SCIENTIFUR

SCIENTIFIC INFORMATION IN FUR ANIMAL PRODUCTION

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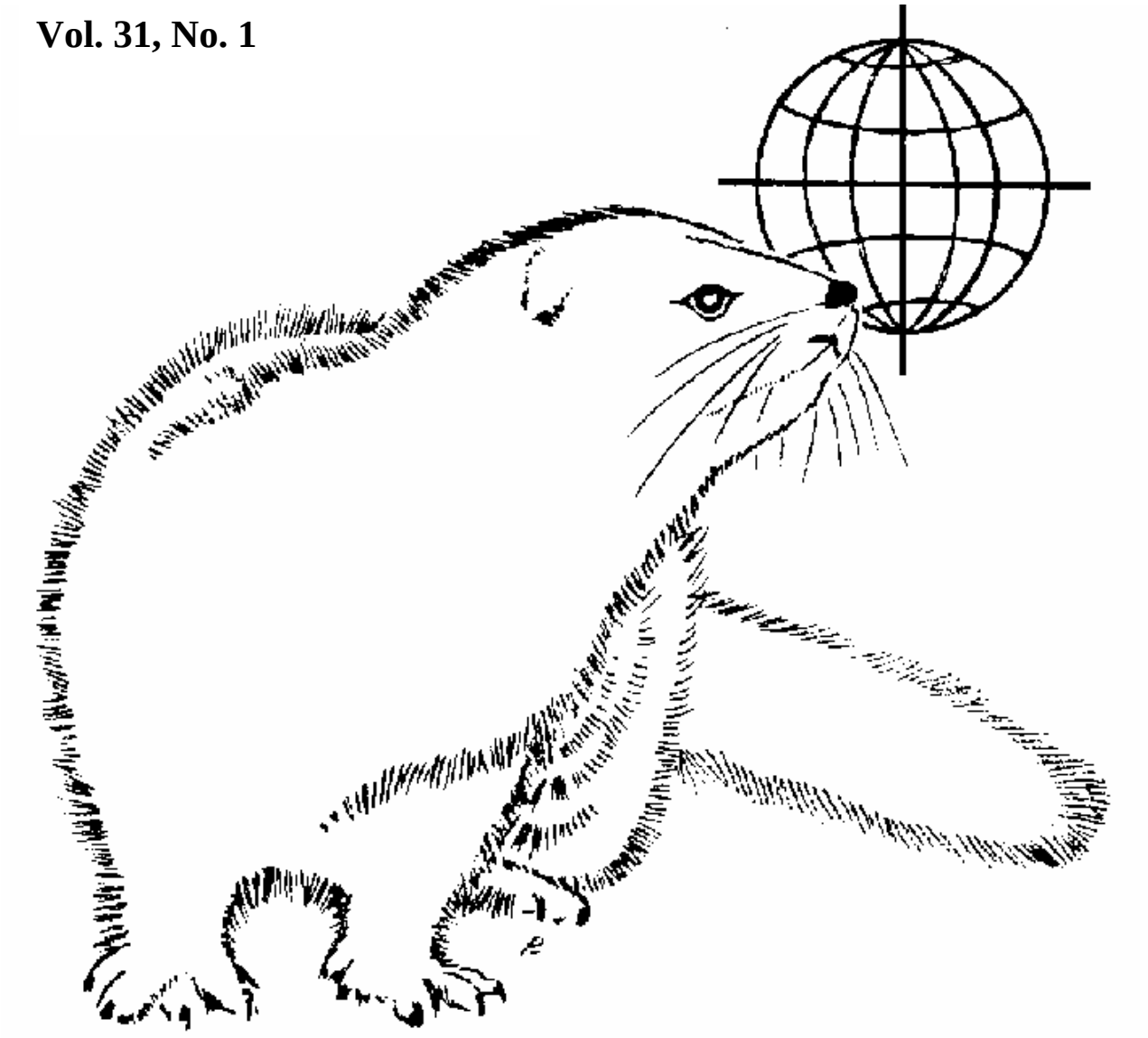

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INTERNATIONAL FUR ANIMAL SCIENTIFIC ASSOCIATION

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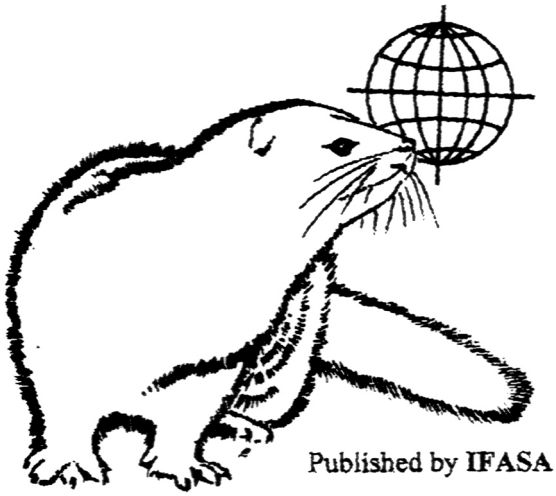

Notes from the Group of Editors

Till now reviewed articles have been published once a year in a separate issue of Scientifur. However, this has resulted in long publishing times. Therefore, it has been decided to change this procedure so that from now on reviewed articles are published as soon as they have been accepted.

Thus, this issue of Scientifur, Volume 31, No 1, contains two reviewed articles, a short communication, the abstracts from the Annual Report 2006, Danish Fur Breeders' Research Center, as well as the abstract of a PhD thesis by Razvan Anistoroaei.

We take this opportunity to remind you of the Fur Animal Seminar, NJF Seminar No 403, which takes places in Kolding, Denmark, 13-15th August, 2007. For more information on this meeting please contact Lene Melchiorsen by

- E-mail: lm.pfc@kopenhagenfur.com,
- Fax: +45 96 13 57 14,
- Post: PFC/Kopenhagen Fur, Herningvej 112 C, DK-7500 Holstebro, Denmark, or
- Tel: +45 96 13 57 00

We hope to see you in Kolding.

On behalf of the
Group of Editors

Birthe Damgaard

Introducing an open water surface as an alternative to the traditional valve drinker for ranch mink (*Mustela vison*) in the lactation period

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Abstract
This study investigated if replacing the traditional valve supply by an open water surface accelerates the onset of drinking in mink kits and improves water intake in kits and dams. Furthermore, the effect of valve placement (height) was considered.

The experiment included 18 mink dams with 2 male and 2 female kits each, a total of 90 animals. The experimental period lasted 34 days and started when kits were 20 days old. Kits drinking from an open water surface started drinking 1-3 days sooner than kits provided with valves ($p=0.0215$) and licked saliva for a shorter period (fig. 2). In this way, they became less dependent of the dam at an earlier age. Still, their weaning weights were inferior to kits drinking from valves ($p=0.0146$), possibly due to increased activity levels and stress induced changes in maternal care.

Results suggested that both kits and dams benefit from improved water access in the lactation period.

Keywords: Drinking water supply, mink kits, saliva licking.

Introduction
When water is provided by conventional valves, an interval of approximately two weeks is observed between the onset of eating and drinking in mink kits (Brink et al., 2004; Møller, 1991b). In this interval, their water input depends on milk, dietary water and saliva licking (Brink et al., 2004; Møller, 1991b). Saliva licking in mink kits is described as the licking of saliva from the corner of the dam's mouth and has been observed from the age of 5 weeks or even from 3 weeks of age (Brink et al., 2004; Hansen et al., 1999; Jonasen, 1987; Kuby, 1982). The behaviour is observed most frequently at high ambient temperature (Møller, 1991a) and in the case of nursing sickness, when milk yield is severely reduced (Schneider & Hunter, 1993; Olesen et al., 1990); frequencies decrease when access to drinking water is improved (Brink et al.,2004; Møller, 1991b), clearly suggesting that saliva licking is a behavioural response to thirst.

Kits run the risk of insufficient liquid intake, perhaps even after starting to drink from valves. Though they are able to drink, their intake rate may be limited due to the placement and design of the valve. Brink et al. (2004) showed that positioning the valve close to the nest box and thereby also the feed, alternative to the traditional placement at the back of the cage, accelerated the onset of drinking, increased drinking frequency and reduced saliva licking frequency. Møller (1991b) showed that using a complementary water system, the drip water system, allowing kits to lick drops of water outside the valve system, had the same effects. Assuming that water intake per drinking session in these two systems are equal to intake in the conventional system, this indicates that the standard placement and valve design affects water intake adversely.

Water from conventional feed covers about 85% of the water requirement in adult mink (Møller & Lohi, 1989), but total body water balance (subtracting output from input) is regulated by drinking water intake (Einarsson & Hansen, 2000, Wamberg et al.,

1996) and the ability to concentrate urine (Wamberg et al., 1996; Neil, 1992). During the lactation period, dam water output increases due to increased milk output (Fink et al., 2001; Tauson et al., 1998; Olesen et al., 1992) and enhanced metabolic rate (Fink & Tauson, 2000; Tauson, 1998; Tauson et al., 1998; Olsson, 1986). Consequently the need for drinking water increases. Previous studies suggest that adult mink prefer to drink from an open water surface instead of the valve (Hansen and Jeppesen, 2003) and that horses increase their water consumption when they do not have to press a valve to drink (Nyman & Dahlborn, 2001).

