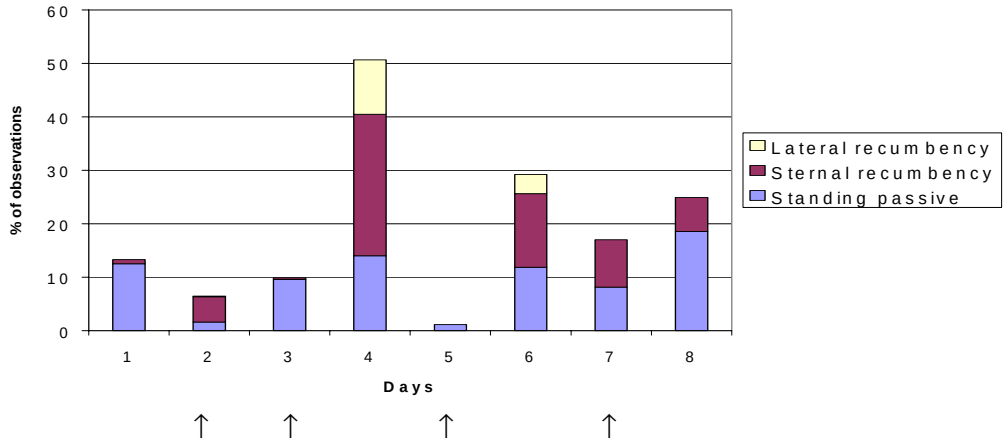
Behaviour (% of observations)	***p* - values**			
	Group[1]	Day[2]	With/without[3]	Day*With/without[4]
Resting	0.076	<0.001	0.42	0.54
Standing passive	0.0075	0.71	0.027	0.76
Recumbency	<0.001	<0.001	0.18	0.17
In Groups	<0.001	<0.001	0.46	0.35
Alone	0.0057	0.026	0.0016	0.059
Lateral	<0.001	<0.001	0.039	0.11
Sternal	<0.001	<0.001	0.41	0.44

[1]Group A, B and C, [2]Day before weaning process begins, removal days and days after removal days, [3]Foals with dams, their dams had not yet been removed and foals without dams, their dams had been removed from the group, [4]Interaction between days and foals with and without dams.

a.



b.



c.

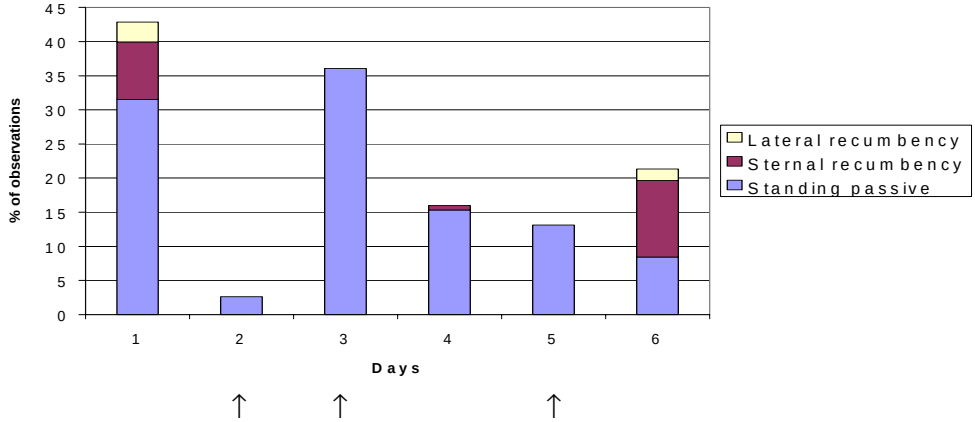


Figure 6. Foals, both with and without dams, resting standing passive and in lateral and sternal recumbency in the three groups, a= group A, b= group B and c= group C. Days with arrows are removal days.

Feeding

The eating behaviours grazing, eating silage and creep-feed are here summarized and called "eating". There was a significant difference between groups in total eating time ($p= 0.026$). Group A spent less time eating than group B and C, and there were also significant differences between the groups for the different eating behaviours (Table 12 and 13). Considering grazing there was an interaction between days and foals ($p= 0.005$). The foals with dams spent more time grazing on removal days than the foals without dams. The foals with dams also spent more time grazing on removal days than days after removal days. Due to grazing being a large part of total eating time a significant interaction between days and foals ($p< 0.01$) also occurred for "eating".

The foals without dams spent less time eating silage ($p= 0.0023$) than the foals with dams (fig. 7). Both foals with and without dams spent equal amount of time eating in the creep-feeder but they spent the most time in the creep-feeder the day before the weaning process started ($p< 0.001$). Figure 8a-c shows the per cent of observations that the foals, with and without dams, spent grazing, eating silage and eating concentrate.

Figure 7. Foals are grazing (a) and eating silage (b).

Table 12. Feeding behaviour for the three groups (lsmeans)

Behaviour (% of observations)	**Group**					
	A		**B**		C	
	With dams[1]	Without dams[2]	With dams	Without dams	With dams	Without dams
Eating	46.6	45.9	54.0	52.3	57.4	53.4
Grazing	32.1	33.7	47.2	46.2	12.9	24.6
Silage	7.9	4.7	0.9	0.6	30.8	20.5
Creep-feeding	6.7	7.5	5.9	5.5	13.8	8.3

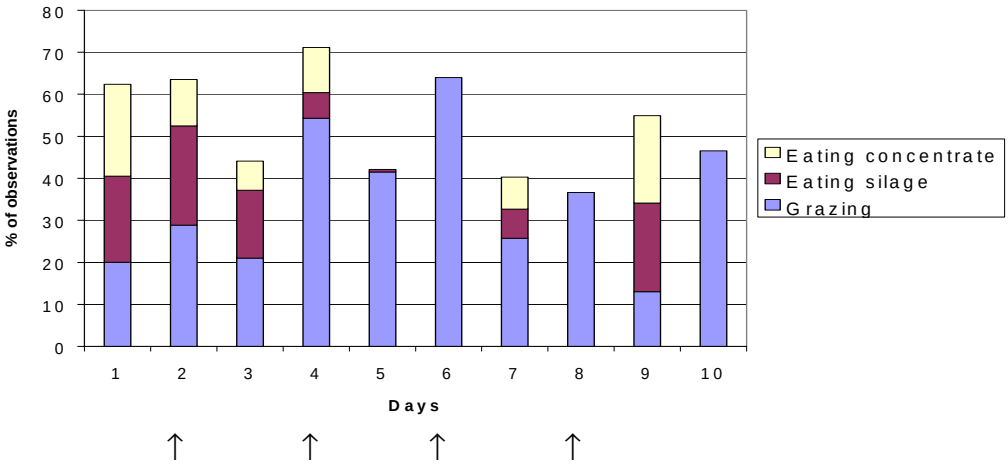
[1]Foals with dams, their dams had not yet been removed, [2]Foals without dams, their dams had been removed from the group.