Based on these observations, continuous access to an open water surface during lactation is likely to effectively relieve the problems caused by insufficient water intake for dams and kits. An open water surface would improve the possibility of mink kits coming into contact with the water when exploring the cage, thereby probably accelerating the onset of drinking. Correspondingly, Phillips and Fraser (1991) showed that providing water in a bowl accelerates the onset of drinking in young pigs. Furthermore, an open water surface would allow more mink to drink at the same time, whereas the delivery rate in the valve system is limited to a single valve, which may not meet the increased water requirement during lactation. Therefore the aim of this study is to investigate if offering drinking water from a bowl instead of the traditional valve affects the onset of drinking in mink kits. Furthermore we investigate the effect of drinking from the bowl on the 24-hour consumption of drinking water in a group of lactating dams and their kits. The effect of valve placement is considered by comparing two placement heights.

Materials and methods

Experimental design:
The study was conducted between 18th of May and the 21st of June 2001. 18 Wild mink dams giving birth to min. 6 kits on the 28th of April were sampled from the breeding population held under standard production conditions at the research farm at the Danish Institute of Agricultural Sciences, Research Centre Foulum, Denmark. Dam ages ranged between 1-4 years. Litters were standardized so that they consisted of two male and two female kits each, yielding a total of 90 animals.

The kits in each litter were marked individually using hair dye. On the 18th of May all animals were weighed and separated into 3 experimental groups each with 6 dams and their litters. Animal weights were also recorded at the end of the study. In the first group, “bowl”, water was supplied ad libitum in metal bowls placed approximately 4 cm above the cage floor. In the two other groups water was supplied by valve drinkers placed approximately 12 and 4 cm above the cage floor, termed “high valve” and “low valve”, respectively. To make a clear distinction between the open water surface and the valve supply, the valve used was designed so that no water drops were left at the valve after use. Water waste was collected by a funnel placed towards the edge of the cage to avoid urine collection. Two dams and their litters were excluded from the experiment due to pre-weaning diarrhoea and nursing sickness. Animals were otherwise free from diseases.

The animals were housed in standard production cages (90x30x45 cm3) suspended on trestles in a closed experimental hall. The ambient temperature varied only slightly around 20 oC and the humidity ranged between 45-65% according to the cleaning routine. Until day 38 postpartum the cages were provided with floors of a finer mesh than the standard to help kits move about the cage. Due to video recordings of behaviour an open nest box (30x33x22.5cm3) missing the top and front was used. The animals were fed wet standard mink feed ad libitum. To facilitate kit access, meals were fed in metal bowls placed next to the nest box. Between May 22nd and June 21st consumption of water and feed were measured daily.

24-hour video recordings of behaviour were made on the following dates: 23rd, 27th and 31st of May, 4th, 8th, 10th, 12th, 14th and 16th of June. Recordings were split into 5-minute sequences, switching between pairs of cages within an experimental group for each sequence. In this way, each pair of cages was recorded for 5 minutes every 15 minutes, yielding a total of 8 hours of recordings, evenly distributed within a 24-hour period. The onset of drinking was determined from these video recordings. A more detailed analysis was performed on four recordings: 23rd and 31st of May and 8th and 16th of June, corresponding to day 25, 33, 41 and 49 postpartum. The occurrence of selected

behavioural elements (table 1) during each sequence was recorded using one-zero sampling (Martin & Bateson, 1993).

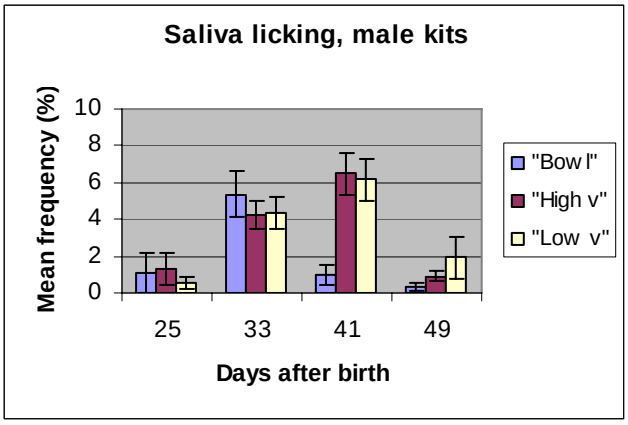
Table 1. Definitions of selected behavioural elements recorded in kits and dams by one-zero sampling.

Behavioural element	Definition for kits	Definition for dams
Saliva licking	Licking the corner of the dam's mouth.	
Drinking	The animal's head is in contact with the water supply for more than 3 seconds.	
Eating	The animal's head is in contact with the feed for more than 3 seconds.	
Stereotyping		Repeated, relatively invariant sequences of movements, which have no obvious function. (Definition by Broom & Johnson (1993)).
Scratching		Scratching the feed bowl or nest box with paws.

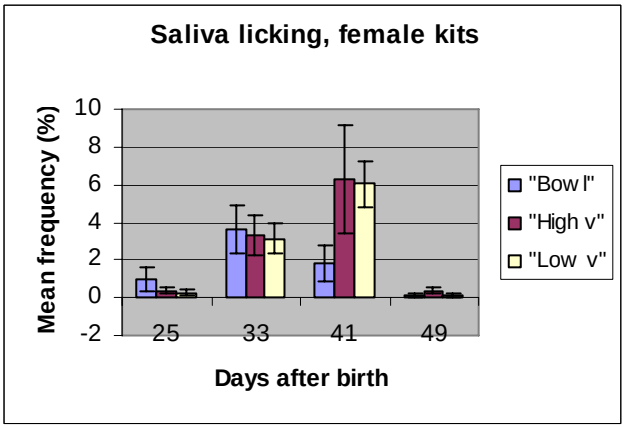
Statistical analysis:

When the data met assumptions regarding normality and homogeneity, the MANOVA/ANOVA test and post hoc Tukey's test (Fowler & Cohen, 1990) was used. If not, the Kruskal-Wallis or Mann-Whitney U-test and post hoc Dunn's test was used for tests between independent samples. Since observations on the same animals were made over time, the repeated statement was used in SAS, testing for differences between the three types of water supply (between-subjects effects). The p-value regarding development in time (within-subjects effects) is not reported because the progression during the experimental period was obvious.

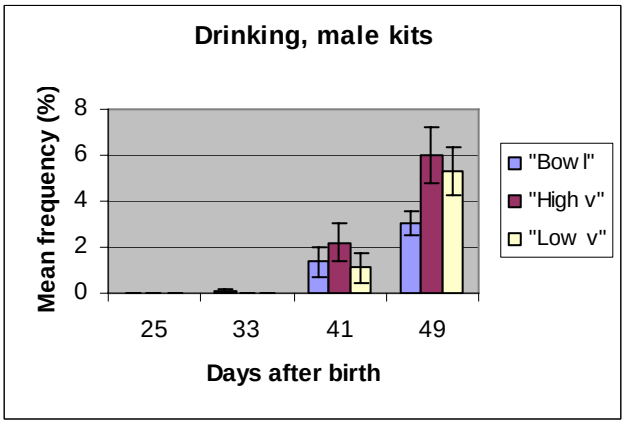
Most often, data set containing the behavioural observations from the video analysis assumed discrete and very low values, precluding the possibility of using the repeated measures analysis of variance. Instead analysis of variance was performed on sums of observations, thereby omitting the effects of time. The development in time is illustrated in fig. 2 and 3.



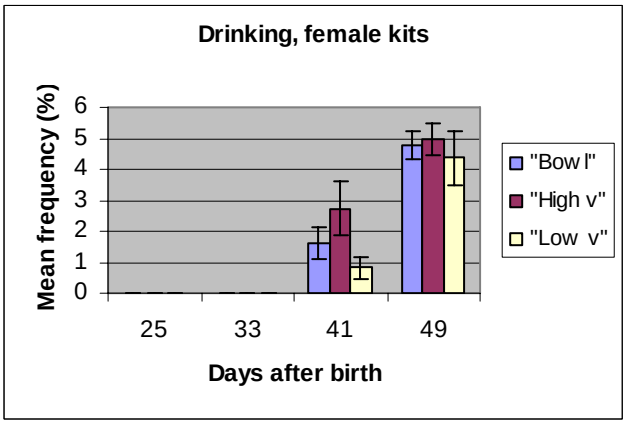
Graph A



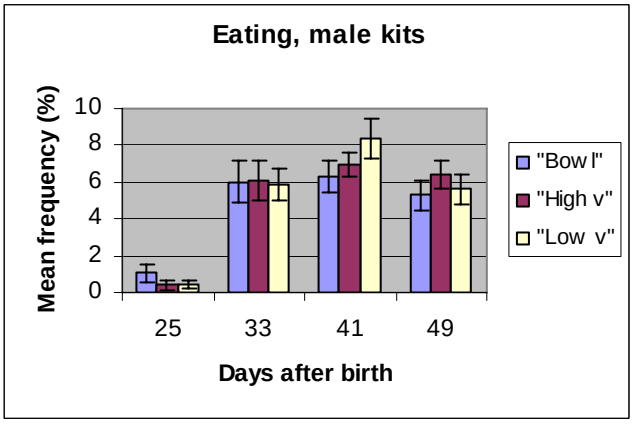
Graph B



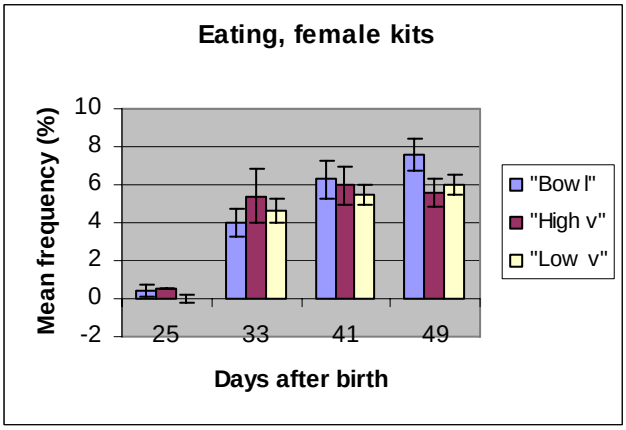
Graph C



Graph D

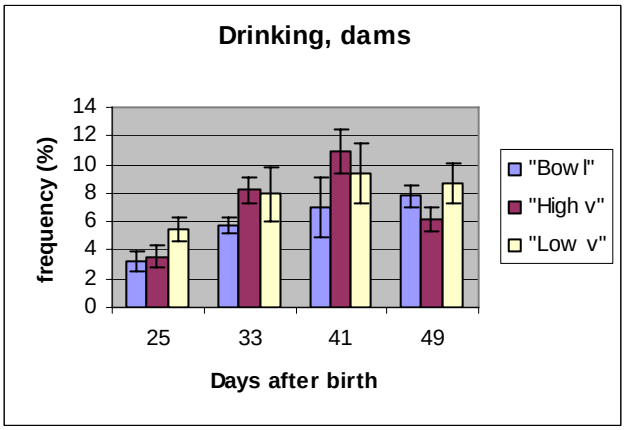


Graph E

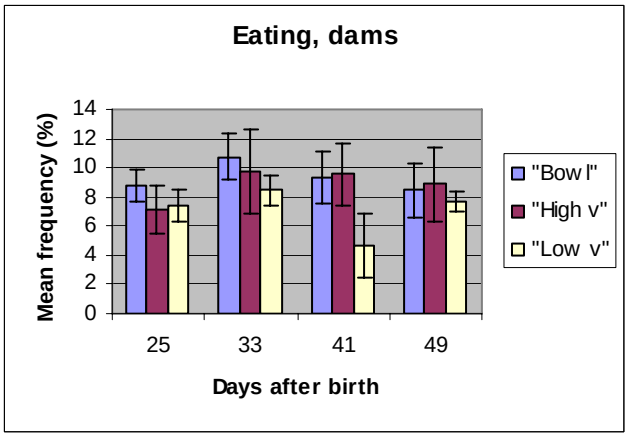


Graph F

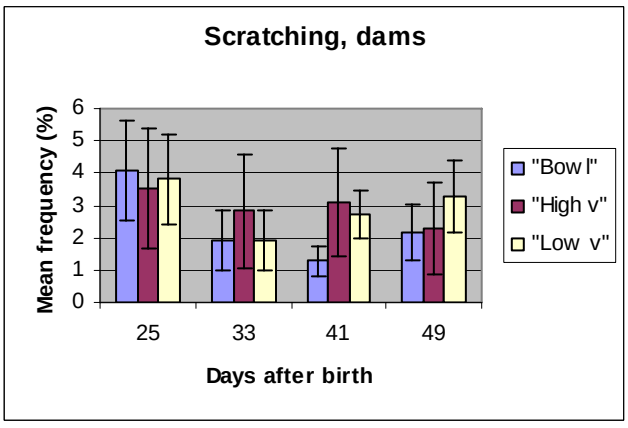
Figure 1. Graph A-E showing development in time for kit behavioural elements. The mean frequencies (+/- SEM) are the mean percentage of sample intervals in one-zero analysis in which the behaviour occurred (n: "bowl" =12, "high valve" 2=10, "low valve"=10). Please note that the graphs do not have the same graduation.



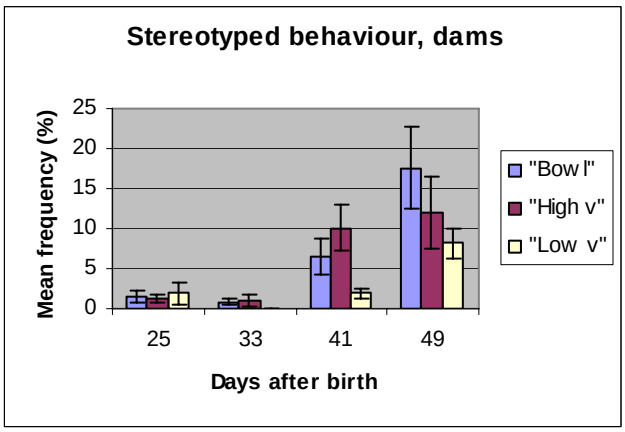
Graph A



Graph B



Graph C



Graph D

Figure 2. Graph A-D showing the development in time for dam behavioural elements (+/-SEM). The mean frequencies are the mean percentage of sample intervals in a one-zero analysis in which the behaviour occurred (n: "bowl"=6, "high valve"=5, "low valve"=5). Please note that the graphs do not have the same graduation.

Results

Onset of eating and drinking in mink kits (table 2a and b):

On average, all kits started eating feed on day 33 post partum about 9 days before they started drinking water. The onset of drinking differed significantly among groups and was unaffected by gender and dam age. However, these differences were not large enough for Tukey's test to show which groups differed. Comparing the mean onset of drinking, the largest differences were found between "bowl" and the other two groups. On average, "bowl" male kits started drinking 3.28 and 3.98 days sooner than "high valve" and "low valve" males respectively. On average, "bowl" female kits started drinking 0.88 day earlier than female kits in the other two groups. Differences between the two groups drinking form valves were negligible.

Comparing "high valve" and "low valve" showed that the valve placement did not affect the onset of eating or drinking.

Table 2a. Median (and 25% - 75% quartiles) onset of eating in kits and mean (+/- SEM) onset of drinking in kits (n: "bowl"=12, "high valve"=10, "low valve"=10).

	"Bowl" males	"High valve" males	"Low valve" males	"Bowl" females	"High valve" females	"Low valve" females
Onset of eating (days after birth)	33.00 (25.00-3.00)	33.00 (33.00-33.00)	33. 00 25.00-33.00	33.00 29.00-33.00	33.00 33.00-33.00	33.00 33.00-33.00
Onset of drinking (days after birth)	38.92 (+/-0.82)	42.20 (+/-0.88)	42.90 (+/-1.35)	40.42 (+/-0.63)	41.30 (+/-0.70)	41.30 (+/-1.91)

Table 2b. χ^2, F and p values for the onset of eating and drinking in mink kits.

	χ^2, F and p values
Onset of eating (days after birth)	Treatment: $\chi^2 = 4.11$, 2df p = 0.13
	Placement: $\chi^2 = 4.11$, 2df p = 0.731
Onset of drinking (days after birth)	Treatment: $F_{2,54} = 4.12$ p = 0.0215 Gender: $F_{1,54} = 0.33$ p = 0.5685 Dam age: $F_{1,54} = 0.09$ p = 0.7688 Treatment x gender: $F_{2,54} = 1.05$ p = 0.3581 Treatment x dam age: $F_{2,54} = 1.48$ p = 0.2365 Gender x dam age: $F_{1,54} = 0.26$ p = 0.6121
	Placement: $F_{1,33} = 0.60$ p = 0.4455 Gender: $F_{1,33} = 1.16$ p = 0.2900 Dam age: $F_{1,33} = 0.19$ p = 0.6619 Placement x gender: $F_{1,33} = 0.14$ p = 0.7121 Placement x dam age: $F_{1,33} = 1.28$ p = 0.266 Gender x dam age: $F_{1,33} = 0.27$ p = 0.6041

Consumption of feed and water (table 3a and b):
Consumption of feed was similar in the three groups. The mean water consumption in "bowl" by far exceeded that of the other groups. Mean consumption of feed and water was nearly the same in the groups drinking from valves.

Table 3a. Mean (+/- SEM) water and feed consumptions pr. day in the experimental period (water consumption: n: "bowl"=6, "high valve"=5, "low valve"=4; feed consumption: n: "bowl"=5, "high valve"=4, "low valve"=5). Mean (+/- SEM) kit and dam weight changes in the experimental period. (Kits: n: "bowl"=12, "high valve"=10, "low valve"=10 and dams: n: "bowl"=6, "high valve"=5, "low valve"=5).

	"Bowl"	"High valve"	"Low valve"
Water consumption pr. day (g)	258.45 (+/-9.28)	170.68 (+/-6.31)	173.50 (+/-6.01)
Feed consumption pr. day (g)	512.42 (+/-8.60)	477.37 (+/-12.10)	520.43 (+/-10.58)
Male kit growth (g)	633.58 (+/-20.31)	635.00 (+/-30.99)	651.20 (+/-25.51)
Female kit growth (g)	496.17 (+/-14.41)	477.70 (+/-23.62)	540.10 (+/-15.26)
Dam weight loss (g)	64.17 (+/-40.26)	152.00 (+/-20.77)	35.00 (+/-46.07)

Table 3b. F and p values for consumption of water and feed and weight changes in the experimental period.