Table 13. *p*-values for the different behaviours

Behaviour (% of observations)	***p* - values**			
	Group[1]	Day[2]	With/without[3]	Day*With/without[4]
Eating	0.026	0.004	0.088	<0.01
Grazing	<0.001	<0.001	0.27	0.005
Silage	<0.001	0.05	0.0023	0.34
Creep-feeding	0.11	< 0.001	0.085	0.23

[1]Group A, B and C, [2]Day before weaning process begins, removal days and days after removal days, [3]Foals with dams, their dams had not yet been removed and foals without dams, their dams had been removed from the group, [4]Interaction between days and foals with and without dams.

a.



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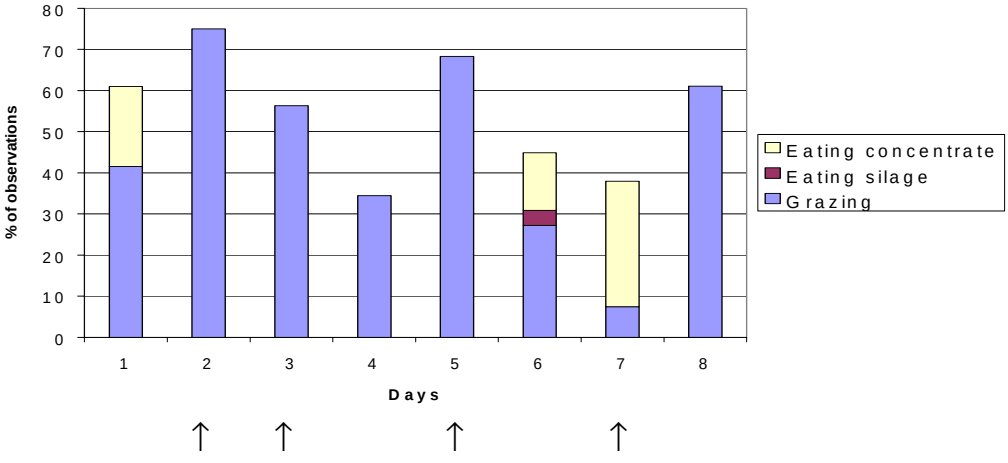

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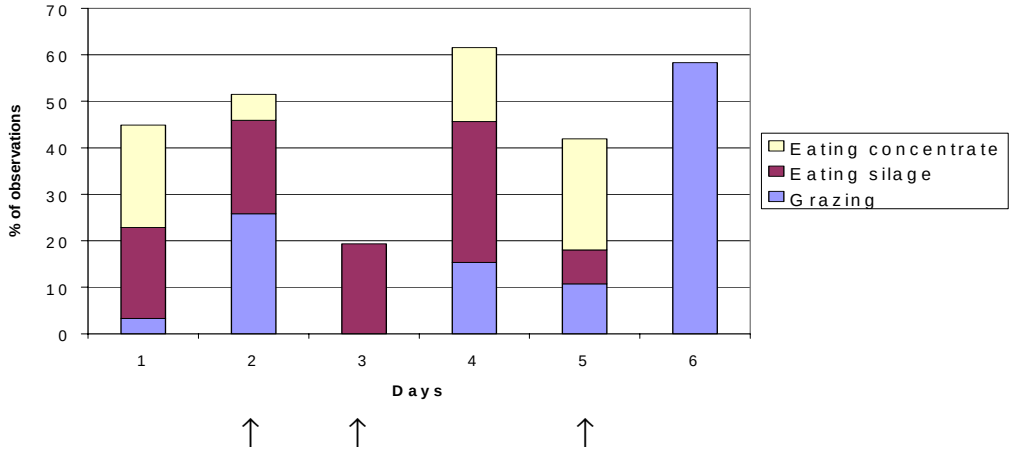


Figure 8. Foals, both with and without dams, grazing, eating silage and concentrate in the three groups, a= group A, b= group B and c= group C. Days with arrows are removal days.

Drinking

The foals with dams drank water 0.05 times per foal and hour in group A, 0.06 times in group B and 0.02 times per foal and hour in group C (Table 15 and 16, page 37). The drinking frequency for the foals without dams was 0.1 times per foal and hour in group A, 0.05 times in group B and 0.1 times per foal and hour in group C. There was a significant difference between groups (p= 0.032) but not between removal days and days after and not between foals with and without dams.

Suckling

The suckling frequency for group A was 0.86 times per foal and hour, for group B 1.27 and for group C 0.84 times per foal and hour (Table 15 and 16, page 37). There was a significant difference between groups (p= 0.035) but not between removal days and days after for the foals with dams. The most common length of a suckling bout was > 1 minute but < 1.5 minute in all three groups (Table 14).

Table 14. Distribution of length of suckling bout in per cent for group A, B and C

Length of suckling bout (minutes)	**Group**		
	A (%)	B (%)	C (%)
< 0.5	7.9	10.9	13.8
> 0.5	30.9	27.9	15.4
> 1	39.5	40.1	50.8
> 1.5	19.1	19.7	16.9
> 2	2.6	1.4	3.1

It was rare that the dams rejected their foal when they tried to suckle. This was only observed 9 times in group A where 150 suckling bouts were observed, 2 times in group B where 139 suckling bouts were observed and 6 times in group C where 63 suckling bouts were observed.

Of 131 suckling bouts in group A, the foals ended 110 (84%) and the dams ended 21 (16%). In group B the foals ended 122 (86%) suckling bouts of 142 and the dams ended 20 (14%). Of 58 suckling bouts in group C, the foals ended 53 (91%) and the dams ended 5 (9%).