	F and p values
Water consumption pr. day (g)	Treatment: $F_{2,11} = 32.72$ $p < 0.0001$ Time x treatment: $F_{58,319} = 2.79$ $p = 0.0056$ Placement: $F_{1,7} = 0.33$, $p = 0.5831$ Time x placement: $F_{29,203} = 1.05$ $p = 0.3991$
Feed consumption pr. day (g)	Treatment: $F_{2,12} = 1.29$ $p = 0.3120$ Time x treatment: $F_{58,348} = 1.44$ $p = 0.1587$ Placement: $F_{1,7} = 1.79$, $p = 0.2226$ Time x placement: $F_{29,203} = 1.68$ $p = 0.1705$
Kit weight gain (g)	Treatment: $F_{2,59} = 4.54$ $p = 0.0146$ Time x treatment: $F_{2,59} = 3.57$ $p = 0.0344$ Gender: $F_{1,59} = 52.57$ $p < 0.0001$ Gender x time: $F_{1,59} = 72.79$ $p < 0.0001$ Dam reproductive experience: $F_{1,59} = 37.42$ $p < 0.0001$ Dam reproductive experience x time: $F_{1,59} = 16.27$ $p = 0.0002$ Placement: $F_{1,36} = 4.74$ $p = 0.0361$ Gender: $F_{1,36} = 33.82$ $p < 0.0001$ Dam reproductive experience: $F_{1,36} = 5.58$ $p = 0.0237$
Dam weight gain (g)	Treatment: $F_{2,13} = 0.80$ $p = 0.4701$ Time x treatment: $F_{2,13} = 2.44$ $p = 0.1258$

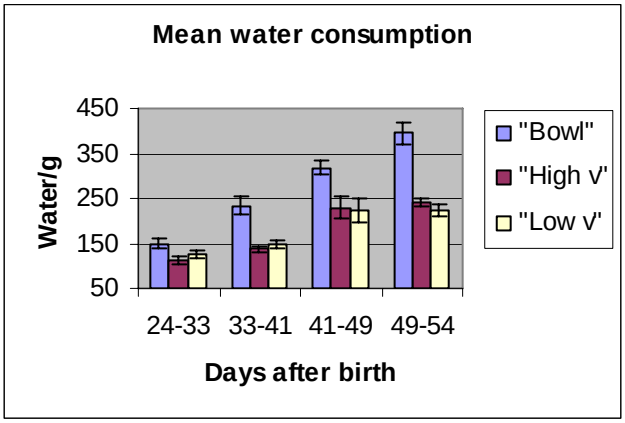


Figure 3a. Mean water consumption pr. dam and her 4 kits for four periods of time, corresponding to days of video recordings analysed in detail.
(n: "bowl"=5, "high valve"=4, "low valve"=5).

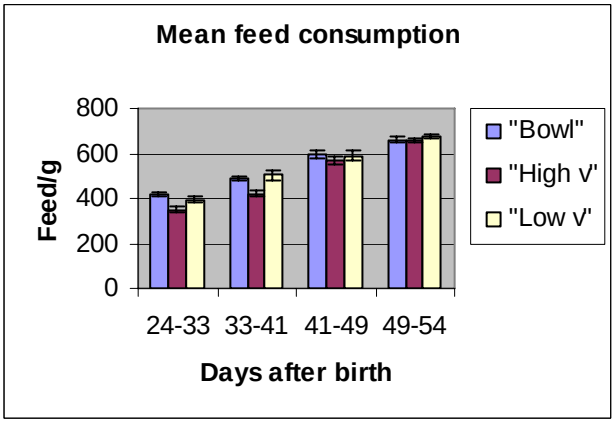


Figure 3b. Mean consumption of feed pr. dam and her 4 kits for four periods of time, corresponding to days of video recordings analysed in detail.
(n: "bowl"=6, "high valve"=5, "low valve"=4).

Weight changes, kits and dams (table 3a and b):
The type of water supply (bowl or valve) significantly affected kit weight gain. Comparing the three groups showed that kits in the "low valve" presented the largest weight gain.

Male kit weight gain was superior to female kit weight gain. Furthermore, kits from multiparous dams showed a higher growth rate than kits from primiparous dams: mean male kit gain, multiparous=709.00g SEM=20.02g, primiparous=616.38g SEM=15.20 and female kit weight gain, multiparous=535.38 SEM=14.66, primiparous=493.71 SEM=13.24.

Placement of the water valves significantly affected kit growth. Means showed that kits gained more weight when the valve was in the lowest position. There was also an effect of kit gender and dam age consistent with the one presented in all three groups.

None of the variables tested significantly affected dam weight loss.

Occurrence of behavioural elements, kits (table 4a and b):
Saliva licking occurred less frequently in the group "bowl" compared to "high valve" and "low valve"

Close to being significant, kits in the group "high valve" were observed drinking most often. Eating frequencies were unaffected by the treatment. Frequencies of behavioural elements did not differ due to kit gender.

Table 4a. The occurrence of selected behavioural elements in kits presented as mean percentage (+/- SEM) of sample intervals in a one-zero analysis in which the behaviour occurred (mean percentage= total occurrences*100 / total no. of sample intervals). (Kits: n: "bowl" =12, "high valve" 2=10, "low valve"=10 and dams: n: "bowl"=6, "high valve"=5, "low valve"=5).

	"Saliva licking"	"Drinking"	"Eating"	"Scratching"	"Stereotypy"
"Bowl" males	1.93 (+/-0.37)	1.13 (+/-0.28)	4.67 (+/-0.61)		
"High valve" males	3.20 (+/-0.55)	2.05 (+/-0.34)	4.96 (+/-0.42)		
"Low valve" males	3.25 (+/-0.39)	1.61 (+/-0.31)	5.05 (+/-0.38)		
"Bowl" females	1.63 (+/-0.35)	1.58 (+/-0.16)	4.59 (+/-0.42)		
"High valve" females	2.59 (+/-0.78)	1.92 (+/-0.31)	4.22 (+/-0.57)		
"Low valve" females	2.39 (+/-0.32)	1.30 (+/-0.25)	4.10 (+/-0.29)		
"Bowl" dams		5.95 (+/-0.48)	9.33 (+/-0.88)	2.36 (+/-0.73)	6.60 (+/-1.71)
"High valve" dams		7.17 (+/-0.76)	8.83 (+/-1.42)	2.94 (+/-1.44)	6.08 (+/-2.01)
"Low valve" dams		7.86 (+/-1.30)	7.04 (+/-0.54)	2.94 (+/-0.77)	3.01 (+/-0.67)

Table 4b. F and p values for the occurrence of selected behavioural elements in kits and dams.

F and p values				
"Saliva licking"	"Drinking"	"Eating"	"Scratching"	"Stereotypy"
Treatment: $F_{2,58}$ = 3.64 p = 0.0324 Gender: $F_{1,58}$ = 2.29 p = 0.1358	Treatment: $F_{2,58}$ = 2.95 p = 0.0602 Gender: $F_{1,58}$ = 0.00 p = 0.9752	Treatment: $F_{2,58}$ = 0.01 p = 0.9939 Gender: $F_{1,58}$ = 2.32 p = 0.1328		
	Treatment: $F_{2,13}$ = 1.28 p = 0.3112	Treatment: $F_{2,13}$ = 1.45 p = 0.2707	Treatment: $F_{2,13}$ = 0.12 p = 0.8904	Treatment: $F_{2,13}$ = 1.44 p = 0.2723

Occurrence of behavioural elements, dams (table 4a and b):
There was a tendency for dams in "low valve" to show least stereotyped behaviour, but the treatment did not significantly affect dam behaviour.

Discussion
The present study shows that replacing the conventional valve with a bowl of water advances mink kits' intake of water. This corresponds to results of Møller (1991b), using the drip water system, allowing kits to lick water dripping from the valve. The fact that kits take in water sooner when it is available outside the valve system suggests that the valve delays the onset of drinking. In the present study, most kits drinking from bowls started drinking water between days 37-43 after birth, matching the time when they start licking water in the drip water system (Møller, 1991b). The majority of kits drinking from valves were observed to start drinking between 40-47 days of age in the present study. Similar results have been reported for kits reared under standard farm conditions, usually starting to drink between days 42-48 after birth (Møller, 1991b).

Differences in onset of drinking were not affected by valve placement in the present study, most likely

due to the small placement difference (12 or 4 cm above the floor at the back of the cage). Placing the valve near the nest box and feed, Brink et al. (2004) observed the onset of drinking already from 33 days post partum, suggesting that kits' ability to find the valve also impedes the onset of drinking. On average kits started eating at the age of 33 days, corresponding to results of Møller (1991b). Brink et al. (2004) observed kits starting to eat as early as 21-26 days of age.

Video recordings of behaviour were not detailed enough to allow separation of successful and unsuccessful attempts to drink. This relates primarily to the valve drinkers, since drinking from the bowl should not involve any difficulties after discovering the water. In the drip water system, the difference between licking drops of water outside the valve system and actually releasing the valve is about five days. The ability to release the valve is not enhanced by licking water dripping from it (Møller, 1991b), showing that though the kits associate the valve with water, it still impedes their intake. In the present study the first observations of kits drinking from valves (in the groups "high valve" and "low valve") may therefore actually have been unsuccessful, implying an underestimation of differences compared to kits drinking from bowls.