Non-nutritional sucking

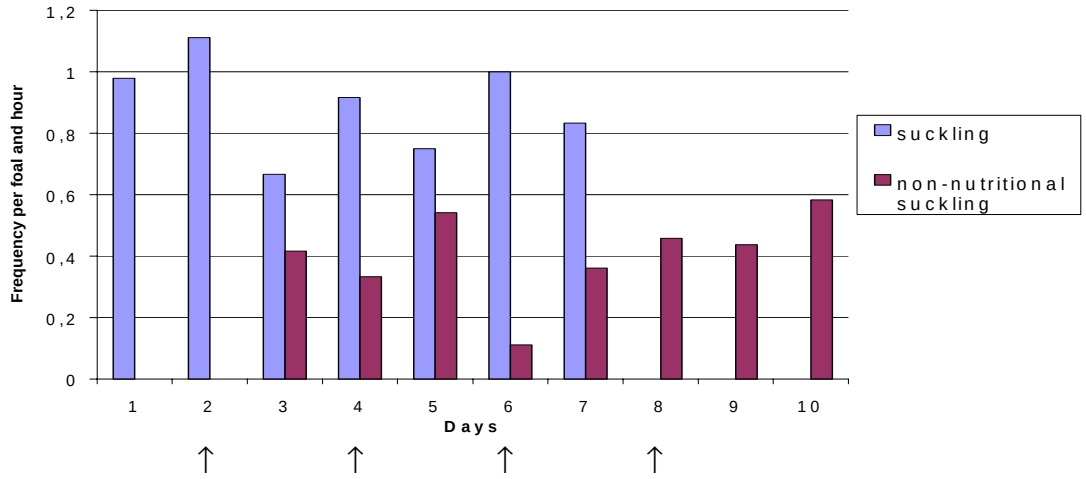
The foals without dams tried to suckle other foals (fig. 9). This happened in all three groups. The foals with dams were never observed trying to suckle another foal. The frequency for suckling on another foal was 0.4 times per foal and hour in group A, 0.3 in group B and 0.3 times per foal and hour in group C (Table 15 and 16, page 37). There were no significant differences between groups or between removal days and days after removal days.

Fig. 19. A foal tries to suckle another foal.

Figure 10a-c show suckling frequency for foals with dams and non-nutritional suckling frequency for foals without dams in the three groups.

Observations of foals trying to suckle other mares were rare and only occurred when the foal's dam had been removed. It occurred six times each in group A and B and fifteen times in group C. On one occasion, in group C, a foal without dam managed to suckle another mare for a few seconds before the mare discovered that it wasn’t her foal and fought it off.

a.



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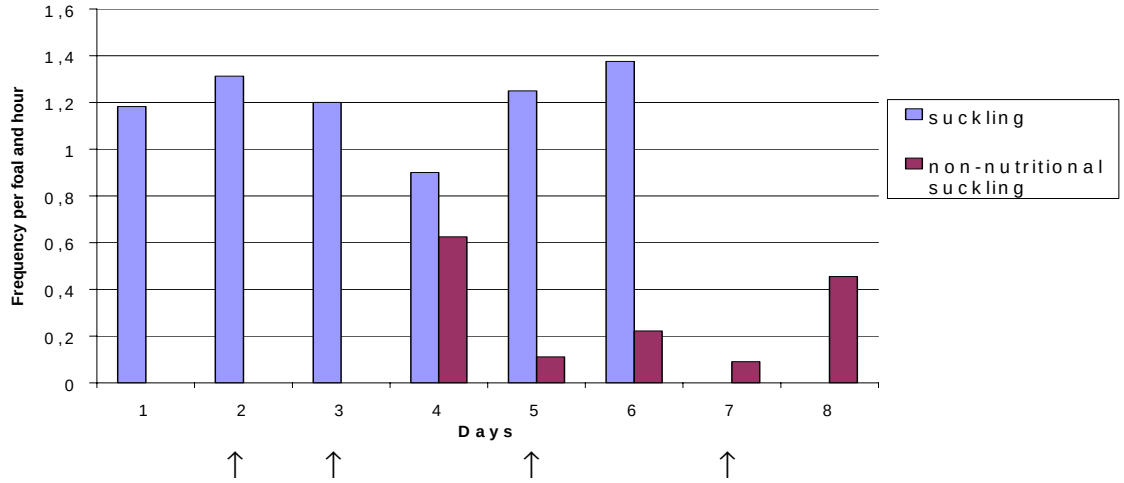

c.

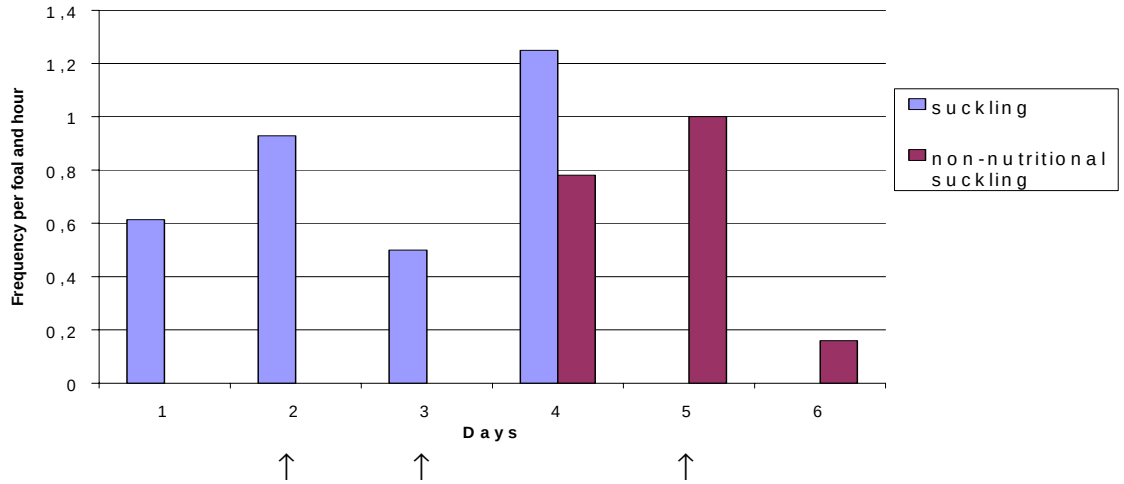

Figure 10. Suckling and non- nutritional suckling in the three groups, a= group A, b= group B and c= group C. Days with arrows are removal days.

Aggression

The frequency of aggression was 0.1 times per foal and hour in group A, 0.09 times in group B and 0.2 times per foal and hour in group C for the foals with dams (Table 15 and 16, page 37). The foals without dams had similar frequencies, 0.07 times per foal and hour in group A, 0.2 times in group B and 0.3 times per foal and hour in group C. There were significant differences between groups ($p < 0.0069$), but not between foals with and without dams. All the foals, with and without dams, showed more aggression on removal days than the day after removal days ($p < 0.02$).

For submissive behaviour the frequency was 0.04 times per foal and hour in group A, 0.06 times in group B and 0.1 times per foal and hour in group C for the foals with dams (Table 15 and 16, page 37). For the foals without dams the frequency for submissive behaviour was 0.3 times per foal and hour in group A, 0.2 times in group B and 0.3 times per foal and hour in group C. The foals without dams showed submissive behaviour more often than the foals with dams ($p < 0.001$). There was no significant difference between groups or between removal days and days after removal days.

Defecation and urination

The foals with dams defecated 0.3 times per foal and hour in group A and B, and 0.1 times per foal and hour in group C (Table 15 and 16, page 37). The foals without dams defecated 0.4 times per foal and hour in group A, 0.5 times in group B and 0.3 times per foal and hour in group C. During the last removal occasion in group A, the foals defecated a lot the first half hour after the dams had been removed, 24 times (in total). All the foals defecated more on removal days than days after removal days ($p = 0.039$). There was no significant difference between groups or between foals with and without dams.