Sufficient water intake is especially important in the period where kits transfer from suckling to eating. At this time dams may not be able to keep up with the demand for milk, as indicated by the progressing weight loss (Hansen & Berg, 1998) and the increasing incidents of nursing sickness (Schneider & Hunter, 1993; Henriksen & Elling, 1985). As a result, the relative growth rate of the kits may also decrease (Tauson, 1994; Korhonen et al., 1991), showing that the transition period is a peak load period. This means that the effect of relatively small changes in management practises is probably intensified in this two-week interval. Due to the high dry matter content of the feed compared to milk, the need for water is pronounced in kits transferring from suckling to eating. Since moving the water supply closer to the nest box also involves moving it closer to the feed, the accelerated onset of drinking observed by Brink et al. (2004) may not only be due to decreased distance to the nest box, but also to increased motivation to find water right after eating. Improved water intake would enable kits to take in more feed (cf. Moe et al., 2001; Møller, 1991b) to maximise their growth.

Opposing this, kits reared under standard production conditions in the present study ("low valve") presented the largest weight gain at weaning. The inferior weight gain in kits drinking from bowls could be due to minor infections caused by water contamination. A major problem concerning the open water surface during the experimental period was faecal contamination, a serious drawback to the hygiene and potentially the health of the animals. However, none of the animals drinking from bowls showed any signs of illness. Alternatively, transferring dams to the experimental cages shortly after giving birth acted as a stressor (Bildsøe at al., 1990a; Bildsøe at al., 1990b) affecting dam maternal behaviour and subsequently kit weight gain. Stressed dams leave the nest box more often, increasing kit mortality, probably due to shortened suckling sessions and less time spent with the kits (Overgaard, 2000; Hansen et al., 1999; Mason et al., 1995), also increasing loss of body heat from the kits.

The tendency was for dams in the group "low valve", experiencing least environmental change compared to standard production conditions, to perform the lowest number of stereotypies. However, differences in stereotypy frequencies showed no significant differences in stress levels between groups. The lower weight gain could also be due to increased activity in kits drinking from water bowls. Since kits drinking sooner are likely to be less dependent of the dam and probably more active, this may have affected their weight gain. The inferior weight gain is possibly the result of both factors combined, the effect of each factor being too insignificant to be discovered. Weaning weights matched the weights reported by Hansen (1991) (8 week old kits), Hansen (1997) (June weights) and Clausen and colleagues (2002) (56 day-old kits). The well-known gender biased kit growth rate (e.g., Hansen, 1997; Dunstone, 1993) was confirmed by the present study. Kits born by multiparous dams showed superior weight gain, corresponding to results of Hansen (1997), suggesting improved maternal care in multiparous dams.

Being able to take in water earlier from the bowl, kits licked saliva less frequently compared to kits in the valve system. This supports the hypothesis that saliva licking is motivated by thirst, suggested by Brink et al. (2004) and Møller (1991b). Although saliva licking could be a natural adaptation to transfer water from dams to kits, the behaviour

should be minimised in favour of drinking water as a more effective way of relieving thirst. When saliva licking frequency declined due to improved water intake, Brink et al. (2004) and Møller (1991b) observed reduced suckling frequency. Though suckling frequency could not be observed reliably on the video recordings, it is reasonable to assume that kit milk intake also declined in the present study. Reduction of saliva licking and suckling frequency make kits less dependent of the dam at an earlier age, relieving the strain placed on her.

Moreover, it should be easier for dams to drink from the bowl compared to the valve drinker. Mink drink in the same way as cats and dogs, by slurping water in with the tongue and it is probably easier for them to drink larger amounts in a short time from an open water surface (Risager, 1993). Therefore animals drinking out of a bowl were expected to drink larger amounts of water on average per day compared to those drinking from valves. As expected, the average daily consumption measured from the water bowls was approximately 50% larger than from the valves. However, the risk of unregistered water loss from the bowls clearly exceeds loss from the valves, primarily because dams were able to dip their head in the bowl or scratch water out of the bowl. Though rarely observed during the experimental period and never seen on the video recordings, this source of error made it impossible to determine to which extend water intake was in fact increased in animals drinking out of bowls.

The present study found that allowing mink kits to drink from an open water surface accelerates the onset of drinking and possibly enhances kit and dam water intake. Supporting the view that saliva licking is motivated by insufficient water intake in the transition period between suckling and eating, accelerating kits' water intake advanced decline in their saliva licking frequency. Both dams and kits may benefit from this; the kits become less dependent of the dam at an earlier age and the physiological strain placed on her in the lactation period is relieved, probably also through a faster decline in suckling frequency.

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Direct scan sampling reliably reflects video recorded differences in stereotypy in selected lines of mink

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Abstract
The present study aimed to investigate whether different observation methods reveal uniform inter-individual and inter-group differences of stereotypic behaviour in mink. The mink came from two breeding lines (F3), a high stereotyping line (HSL; N=140) and a low stereotyping line (LSL; N=132). Direct scanning observations were performed from 06:00 to 18:00 h and divided into morning, midday and afternoon observations. Based on the direct observations, 12 high stereotyping animals (HSA) and 12 low stereotyping animals (LSA) were selected for 24 h video recording. Generally, there was a positive correlation between direct observations performed during morning, midday, and afternoon. The 24 h video observations also reliably reflected the individual differences and the group differences, and for the HSA they resulted in the same daytime level of stereotypy as the direct scanning. The only incongruity between the results of the two observation methods was that the LSA level of stereotypy was slightly underestimated by the direct scanning method.

Keywords: diurnal activity; observation methods; stereotypies; selective breeding.

Introduction
An experiment on selection for and against stereotypic behaviour in mink was started in 2001 (Jeppesen et al., 2003; Jeppesen et al., 2004). The selection criterion was direct daytime scanning of one and a half year old female mink for stereotypic behaviour. Feeding was postponed to the end of the daily observation period. High and low stereotyping offspring were selected for the high and the low stereotyping selection line, respectively. The selection was effective: Fewer animals from the low stereotyping line performed stereotypic behaviour, and they did it at a lower frequency, as compared to animals from the high stereotyping line. The heritability of the stereotypic behaviour was 0.30 (Hansen et al., 2005).

It has been shown that mink with high levels of pre-feeding stereotypy also perform more stereotypic activity later in the day and night (Mason, 1993a). These results were based on the variation of stereotypy within single populations. The above mentioned selection produced populations or selection lines that differed with respect to stereotypy as well as weight and reproduction measures (Jeppesen et al., 2004). In the present paper it is examined if the results of the previous single-population studies also apply to the selection line situation: whether the daytime difference between the lines correctly reflected the line difference during morning and afternoon and during the whole 24 h period. In addition it was examined whether postponing of feeding until the end of the daily observation period affects the behaviour.

The study allows a comparison of the outcome of direct scanning observations with the outcome of scanning of the video recordings. Bildsøe et al. (1990) did such a comparison on daytime stereotypies, and found a close correlation between the outcomes of the two methods. Here, the

comparison is made once more but on a material that covers a wider range of stereotypic behaviour due to a great difference between lines with respect to stereotypy.

Materials and methods

Animals and housing

The study included 272 adult female farm mink (*Mustela vison*) of the color type "wildmink". The animals were housed in standard two-row outdoor mink sheds at the Danish Institute of Agricultural Sciences in Foulum, Denmark (56º29´N, 9º34´E). They were housed individually in standard-sized wire cages (Hedensted-Gruppen, Hedensted, Denmark; W: 30 cm, H: 45 cm, L: 90 cm). Each cage was connected to a straw covered wooden nest box (W: 28 cm, H: 20 cm, L: 23 cm). Food was available close to ad libitum, according to Danish standard farm feeding routines. The daily feed allowance per shed was regulated based on the number of cages with feed leftovers from the day before. If less than 33% of the cages had more leftovers than could be eaten before the next feeding time, the allowance was increased by 20 gram per cage. If more than 66% of the cages had more leftovers than could be eaten before the next day, the allowance was reduced. The daily leftovers were distributed among individuals that did not eat their daily portion. Water was available ad libitum.

Mink from two breeding lines (F3) were used, a high stereotyping line (HSL; N=140) and a low stereotyping line (LSL; N=132). The lines were established in 2001 by controlled selection of breeding mink (Jeppesen et al., 2003). The animals were born in 2003 and they all delivered a litter in 2004. Sections of cages with mink from the two lines were placed in between each other in a random order.

Direct observations

During the direct observations in October the observer stood still in front of the neighbouring cage section for 30 seconds (one section = six cages). This was done to minimize curiosity towards the observer. Disturbance was kept at a minimum. Following the 30 seconds, the behaviour of the six animals in the section under observation was scanned. The behaviour was classified according to Table 1. The interval between successive scanning rounds was between 30 and 60 minutes and one scanning round lasted about 30 minutes. The scanning rounds were equally distributed over days and observation hours. Three observers were used, but due to the very rigid definitions of the behaviour elements, variability was very limited.

Table 1. Catalogue of the behavioural elements used in the direct observations and in the video observations.