The foals with dams urinated 0.4 times per foal and hour in group A, 0.5 times in group B and 0.2 times per foal and hour in group C (Table 18 and 19, page 37). The foal without dams urinated 0.3 times per foal and hour in group A, 0.5 times in group B and 0.09 times per foal and hour in group C. There were significant differences between groups ($p < 0.001$), but not between foals with and without dams. All the foals, with and without dams, urinated more on removal days than days after removal days ($p = 0.008$).

Play and grooming

There were few observations of play behaviour. The frequency of play behaviour was 0.3 times per foal and hour for the foals with dams in group A, 0.2 times in group B and 0.07 times per foal and hour in group C (Table 15 and 16, page 37). The foals without dams played 0.07 times per foal and hour in group A, 0.05 times in group B and 0.3 times per foal and hour in group C. There was no significant difference between groups but there was an interaction between days and foals ($p = 0.025$). The foals with dams spent more time playing than the foals without dams on days after removal days.

The foals with dams groomed with another foal or with its dam 0.2 times per foal and hour in group A, 0.2 times in group B and 0.02 times per foal and hour in group C (Table 15 and 16). For the foals without dams the frequency was 0.05 times per foal and hour in group A, 0.06 times in group B and 0.09 times per foal and hour in group C. There was no significant difference between groups but there was an interaction between days and foals (p= 0.004). The foals with dams groomed more than the foals without dams on removal days. The foals with dams also groomed more on removal days than on days after removal days.

Table 15. Frequency of behaviours for foals with and without dams

Behaviour (frequency per foal and hour)	**Group**					
	A		**B**		**C**	
	With dams[1]	Without dams[2]	With dams	Without dams	With dams	Without dams
Drinking	0.05	0.1	0.06	0.05	0.02	0.1
Suckling	0.86	-	1.27	-	0.84	-
Non-nutritional sucking	-	0.4	-	0.3	-	0.3
Aggression	0.1	0.07	0.09	0.2	0.2	0.3
Submission	0.04	0.3	0.06	0.2	0.1	0.3
Defecation	0.3	0.4	0.3	0.5	0.1	0.3
Urination	0.4	0.3	0.5	0.5	0.2	0.09
Play	0.3	0.07	0.2	0.05	0.07	0.3
Grooming	0.2	0.05	0.2	0.06	0.02	0.09

[1]Foals with dams, their dams had not yet been removed, [2]Foals without dams, their dams had been removed from the group.

Table 16. *p*-values for the different behaviours

Behaviour	***p*-values**			
	Group[1]	Day[2]	With/without[3]	Day*With/without[4]
Drinking	0.032	0.11	0.42	0.29
Suckling	0.035	0.41	<0.001	-
Non-nutritional sucking	0.57	0.13	<0.001	-
Aggression	0.0069	0.02	0.66	0.58
Submission	0.15	0.097	<0.001	0.33
Defecation	0.071	0.039	0.12	0.37
Urination	<0.001	0.0082	0.55	0.95
Play	0.19	0.87	0.028	0.025
Grooming	0.43	0.021	0.0041	0.004

[1]Group A, B and C, [2]Day before weaning process begins, removal days and days after removal days, [3]Foals with dams, their dams had not yet been removed and foals without dams, their dams had been removed from the group, [4]Interaction between days and foals with and without dams.

Special observations

- When we were observing the last group we also saw the first group which was in the pasture next to us. We noticed that the foals were still trying to suckle on each other and this was twelve days after the last dams had been removed.

- When the first three dams were removed from group A, the foals which still had their dams with them showed a lot of aggression towards the foals which had just lost their dams. This behaviour was only seen at this occasion.

- Suckling often occurred after the foals had been resting.

- When a mare ended the suckling bout it was often because she was disturbed by something else, for example another mare.

- One foal in group A was never seen in the creep-feeder.

Discussion

The time budgets for the main activities of the three groups were very similar and the time budgets before and after weaning were also very similar. This indicates that the foals adapted quickly to the new circumstances and it may be related to the fact that they were kept on familiar pasture, in a familiar group and that the mares were removed a few at a time. The foals in this study spent less time resting and more time foraging than the foals at the same age in Camargue according to Boy and Duncan (1979). This can be explained by the fact that the foals in this study were observed only during daytime whereas the foals of Camargue were observed both day and night.

In this study the foals without dams were both running and walking more than the foals with dams on removal days. The foals without dams were also more vocal than the foals with dams on removal days. There was no pattern in which removal occasion the foals were most vocal. It seems as the individual differences were the strongest. During the first two hours after mares had been removed the foals were most vocal the first thirty minutes. The vocalisations were whinnies, a long distance distress call. The day after removal days the foals without dams had calmed down and were no longer more active or more vocal than the foals with dams. There was a positive correlation between vocalisation and running. This has also been shown in previous studies (Kiley, 1972; McCall *et al*., 1985). The increased activity and the vocalisations during removal days show that the foals were upset by the removal of their dams.

Since the mares were removed stepwise, most observationdays had a mix of foals that had been without their dams for several days, those who recently had lost their dams and those who still had their dams available. At the first removal occasion all the foals without dams had lost their dame that day. At later removal occasions the foals in the “without dame-group” were both foals that had lost their dams that day and foals that had lost their dams at an earlier removal occasion. How much the foals reacted (vocalisations, running etc.) on removal days was very different between the different removal occasions. Because the foals were not observed individually we can not be sure but it was our impression that there was a strong individual difference between the foals’ reaction to the removal of their dams. It seemed as the foals, which had lost their dame on an earlier removal day, were more calm than the foals who had just lost their dame. This affects the mean value of the observations.

Sleep in horses is affected by environmental disturbances and by changes of diet. Sleep is important for normal growth and behaviour and young animals sleep more than adults (Houpt, 1980). After the removal of mares in this study, the foals did not spend less time resting but changed their resting behaviour. This indicates that the foals were insecure in their common environment due to the removal of their dams. On removal days all foals, both with and without dams, spent less time resting and less time in a recumbent posture. This shows that all foals were disturbed on removal days. Patterns of sleep can be used as an indication of stress in husbandry and management practices should interfere as little as possible with normal patterns of resting behaviour (Fraser, 1992). The foals without dams rested less alone and less in lateral recumbency than the foals with dams during days after removal days. This indicates that the foals without dams still had not adapted to the new situation. In this study there was no opportunity to continue the observations in order to reveal how much time they needed to regain a normal resting behaviour. This area needs further research to establish how severe resting behaviour is disturbed at weaning. Since the foals without dams spent less time in lateral recumbency one might assume that they did not get enough of the important REM-sleep. Loss of sleep may play an important role in the investigation for the causes of stress related diseases. (Fraser, 1992)

Most herds stop grazing and seek shelter during a heavy rainstorm (McDonnell, 1999). Group C had a lot of rain during the observation period and they did not have any shelter. The ground was wet and muddy. This might explain why group C rested standing passive more than the other groups. Group C also rested standing passively through the second removal occasion when it was raining heavily.

Foals without dams spent less time eating than foals with dams on removal days. This indicates that the foals were disturbed by the loss of their dams. Despite the efforts made to make the foals eat more silage by reducing the amount of concentrate, the foals without dams still ate less silage. This might be because there was only one feeder, which made it crowded and probably harder to get to the silage for the foals without a dame by their side as long as there were other mares in the group.

Group C spent less time grazing and more time eating silage, which can be explained by the fact that they were observed later in the autumn when there was very little grass left. Group B ate very little silage probably because the feeder was placed in a part of their pasture where they seldom were. This section of the pasture was partly surrounded by trees and had very little view towards the other horses. It seemed as they felt isolated in this part of the pasture.

One foal was never seen in the creep-feeder. The staff had pushed him in ones to teach him, but he was still never seen in the creep-feeder during the observation period. It got crowded in the creep-feeder and he seemed to be a low ranking colt. Usually there was still concentrate left when the foals had left the creep-feeder, so he could have gone in after the others to eat but he did not do that either.

Although no significant differences, the foals without dams in group A and C drank twice as often and more than the foals with dams. This might indicate that the foals without dams compensated for the lack of milk. There are probably too few observations of drinking behaviour to get significant differences between the foals because it needs more observation time per day. The few observations of drinking are not strange since horses generally go to water once a day or every two days. If water is available in their grazing areas, horses may drink small amounts more frequently. (McDonnell, 1999)

The suckling frequency was about once per hour in all three groups and this is usually the case for foals at five month of age. The most common length of the foals suckling bouts was 1-1.5 minute. Nursing often occurred after the foals had been resting. These results are similar to the studies of Carson and Wood-Gush, (1983), Barber and Crowell-Davis (1994) and Tyler (1972).

The foals ended the majority of the nursing bouts, this means that the mares let them suck as long as they wanted. Duncan *et al*. (1984) observed that in the last month before weaning, the dams terminated a large proportion of bouts. This indicates that the mares in this study had not started the weaning process themselves, which is not strange because when mares get to choose they wean their foals much later. (Duncan *et al*., 1984; Berger, 1986; Tyler, 1972) The few times a mare ended the nursing bout it was often because she was disturbed by something else, for example another mare.

Algers (1980) came to the conclusion that piglets weaned at three weeks of age showed more massage and sucking behaviour on other piglets compared with piglets weaned at six weeks of age. The newborn piglet is dependent on a strong motivation to suckle the sow to be able to survive. This motivation is still high at three weeks of age. The behaviour is fundamental for the piglet and the motivation to perform the sucking behaviour probably increases in relation to the time difference since the last nursing occasion. Piglets who frequently are exposed to massage and sucking behaviour from their siblings show skin lesions on the parts of the body where the behaviour has been performed. Sucking is an essential behaviour for the young animal, when it is weaned early the possibility to perform this essential behaviour is removed and this can be very stressful for the animal. This study led to a new law: it is not allowed to wean piglets before four weeks of age.

McCall *et al*. (1985) observed this non-nutritional sucking behaviour in their study of four month old weanlings. Our study shows that it is obvious that the foals, at five month of age, still have a strong motivation to suck. The foals in group A was still seen trying to suckle on each other twelve days after the last mares had been removed. There was no opportunity to continue the study in order to reveal for how long this behaviour was performed. It is probably better to let the foals become older than five month before they are weaned. More research is needed to determine at which age the motivation for sucking behaviour no longer exists for the foals. When the foals are old enough not to perform this behaviour when separated from their dams, is probably a better time for weaning.

Foals start to interact with other foals when they are two to three weeks old. After their third week playful interactions become more numerous (Tyler, 1972). Hoffman *et al*. (1995) concluded that foals may cope better with weaning placed singly in to stalls rather than in pairs because the paired foals showed a lot of aggression. To measure stress responses in the foals they used behavioural scores, 1 to 10, the higher the score the less stress behaviour in the foal. Holland *et al*. (1996) used the same behavioural scores when they measured stress behaviour in foals weaned gradually and abrupt. Holland *et al*. (1996) got overall higher behavioural scores than Hoffman *et al*. (1995). This might be because Holland *et al*. (1996) kept their foals on familiar pastures in familiar groups. Threat postures are used primarily in maintaining individual distance within the group and the most common expression of submission is simply to move away (Feist and McCullough, 1976). Kept on pasture the space is big enough for the horses to move away to show submission and the conflicts are few.

The foals without dams were not more aggressive than the foals with dams. Although few observations, the foals without dams showed submission three times as often or more than the foals with dams. When the first three mares were removed from group A, the foals which still had their dams with them showed a lot of aggression towards the foals who had just lost their dams. The staff informed us that the mares removed that day were the high ranking mares of that group. When a foal remain close to it’s mother it shares her status and is not threatened by other horses that are subordinated to the mother (Tyler, 1972).

The defecation and urination frequencies in this study was similar to the study on New Forest ponies by Tyler (1972) where they both defecated and urinated about once every third hour. In this study the defecation and urination frequency did not increase for the foals without dams, but it was very individual. At the last weaning occasion in group A, the foals defecated 24 times (in total) in the first half hour which shows that they were stressed by the removal of the last three dams.

The foals did not play or groom very often and foals generally don't. In the study of McCall *et al*. (1985) the foals did not play after their mares had been removed, not until two weeks post-weaning. The foals in this study could play the day after their dams had been removed, but they played less than the foals which still had their dams in the group. The foals without dams also groomed less on removal days. The fact that the foals without dams already the day after both played and groomed suggests that it is a god weaning method.

Weaning is a standard practice on most studs, domestic foals are separated from their dams earlier and more abruptly than under natural conditions. Already in 1987 Kiley-Worthington discussed whether or not it is either sensible or necessary to wean foals. She concludes that when case histories of established stereotype performers are known the development of the behaviour can very often be traced back to the weaning period. This is not surprising as the association between mother and foal is very strong and long lasting. The separation causes psychological trauma for both mare and foal. For the foal, which is developing both physically and behaviourally very rapidly at this stage, such traumatic experience is irreversible (Kiley-Worthington, 1987). Nicol (1999) found that the majority of equine stereotypies start within one month after weaning. This appears to confirm Kiley-Worthington's (1987) view that 'weaning may be the single most important factor governing the development of stereotypies'.