Elements	Description
Active	The animal was moving in the cage, exploring, eating, drinking or performing other normal behaviours.
Inactive	The animal was lying in the cage without moving.
In nest box	Half or more of the body of the animal was in the nest box.
Stereotypy	The animal repeated fixed movements at least 5 times in exactly the same stereotyped way. All of the movement stereotypies described by Bildsøe et al. (1991) were included in the element, e.g. running back and forth the length of the cage, sometimes with a somersault in the back of the cage, moving the head in circles, or repeatedly jumping back and forth with the head, forelimbs and upper part of the body without moving the hind part.

Observations were made during October, 2004. In order to see if the feeding motivation was different between the two lines, half of the daytime observations were performed during postponed feeding. Each animal was subjected to a total of 102 scanning observations during four days with normal feeding time (11:00 h) and a total of 104 scanning observations during five days with postponed feeding time (15:00 h). The observation period was from 06:00 to 18:00 h and it was divided into three time periods: morning (06:00-08:00 h), midday (09:00-15:00 h) and afternoon (16:00-18:00 h). The data collected during normal and postponed feeding correlated positively for each of the behavioural elements in each of the periods: morning, midday and afternoon. Spearman rank correlations ranged from $r_s = 0.19$ to $r_s = 0.64$ with all $P<0.02$ in the HSL and from $r_s = 0.21$ to $r_s = 0.67$ with all $P<0.02$ in the LSL. Based on these correlations, data for normal and postponed feeding in each of the two selection

lines were pooled for each behavioural element for further analysis.

Video recording

Based on the direct observations, 12 high stereotyping animals (HSA) and 12 low stereotyping animals (LSA) were selected for 24 h video recording. The HSA represented extreme animals with the highest levels of stereotypic behaviour (eight from the HSL and four from the LSL). The LSA represented extreme animals with none or very low levels of stereotypic behaviour (eight from the HSL and four from the LSL). Recordings took place in October 2004, after the direct observations were finished. A video monitoring system MSH-video camera was installed above the cage and infrared lights were used as a supplement. The behaviour was recorded by scan-sampling every 10 minutes. Table 1 specifies the elements. For analysis, the video data were allocated to two time periods: day (06:00 -18:00 h) and night (18:00 – 06:00 h). The day-time data for the 12 HSA and the 12 LSA were extracted from the direct scanning and used for comparison.

Statistical analysis

Nonparametric statistics were used. A Spearman's rank correlation test was used for pair wise correlations between morning, midday and afternoon for each of the behavioural elements within the two selection lines. Differences in mean scores between the three observation periods of each of the behavioural elements in both selection lines were tested statistically using a Friedman two-way analysis of variance by ranks. Differences between the two selection lines in the number of animals performing stereotypic behaviour were tested statistically with a χ^2 test, and differences in stereotypy mean score between the two selection lines were tested statistically using a Wilcoxon-Mann-Whitney-test.

All of the pair wise comparisons concerning the 24 h data were based on Wilcoxon-Mann-Whitney-test when different animals were compared. Comparisons within each group were based on Wilcoxon signed rank test.

All tests were two tailed and performed according to Siegel & Castellan (1988). Differences were considered significant if $P<0.05$.

Results

The number of animals performing stereotypic behaviour in the HSL was significantly higher than in the LSL in all three time periods (Table 2; $P<0.001$). The HSL had a significantly higher level of stereotypic behaviour in the morning and midday periods compared to the LSL ($P<0.01$) and showed the same tendency in the afternoon period ($P=0.14$). So, there was a marked difference between lines with respect to stereotypy.

Table 2. The number of animals performing a behavioural element (N) and the mean percentages of observations of the measured behavioural elements in the high stereotyping line (HSL, N = 140) and in the low stereotyping line (LSL, N = 132) during direct observations in the morning (06.00-09.00), midday (09.00-15.00) and afternoon (15.00-18.00). Means are based on all animals in the line. P_N-values: χ^2- test of differences between the number of animals performing the element in the three periods. P_{SC}-values: Friedman two-way test of difference between mean scores in the three periods.

Direct observations		Morning		Midday		Afternoon		P_N	P_{SC}
		N	Mean score %	N	Mean score %	N	Mean score %		
HSL									
	Active	137	28.24	139	10.92	139	20.95	NS	<0.001
	Inactive	52	1.75	136	7.74	48	1.35	<0.001	<0.001
	In nest box	140	61.20	140	72.48	140	74.15	NS	<0.001
	Stereotypy	96	8.71	118	8.86	60	3.36	<0.001	<0.001
LSL									
	Active	129	25.28	129	6.39	132	19.78	NS	<0.001
	Inactive	24	0.78	114	6.29	57	2.26	<0.001	<0.001
	In nest box	132	73.12	132	86.32	132	77.45	NS	<0.001
	Stereotypy	20	0.87	37	0.99	14	0.51	<0.01	<0.01

The mean scores of each behavioural element differed significantly between the three time periods in each of the two selection lines (Table 2). The animals were most active in the morning and in the

afternoon, most inactive in the midday period, and least stereotyping in the afternoon period. Individuals followed the same trend with respect to variation between periods, since all except one of the pair wise correlation coefficients for each behavioural element were positive (Table 3). The correlations between morning and midday scores were high and highly significant for all elements in both lines. The correlations between morning and afternoon respectively midday and afternoon were lower and only some of them reached significance. However, apart from the morning-afternoon correlation in the HSL the level of the individual's stereotypic behaviour correlated positively throughout the day in both lines.

Table 3. Spearman's rank correlation coefficients and *P*-values for each of the behaviours in the high stereotyping line (HSL) and in the low stereotyping line (LSL). Pair wise comparison of the individual scores of three periods of the day.

	Morning/Midday		Morning/Afternoon		Midday/Afternoon	
HSL (N=140)	r_s	*P*	r_s	*P*	r_s	*P*
Active	0.29	<0.0004	0.06	0.49	-0.03	0.69
Inactive	0.28	<0.0007	0.17	<0.05	0.11	0.19
In nest box	0.29	<0.0006	0.01	0.88	0.006	0.42
Stereotypy	0.54	<0.0001	0.11	0.18	0.27	<0.002
LSL (N=132)						
Active	0.32	<0.0002	0.21	<0.01	0.12	0.16
Inactive	0.37	<0.0001	0.14	0.09	0.22	<0.01
In nest box	0.33	<0.0001	0.19	<0.03	0.19	<0.03
Stereotypy	0.29	<0.0007	0.34	<0.0001	0.22	<0.001

The postponed feeding affected the day-time behaviour of the two lines differently (Table 4). HSL mink were less in the nest and performed more stereotypies when the feeding was postponed whereas theese behavioural elements were not affected in the LSL line. Both lines were more inactive out in the cage during postponed feeding than during normal feeding, but mink in line LSL decreased their active behaviour out in the cage during postponed feeding.

Table 4. The mean percentages (± SD) of day-time observations (h. 09.00-15.00) of the measured behavioural elements in the high stereotyping line (HSL, N = 140) and in the low stereotyping line (LSL, N = 132) during postponed and normal feeding. *P*-values: Wilcoxon matched pairs signed rank test.

	Line LSL			*Line HSL*		
	Postponed f.	Normal f.	*P*	Postponed f.	Normal f.	*P*
Active	5.62 ± 5.88	7.16 ± 5.44	0.0001	11.73 ± 9.98	10.07 ± 7.99	ns
Inactive	7.83 ±10.27	4.69 ±6.72	0.0001	9.22 ±7.85	6.20 ±5.64	0.0001
Nest box	85.40±15.57	87.26±11.50	ns	68.78±21.21	76.30±15.01	0.0001
Stereotypi	1.13±3.66	0.84±2.22	ns	10.25±13.02	7.40±9.06	0.0017

Figure 1 shows the percentage of observations of stereotypy in the 12 HSA and the 12 LSA as they were revealed by the direct scanning and by the scanning of the video recordings. In the 24 h video recordings, the HSA showed significantly more stereotypic behaviour during the day than during night ($P<0.01$), as opposed to the LSA, where there was no difference between day and night ($P=0.21$).

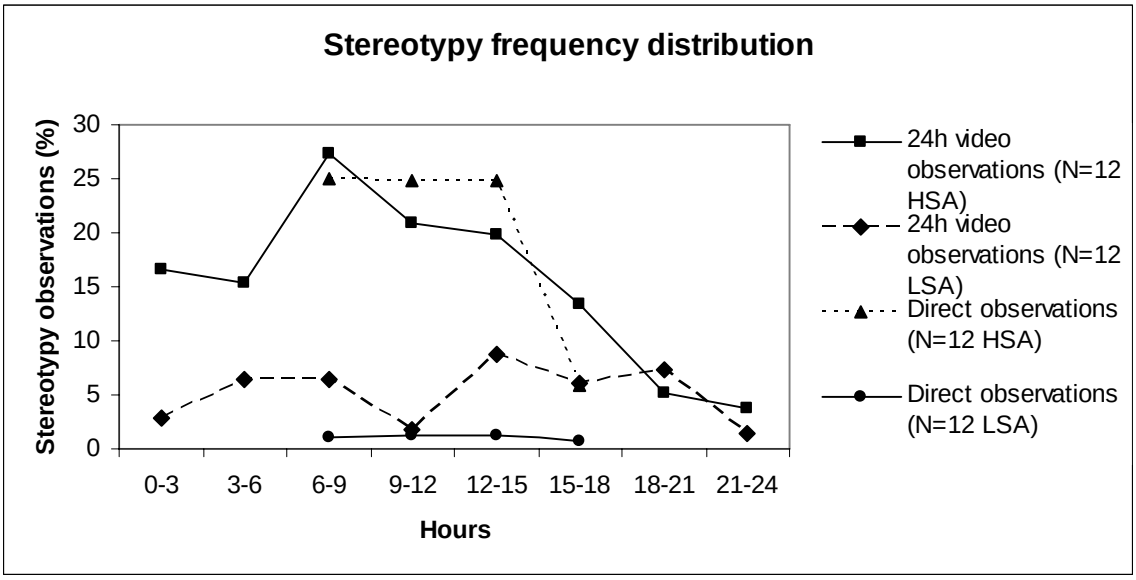

Figure 1. Percentages of stereotyped behaviour in day-time direct observations and 24 h video observations. High stereotyping animals (HSA) represents animals with high levels of stereotypic behaviour in the direct scanning (eight from the HSL and four from the LSL). Low stereotyping animals (LSA) represent animals with none or very low levels of stereotypic behaviour in the direct scanning (eight from the HSL and four from the LSL).