According to Waters *et al*. (2002) the weaning method and the housing system is important for the risk of developing behavioural problems. The paddock-weaned horses had a lower risk and maybe other calm, grazing horses reduces the stress of weaning. The housing is often changed at weaning but the best is probably if the foals can remain on pasture after weaning. According to Waters *et al*. (2002) age was not significantly associated with development of abnormal behaviour. However, the majority of the horses in their study (70%) were weaned between ages 4 and 6 month and 12% were weaned at less than 4 month. Only 11% were weaned at 6-8 month and 2% were more than 8 month at weaning.

To wean or not to wean? This is an area that needs more research. Several kinds of weaning systems are in use today and the gradual weaning in familiar surroundings and familiar groups is obviously the best one. However, the age of the foals is rarely concerned and the foals are probably often too young. In Sweden we have an old tradition of weaning the foals early when the mare was needed for work. In Sweden a lot of studs wean when they take the horses from pasture for practical reasons, for example too small boxes. We have a short pasture period in Sweden and late weaning require proper feeding of mare as well as foal because in late summer/autumn the pasture has a low production of nutrients. The negative effects of late weaning is in reality often an effect of poor pasture. Weaning after the horses have been taken from the pasture usually demands a loose housing system, but then it is more difficult to feed mares and foals separately. We need to develop new housing systems where it is possible to wean the foals at an older age. We also need proper recommendations for how and when to wean our foals. The decision how to wean the foals and at which age should be based on the natural behaviour of the horse and not on tradition.

Sammanfattning

Avvänjning av föl är en rutinsak på de flesta stuterier idag, och avvänjningsmetoderna skiljer sig åt. På stuteriet där denna studie genomfördes används en metod som tros minska avvänjningsstress hos fölen. Syftet med studien var att jämföra beteendet hos föl i grupp före och efter successivt bortförande av deras mödrar.

Tre grupper med varmblodiga travföl (12, 11 och 11 föl i respektive grupp, både sto- och hingstföl) hölls tillsammans med sina mödrar i varsin lösdrift med tillhörande bete på ca 3-4 ha. De hade fri tillgång på ensilage och dessutom hade fölen tillgång till kraftfoder (Krafft Grov) via creep-feeding. När fölen var 5 månader gamla påbörjades förflyttningen av mödrarna. Var eller varannan dag togs 2-4 ston bort från gruppen, tills dess att alla ston var borta. Stona flyttades en bit bort så att de och fölen inte kunde se eller höra varandra. Fölen fick gå kvar i samma lösdrift under hela avvänjningsprocessen.

Observationer av fölens beteenden gjordes dagligen i tvåtimmarsskift från dagen innan de första stona flyttades tills dagen efter de sista stona flyttats. De tre grupperna observerades i respektive 28, 26 samt 20 timmar. Totalt registrerades 24 olika beteenden, en del kontinuerligt och andra med ett intervall av 2 minuter. Medelvärden för varje 14-minutersperiod beräknades och analyserades med GLM-proceduren i SAS, Statistical Analysis System.

Fölens tidsbudget dagen efter att alla ston var bortförda var väldigt lik den tidsbudget de hade dagen innan bortförandet av ston påbörjades. Återgången till den normala tidsbudgeten indikerar en snabb anpassning till den nya situationen. En anledning till den till synes snabba anpassningen kan vara att fölen under hela avvänjningsprocessen befunnit sig i en bekant omgivning och med bekanta flockmedlemmar. Under flyttningsdagarna (de dagar då ston fördes bort) skrittade och sprang fölen utan mödrar mer än fölen med sina mödrar kvar i gruppen. Fölen utan mödrar vokaliserade även mer under flyttningsdagarna, huvudsakligen av typen långdistansrop, jämfört med föl med mödrar. De “avvanda” fölen var således uppenbart påverkade av att deras mödrar förts bort. Dessutom ägnade alla föl i gruppen, både de med och de utan mödrar, mindre tid till att ligga ner och mindre tid till att vila överhuvudtaget under flyttningsdagarna. Det här visar att alla föl, även de som fortfarande hade sin moder kvar i flocken, var synbart påverkade av situationen under flyttningsdagarna. Dagarna efter att ston blivit flyttade från gruppen, spenderade fölen utan mödrar mindre tid att vila ensamma och även mindre tid vilandes i lateralt läge, jämfört med föl med mödrar. Detta visar att fölen utan mödrar var mindre trygga och ännu inte till fullo hade anpassat sig till den nya situationen. Fölen ägnade lika mycket tid totalt åt att vila som innan stona fördes bort, men de ändrade sitt vilbeteende till att vila mer stående eller liggande på bröstet och mindre liggande på sidan, lateralt. På grund av den minskade laterala vilotiden finns en risk att fölen inte fick tillräckligt av den viktiga REM-sömnen, som bara kan infinna sig när de ligger lateralt.

Innan sto och föl skildes åt diade fölen ungefär en gång per timme, vilket är normalt för föl vid 5 månaders ålder. Vid majoriteten av dessa digivningar var det också fölet som var den avslutande parten. Detta visar tydligt att stona ännu inte hade påbörjat sin avvänjningsprocess av fölen, en slutsats som är högst rimlig eftersom ston som själva får avvänja sina föl gör detta långt senare. Det är tydligt att föl vid 5 månaders ålder fortfarande har en hög motivation att suga. Dagen efter att ston förts bort från grupp A, observerades att deras föl försökte dia på andra föl. Försök att dia andra ston var sällsynt, fölen kunde inte komma så nära innan de blev bortjagade av stoet. Dock observerades diförsök på andra föl ännu 12 dagar efter att de sista stona förts bort.

Bindningen mellan sto och föl är mycket stark och varar en lång tid in på fölets uppväxt. Avvänjning innebär därför mer eller mindre ett psykologiskt trauma för fölet, som både fysiskt och beteendemässigt utvecklas väldigt snabbt. Rapporter från forskare pekar på att det finns en stark koppling mellan tidig, abrupt avvänjning och framtida stereotypier. Majoriteten av stereotypier påbörjas inom en månad efter avvänjning (Nicol's, 1999). I fall där individens hela historia är känd kan etablerade stereotypier hos vuxna hästar ofta spåras tillbaka till individens avvänjning. Avvänjning kan vara den enskilt mest betydande orsaken till utvecklandet av stereotypier (Kiley-Worthington, 1987).

I flera studier har det visats att grupphållna föl visar mindre stress vid avvänjningen. Kanske andra lugna hästar hjälper till att minska stressen för fölen. Vid avvänjningen tas ofta fölen abrupt från modern och flyttas till en ny miljö. En gradvis avvänjning där fölen får gå kvar i sin invanda miljö och med sin invanda grupp är helt klar det bästa alternativet. Det tas sällan hänsyn till fölens ålder och troligtvis avvänjs de ofta för unga. Sen avvänjning har dåligt rykte, antagligen därför att man blandar ihop effekten av sent höstbete och diandet. Sen avvänjning kräver ordentlig utfodring av såväl sto som föl. De flesta stuterier avvänjer fölen, av praktiska skäl, när hästarna tas in från betet. Vi behöver vidareutveckla våra inhysningssystem för att göra det praktiskt enklare för en senare avvänjning. Vi behöver bra rekommendationer för hur och när föl bör avvänjas. Hur och när föl ska avvänjas bör grundas på hästens naturliga beteende och inte tradition.

References

Algers, B., 1980. Animal health and behaviour in flatdeck rearing of weaned piglets. Report 4. Department of animal hygiene with Farrier's School. Swedish University of Agricultural Sciences.

Barber, J.A. & Crowell-Davis, S.L., 1994. Maternal behaviour of Belgian (*Equus caballus*) mares. *Appl. Anim. Behav. Sci.* **41**, 161-189.

Beech, J., 1987. Tumours of the pituitary gland (pars intermedia). In: N.E. Robinson (Ed.) Current Therapy in Equine Medicine: 2. p 182. W.B. Saunders, Philadelphia, PA.

Berger, J., 1977. Organizational Systems and Dominance in Feral Horses in the Grand Canyon. *Behav. Ecol. Sociobiol.* **2**, 131-146.

Berger, J., 1986. Wild horses of the Great Basin. University of Chicago Press, Chicago

Boy, V. & Duncan, P., 1979. Time-budgets of Camargue horses. I. Developmental changes in the time-budgets of foals. *Behaviour,* **71**, p. 3-4.

Cameron, E.Z., Stafford, K.J., Linklater, W.L. and Veltman, C.J., 1999. Suckling behaviour does not measure milk intake in horses, *Equus caballus. Anim. Behav.* **57,** 673-678.

Carson, K. And Wood-Gush, D.G.M., 1983. Behaviour of Thoroughbred foals during nursing. *Equine vet. J.* **15**, 257-262.

Crowell-Davis, S.L., 1986. Spatial relations between mares and foals of the Welsh pony (*Equus Caballus). Anim. Behav.* **34,** 1007-1015.

Dallaire, A. and Ruckebusch, Y., 1974. Sleep patterns in the pony with observations on partial perceptual deprivation. *Physiology and Behavior.* **12**, 789-796.

Dallaire, A., 1986. Sleep as a behavior. *Vet. Clinics of North America: Equine Practice.* **2,** 591-607.

Dantzer, R. and Mormède, P., 1985. Stress in domestic animals: A psychoneuroendocrine approach. In; G. P. Moberg (Ed.) Animal Stress. p 81. Am. Phys. Soc., Bethesda, MD.

Duncan, P., Harvey, P.H. and Wells, S.M., 1984. On lactation and associated behaviour in a natural herd of horses. *Anim. Behav.* **32,** 255-263.

Duncan, P. 1980. Time-budgets of Camargue horses. II. Time-budgets of adult horses and weaned sub-adults. *Behaviour*. **72**, 26-49.

Duncan, P., 1985. Time-budgets of Camargue horses. III. Environmental influences. *Behaviour,* **92,** 188-208.

Erickson, H. H., 1993. Behavioral Physiology. In; Swenson, M.J. and Reece, W.O. (Eds.) Duke´s physiology of domestic animals. p 318. 11th ed. Ithaca: Comstock Cornell University Press.

Feist, J. D. and McCullough, D. R., 1975. Reproduction in feral horses. *J. Reprod. Fert, Suppl.* **23**, 13-18.

Feist, J. D. and McCullough, D. R., 1976. Behaviour Patterns and Communication in Feral Horses. *Z. Tierpsychol.* **41**, 337-371.

Frape, D., 1998. Equine Nutrition and Feeding. Second edition. Blackwell Science Ltd. Oxford.

Fraser, A. F., 1992. The behaviour of the horse. CAB International, Wallingford, UK.

Grubb, P. & Jewell, P.A., 1974. Movement, daily activity, and home range of Soay sheep. In: Island survivors; the ecology of the Soay sheep of St. Kilda. (eds P. A. Jewell, C. Milner & J. Morton-Boyd) Athlone Press. Univ. London.

Hart, B.L., 1985. The Behaviour of Domestic Animals. W.H. Freeman and Co., New York.

Heleski, C. R., Shelle, A. C., Nielsen, B. D. & Zanella, A. J. 2002. Influence of housing on weanling horse behaviour and subsequent welfare. *Appl. Anim. Behav. Sci*. **78**, 291-302.

Hoffman, R.M., Kronfeld, D.S., Holland, J.L. & Greiwe-Crandell, K.M. (1995) Preweaning Diet and Stall Weaning Method Influences on Stress Response in Foals. *J. Anim. Sci.* **73,** 2922-2930.

Holland, J.L., Kronfeld, D.S., Hoffman, R.M., Greiwe-Crandell, K.M., Boyd, T.L., Cooper, W.L. & Harris, P.A., 1996. Weaning stress is affected by nutrition and weaning methods. *Pferdeheilkunde.* **3,** 257-260.

Houpt, K. A., Hintz, H. F. and Butler, W. R., 1984. A preliminary study of two methods of weaning foals. *Applied Animal Behaviour Science*. **12**, 177-181.

Houpt, K. A. and Keiper R., 1982. The position of the stallion in the equine dominance hierarchy of feral and domesticated ponies. *J. anim. Sci.* **54,** 945-950.

Houpt, K. A., 1980. The characteristics of equine sleep. *Equine practice*. **2**, 8-17.

Kaseda, Y., 1983. Seasonal changes in time spent grazing and resting of Misaki Horses. *Jpn. J. Zootech. Sci.*, **54**, 464-469.

Kiley, M., 1972. The vocalizations of ungulates, their causation and function. *Z. Tierpsychology.*, **31**, 171-222.

Kiley-Worthington, M., 1987. The behaviour of horses in relation to management and training. J.A. Allen, London. p 256.

Klemm, W. R., 1993. Behavioral Physiology. In; Swenson, M.J. and Reece, W.O. (Eds.) Duke´s physiology of domestic animals. p 924. 11th ed. Ithaca: Comstock Cornell University Press.

Malinowski, K., Hallquist, N.A., Helyar, L., Sherman, A.R. & Scanes, C.G., 1990. Effect of different separation protocols between mares and foals on plasma cortisol and cell-mediated immune response. *J. Equine Vet. Sci.* **7**, 368-374.

McCall, C.A., Potter, G.D. and Kreider, J.L., 1985. Locomotor, vocal and other behavioural responses to varying methods of weaning foals. *Appl. Anim. Behav. Sci.* **14,** 27-35.