During the day, the HSA performed significantly more stereotypic behaviour than the LSA irrespective of the observation method used (P<0.003, video observations; P<0.0007, direct observations). There were no difference between the HSA and the LSA at night (P=0.82).

Among the LSA, the ones performing stereotypies (N=9) did so at a significantly higher level during video observations than during direct observations (P=0.01). All HSA performed stereotypic behaviour (N=12) and there was no difference in stereotypy level between direct observations and video observations (P=0.43).

Discussion

In the present study the mink were most active in the morning and in the afternoon observations, which is close to dawn and dusk (07:53 and 17:55 h respectively). Inactivity in the cage was most frequent during midday observations. The activity pattern therefore resembled the natural one (Dunstone, 1993). The stereotypic behaviour was high in the morning, remained high during midday, and fell to a low level in the afternoon. It was also low during the night. This development over the day applied to both lines in spite of the great difference between lines with respect to level of stereotypy. A low after-feeding level and night level of stereotypy is as seen before (e.g. Mason, 1993a).

Previous studies have shown that restricted feeding increases the stereotypies in mink (Damgaard et al., 2004, Bildsøe et al., 1991). In the present study all mink in the two lines were feed the same way and close to *ad libitum*, but only mink in line HSL increased the stereotypies in the day time during postponed feeding and decreased their stay in the nests. The results indicate that the selection for stereotypies and consequently a higher demand for energy makes the HSL mink more sensitive to changes in feeding routines than LSL mink and that HSL mink respond to postponed feeding by increasing the stereotyped behaviour. The exact feed consumption in each of the two lines was not measured.

Bildsøe et al. (1990) found that video observations and direct scanning observations yielded the same distribution of individual differences in stereotypy performances, and this result is confirmed here, since HSA clearly was shown to perform more stereotypy than LSA by both observation methods. For the HSA, it was also shown that the level of stereotypy as established by the video observations was reliably reflected by the direct scanning

observations. In the LSA, the video based stereotypy level was higher than the level established by direct observation, so, it is inferred that the observer has an effect on the diurnal stereotypy pattern in low stereotyping mink. One explanation could be that the stereotypies of the LSA were less developed and for that reason easier to interrupt (e.g. Mason & Latham, 2004). The lower level of stereotypy in the direct scanning of the LSA could also be due to a higher level of fear in the mink towards the observer, expressed as more individuals in the nest box. Previous investigations have shown low stereotyping mink to be more fearful (Hansen & Jeppesen, 2006), and fearful mink to spend more time in the nest box than confident mink (Malmkvist & Hansen, 2002). However, it cannot be ruled out that the rare incidences of stereotypy in the low stereotyping line are underestimated in the direct scanning due to the 3 to 6 times larger scanning interval.

The present study also showed that individual levels of stereotypy correlated positively between morning and midday as well as between midday and afternoon in both lines in spite of the high daytime variation in the levels of behaviour. This finding shows that the selection for and against midday pre-feeding stereotypies has not just changed the frequency of day-time stereotypies but also the frequency of stereotypies initiated during the natural dawn and dusk activity periods. The low levels of stereotypy during night did not differ between lines.

It has previously been pointed out that the limited time of day during which scanning observations on mink primarily have been made, might not have given a sufficiently representative estimate of the animals' average activity patterns and stereotypy levels (e.g. Mason, 1993b). This suggestion is not confirmed by the present study in which adult female mink were kept singly in standard cages, were fed ad libitum, and exhibited a natural diurnal activity cycle. Under these circumstances, it is shown that daytime scanning reliably reflect inter-group and inter-individual differences in stereotypy performance throughout the day and night, and that daytime scanning also reliably reflect video recorded levels of stereotypy in high stereotyping mink. However, an observer effect was inferred in the low stereotyping animals, since the level of stereotypy was underestimated by the direct scanning in these animals.

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Spontaneous *Proteus mirabilis* and *Enterobacter aerogenes* infection in chinchilla (*Chinchilla lanigera*)

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Abstract

A fatal outbreak of *Proteus mirabilis* and *Enterobacter aerogenes* infection in farm-bred chinchilla was diagnosed. A total mortality of 29 per cent of the animals occurred after 3 weeks of unsuccessful therapy. Both germs were consistently isolated from the intestinal and respiratory lesions but their status in this animal has not been clearly defined as they are not known to produce massive losses in chinchilla so far. Feeding of concentrated pellets with insufficient roughage, along with poor ventilation and inadequate high relative humidity, might have triggered respiratory and caeco-colic digestive disturbances, resulting in dyspnea, diarrhoea and mortality.

Key words: Chinchilla, mortality, bacterial infection

Case report

Chinchillas are herbivorous rodents originating from the mountainous areas of South America (Derrell Clark et al, 1978; Carpentier, 1994). These animals were domesticated for fur production early this century in Argentina, were later used in research and are now commonly kept also as pets. They have the thickest, warmest and highest valuable fur of any animal. Raising these animals for commercial markets is a highly specialized and costly bussiness because only rare and expensive breeding stock produces top-quality pelts. During july 2005, a severe fatal outbreak of animals occurred on a major breeding colony. It didn't appear to be a sex or age predisposition for this condition. The chinchillas in this farm were raised for pelts and polygamous breeding was practiced: 1 male access to 8 females. All the groups were fed the same diet: nutritionally balanced pellet and hay (twice a week). To maintain their hair coat condition, a dust bath pan was provided. The first indication of disease was sudden death of some individuals without previous clinical signs, but most of the cases showed clinical evidence of infection, i.e., lethargy, anorexia, conjunctivitis, coughing, heavy diarrea alternated with constipation, and pyrexia (rectal temperature: 104-108oF). The disease course was usually one week, but death could occurred 12 to 48 hours after the first indication of infection, when animals became recumbant with severe dyspnea. Morbidity was high (46%) and mortality was up to 29%. Cages were disinfected with a blow torch and treatment

was initiated with 300 mg/animal/day of chloramphenicol and oral enrofloxacin given at 200 mg per liter of drinking water for 21 days, with only limited clinical improvement. At necropsy, a severe mucoid enteritis with timpanic caecum was observed. Petechial and ecchymotic haemorrhages were present in the mesentery of some cases. The trachea, bronchi, and bronchioles contained haemorrhagic frothy fluid which could be expressed from the cut lung. There were also vulvovaginitis and rectal prolapse. Histologically, sections of intestine showed increased mucus production and preponderance of goblet cells. Cellular infiltration of the lamina propia was observed but wasn't a constant finding. There was also pulmonary congestion wth mild peribronchiolar lymphoid accumulation in some cases. The interlobular spaces were distended with edema fluid, occasional neutrophils and mononuclear cells. Bacteriological examinations yielded *Proteus mirabilis* and *Enterobacter aerogenes* as consistent isolates from the intestinal content and lungs of carcasses, in pure culture or associated. Both species were even recovered from vaginal, rectal and conjunctival samples taken from agonic animals by swabs in modified Stuart's transport medium. Identification was based according to standard microbiological procedures and confirmation was performed using the API 20 Strep identification system. On the other hand, bacteriologic quality of water and pellet tested were acceptable. Antimicrobial susceptibility by Kirby-Bauer disk diffusion showed that both isolates were susceptible to various antibiotics, including norfloxacin, trimethaprime-sulfametoxazol, ampicillin, cephalotin and gentamicin. A fecal exam didn't revealed parasite infection, and viral particles couldn't be visualised on Electron Microscopy sections. Samples of the feed were toxicologically examined, too. Polyether ionophores and pesticides were not observed, meanwhile mercury was detected in very low levels (0.01 µg/g). Samples of feed were analysed for dry matter and chemical composition (A.O.A.C, 1980) and studies revealed 18.1% crude protein, 9,7% dietary fiber (ADF), 6.9% fat and a Digestible Energy (DE) of 10.16 MJ/kg. These values are among the recommended for a good growth performance (Canada Department of Agriculture, 1975). Nevertheless, the fiber figure was on the lower limit as hay provision wasn't accomplished daily. These factors could have predisposed the risk of digestive problems. In fact, an inadequate nutrient supply (especially fibre) can cause intestinal impaction, which is most frequently a complication of gastro-enteritis in this animal (Cousens, 1963; Lanszky & Horváth, 1997). The owner changed the original pellet at the end of the outbreak, provided daily alphalpha hay and the general condition of the colony eventually improved. A lower level of fibre as recommended will increase the DE intake, but will also negatively influence the retention time of the digesta in the caecum inducing an increased caecal volume and protein level (Lebas et al. 1986). An examination of the farm building and environment revealed poor ventilation system and inconvenient high level of relative humidity (> 70%). Because the chinchilla is by nature a timid animal, shock or stress appears to be a major component in its respiratory picture (Strake et al., 1996). In captive chinchillas, a substantial role plays a high susceptibility of their organism to stress, technological disorders, but especially infectious diseases, influencing the health situation (Novak et al., 1994). Unlike most of the animals with which veterinary surgeons have to deal, the chinchilla is one of recent domestication and a lack of literature still exists, although the problem of infections has been discussed (Martino & Stanchi, 1992; Novak et al., 1994; Webb, 1985). Gastro-enteritis responsible for most sudden deaths in chinchillas of all ages was reported as early as 1963 by Cousens. *Proteus* spp. have been recovered from sporadic cases ranging from pneumonia to enteritis, metritis or intussusceptions, but it is not clear whether a particular strain of *Proteus* can acquire pathogenicity or whether it acts as an opportunist already damaged by other agents (Kennedy, 1970). On the other hand, *E. aerogenes* are seldom and its pathogenicity is debatable (Kennedy, 1970; Strake et al., 1996). Perhaps they are opportunists (Harkness & Wagner, 1995) and though there might be a modern tendency to decry the pathogenicity, in the presence of positive lesions, both germs should be considered as pathogens. Additionally, management factors in this case might have triggered the outbreak.