McCall, C.A., Potter, G.D., Kreider, J.L. and Jenkins, W.L., 1987. Physiological responses in foals weaned by abrupt or gradual methods. *Equine vet. Sci.* **7,** 368-375.

McDonnell, S., 1999. Understanding horse behaviour, your guide to horse health care and management. The Blood-Horse Inc. Lexington, KY.

Miller, R., 1981. Male aggression, dominance and breeding behaviour in Red Desert feral horses. *Z. Tierpsychol.* **57,** 340-351.

Nicol. C., 1999. Understanding equine stereotypies. *Equine vet. J., Suppl.* **28,** 20-25.

SAS Institute Inc. 1989. SAS Users Guide: Statistics. 1982 edn. SAS Institute Inc., Cary, NC, 1989, 584 pp.

Sweeting, M. P., Houpt, C. E. and Houpt, K. A., 1985. Social facilitation of feeding and time budgets in stabled ponies. *J. Animal Science*. **60,** 369-374.

Tyler, S.J., 1972. The behaviour and social organisation of the New Forest ponies. *Anim. Behav. Mono.* **5,** 85-196.

Waring, G. H., Wierzbowski, S. and Hafez, E. S. E., 1975. Kap. 13. The behaviour of horses. In; The behaviour of domestic animals. Third Edition. Ed. E. S. E. Hafez, London.

Waters, A. J., Nicol, C. J. and French, N. P., 2002. Factors influencing the development of stereotypic and redirected behaviours in young horses: findings of a four year prospective epidemiological study. *Equine vet. J.* **34**. 572-579.

Wood-Gush, D. G. M., Duncan, I. J. H. and Frazer, D., 1975. Social stress and welfare problems in agricultural animals. In: E. S. E. Hafez (Editor), The Behaviour of Domestic Animals. 3rd edn. Williams and Wilkins, Baltimore, pp. 182-200.

Appendix

Date	Obs. day	Obs. period	Foal number 1	2	3	4	5	6	7	8	9	10	11	12
11 sept	1	1	N	N	N	N	N	N	N	N	N	N	N	N
		2	N	N	N	N	N	N	N	N	N	N	N	N
12 sept	2	-	N	N	N	N	N	N	N	N	N	N	N	N
		2	W	W	W	N	N	N	N	N	N	N	N	N
13 sept	3	1	W	W	W	N	N	N	N	N	N	N	N	N
		2	W	W	W	N	N	N	N	N	N	N	N	N
14 sept	4	-	W	W	W	N	N	N	N	N	N	N	N	N
		2	W	W	W	W	W	W	N	N	N	N	N	N
15 sept	5	1	W	W	W	W	W	W	N	N	N	N	N	N
		2	W	W	W	W	W	W	N	N	N	N	N	N
16 sept	-	-	W	W	W	W	W	W	N	N	N	N	N	N
		-	W	W	W	W	W	W	N	N	N	N	N	N
17 sept	6	-	W	W	W	W	W	W	N	N	N	N	N	N
		2	W	W	W	W	W	W	W	W	W	N	N	N
18 sept	7	1	W	W	W	W	W	W	W	W	W	N	N	N
		2	W	W	W	W	W	W	W	W	W	N	N	N
19 sept	8	-	W	W	W	W	W	W	W	W	W	N	N	N
		2	W	W	W	W	W	W	W	W	W	W	W	W
20 sept	9	1	W	W	W	W	W	W	W	W	W	W	W	W
		2	W	W	W	W	W	W	W	W	W	W	W	W

Figure 11. Group A. The mixture of foals with and without mothers the different days during the period of weaning. N = foal with dam (“non-weaned”), W= foal without dam (“weaned”, grey cells), days or periods without observation are marked with lines.

Date	Obs. day	Obs. period	Foal number 1	2	3	4	5	6	7	8	9	10	11
1 oct	1	1	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**
		2	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**
2 oct	-	-	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**
		-	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**
3 oct	2	-	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**
		2	**W**	**W**	**W**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**
4 oct	3	1	**W**	**W**	**W**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**
		2	**W**	**W**	**W**	**W**	**W**	**W**	**N**	**N**	**N**	**N**	**N**
5 oct	4	1	**W**	**W**	**W**	**W**	**W**	**W**	**N**	**N**	**N**	**N**	**N**
		2	**W**	**W**	**W**	**W**	**W**	**W**	**N**	**N**	**N**	**N**	**N**
6 oct	-	-	**W**	**W**	**W**	**W**	**W**	**W**	**N**	**N**	**N**	**N**	**N**
		-	**W**	**W**	**W**	**W**	**W**	**W**	**N**	**N**	**N**	**N**	**N**
7 oct	-	-	**W**	**W**	**W**	**W**	**W**	**W**	**N**	**N**	**N**	**N**	**N**
		-	**W**	**W**	**W**	**W**	**W**	**W**	**N**	**N**	**N**	**N**	**N**
8 oct	5	-	**W**	**W**	**W**	**W**	**W**	**W**	**N**	**N**	**N**	**N**	**N**
		2	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**N**	**N**
9 oct	6	1	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**N**	**N**
		2	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**N**	**N**
10 oct	-	-	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**N**	**N**
		-	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**N**	**N**
11 oct	7	-	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**N**	**N**
		2	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**W**
12 oct	8	1	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**W**
		2	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**W**

Figure 12. Group B. The mixture of foals with and without mothers the different days during the period of weaning. N = foal with dam (“non-weaned”), W= foal without dam (“weaned”, grey cells), days or periods without observation are marked with lines.

Date	Obs. day	Obs. period	Foal number 1	2	3	4	5	6	7	8	9	10	11
29 oct	1	1	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**
		2	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**
30 oct	2	-	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**
		2	**W**	**W**	**W**	**W**	**N**	**N**	**N**	**N**	**N**	**N**	**N**
31 oct	3	1	**W**	**W**	**W**	**W**	**N**	**N**	**N**	**N**	**N**	**N**	**N**
		2	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**N**	**N**	**N**
1 nov	4	1	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**N**	**N**	**N**
		2	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**N**	**N**	**N**
2 nov	-	-	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**N**	**N**	**N**
		-	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**N**	**N**	**N**
3 nov	-	-	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**N**	**N**	**N**
		-	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**N**	**N**	**N**
4 nov	-	-	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**N**	**N**	**N**
		-	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**N**	**N**	**N**
5 nov	5	-	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**N**	**N**	**N**
		2	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**W**
6 nov	6	1	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**W**
		2	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**W**	**W**

Figure 13. Group C. The mixture of foals with and without mothers the different days during the period of weaning. N = foal with dam (“non-weaned”), W= foal without dam (“weaned”, grey cells), days or periods without observation are marked with lines.

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