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Reports on: Behaviour

Selection against stereotypic behaviour may have contradictory consequences for the welfare of mink

L.L. Jeppesen

Mink were selected for or against stereotypic behaviour. Adult females from the third offspring generation were examined for stereotypic behaviour and other behavioural activities, and for growth, reproduction, temperament, and stress level. This took place in the autumn 2004. The females from the low stereotyping line had higher body weights at weaning and throughout the autumn. Previously seen tendencies towards smaller litter size in the low stereotyping line did not occur in this generation, most likely due to better slimming of the females in the preceding winter period. The females in the low

stereotyping line showed a tendency towards greater fearfulness, and this tendency is confirmed in other studies. Based on this background it seems as if the selection against stereotypy impairs the welfare of the animals. The results of the stress measurements cannot for the time being enlighten the effect of the selection on the animals' welfare.

Annual Report 2006, 7-12, Danish Fur Breeders' Research Center, Holstebro, Denmark.

Roughage in wintertime IV. Effect of adding husk meal to the feed

S.W. Hansen, T.N. Clausen, P. Sandbøl, B. Houbak

The purpose of this investigation was to reduce the stereotypic behaviour of female mink in the winter period, by lowering the energy content of the feed by addition oat husk meal. Further to investigate the effect on the following reproduction. To the investigation we used tree groups of black mink of each 174 females. The females were fed trial feed until February 21, thereafter feed kitchen feed was fed until day 28 in the nursing period. The control feed (KON) had an energy distribution of protein, fat and carbohydrates on 30:52:18. The group H6.5 got KON feed with 6.5 % oat husk meal and H13 got KON feed with 13 % oat husk meal. The behaviour of the females was evaluated January 18th and February 22nd, in connection with registration of time spend to eat the feed ration.

Females in the KON group ate faster, had a higher activity and lost more body weight than females in H6.5 and H13. The results confirm a connection between weight loss and activity / stereotypic behaviour, but also indicate that a reduced period of feed reduction might reduce the development og stereotypic behaviour. The use of oat husk meal in the winter period had no effect on the later reproduction period.

Annual Report 2006, 13-19, Danish Fur Breeders' Research Center, Holstebro, Denmark.

The use of nestbox and aggression by mink subjected to three different housing conditions

A.M.J. Haagensen, L. L. Jeppesen

Mink with access to one of three different housing systems (standard cages for two juveniles, two connected standard cages for four juveniles and climbing cages for four juveniles) were investigated for the use of nest boxes, aggression, bite marks and low grades. The two connected standard cages had two nest boxes. The climbing cages were used to investigate the effect of three sizes of nest boxes.

The general lesser use of the nest box observed for mink in two connecting standard cages and climbing cages shows that the animals did use the larger available space which these housing conditions provided. This was supported by the fact that animals housed in standard cages were often observed using the nest box for activity, which rarely occurred in the other two housing systems. The animals housed in two connected standard cages with access to two nest boxes were observed to use and further more distribute into both nest boxes as opposed to gathering in one. Especially when many animals chose to stay in the nest box simultaneously. It was also shown that a nest box at 80 % of the standard size was used less and resulted in more bite marks. Combined with the dam's tendency to move her kits out of the nest box more often at this size of nest box, it must be assumed that a decrease of the current standard size nest box will impair the welfare of mink. Despite a generally low observed aggression level in all three housing systems, most bite marks where found among animals housed in group housing systems. On the contrary, data from the auction showed fewer low grades in standard cages and the two combined standard cages compared to climbing cages.

Annual report 2006, 21-28. Danish Fur Breeders' Research Center, Holstebro, Denmark

Running in a running wheel substitutes for stereotypies in mink – but does it improve the welfare of the animals?

S.W. Hansen, B.M. Damgaard

Stereotypies and running in a running wheel may both be defined as repetitive and monotonous behavioural patterns. Stereotypies are usually assumed to indicate reduced welfare, whereas this negative assumption does not apply to running in a running wheel. In this study we examined how restrictive feeding affects stereotypic behaviour in mink and their use of a running wheel, and if mink selected for a high occurrence of stereotypies use the running wheel more than mink selected for a low occurrence of stereotypies. The results showed that access to a running wheel prevented the development of stereotypies but it did not otherwise affect the behaviour or the cortisol level of female mink. The females selected for a high occurrence of stereotypies performed more running in the running wheel than the females selected for a low occurrence of stereotypies, whereas the circadian rhythm of stereotypies and running in the wheel was almost identical for the two groups. On the basis of these results we cannot conclude that access to a running wheel improves the welfare of mink, but the increase in the level of stereotypies and the level of activity in the running wheel is considered to be a reaction to restrictive feeding.

Annual report 2006, 29-38. Danish Fur Breeders' Research Center, Holstebro, Denmark

Reports on: Breeding and reproduction

A preliminary map of the mink chromosomes

K. Christensen, R. Anistoroaei

A short description is given of the techniques used for the mapping work. By typing of around 170 gene markers (mikrosatellites) in 5 families with 92 offspring and application of a hybrid cell panel, there has been successfully mapped 90 markers to 12 of the 15 chromosome pairs in the mink. On chromosome one for instance is mapped the largest linkage group, which contains 14 markers. Moreover the Silver blue gene has successfully been mapped to chromosome three based on segregation of the gene in one of the five families. By homology studies the gene has been identified corresponding to the segregation of silver gene in the dog, which for instance segregates in the Puddle the gene codes for melanophilin. With respect to identification of the function of other colour genes is collected family material which segregates in Cross, Palomino, and Stardust. Planes are ready for families with segregation in Hedlund white, Regal white, Aleutian and Pastel for the spring 2007. And work is done to identify families which segregate in Jet black and in the Red mink. In the year 2007 there are plans to fill the last gaps in the chromosome map for the mink and also for a physical anchoring so it is turned right on the chromosomes.

Annual Report 2006, 39-46, Danish Fur Breeders' Research Center, Holstebro, Denmark.

Crossing wild and standard black mink

V.H. Nielsen

The project is performed to examine the possibility of establishing a line of mink with a reproduction similar to the one in wild mink and an attractive coat color as in standard black mink. Wild mink and standard black mink are crossed and maintained for five generations. Reproduction, fur quality traits and weight are recorded and selection is performed for these traits. Compared to the black line, reproduction and weight are improved. This can be ascribed to inbreeding in the black mink and selection. The analyses and the recordings of fur quality traits do not allow interpretation of the development of these traits.

Annual Report 2006, 47-52, Danish Fur Breeders' Research Center, Holstebro, Denmark.

Mink selected to produce on a low protein content in the feed. Status for growing period 2005 and lactation period 2006

T.N. Clausen, P. Sandbøl, C. Hejlesen

A selection experiment was initiated in 2002 to investigate the possibility of breeding mink with a

good fur quality when the content of protein in the feed was low (SEL), without negative consequences for reproduction and pelt length compared to a control group (KON). At pelting 2005 four new groups were made from these, two groups continuing on selection feed or control feed (K-K11 and S-S14), and two groups changing between control and selection feed (K-S13 and S-K12). The selection experiment will stop at pelting 2006, thereafter genetic parameters will be estimated.

The selection group had lower kit weights in the breeding period 2005 than the control group. They did not compensate before pelting, so their pelting weight and skin length was lower. In spite of shorter skins their quality was not better. Both groups have had a positive increase in skin length throughout the years.

Number of kits day 28 and day 42 was lower in the group that was fed selection feed in both periods than in the other groups. Females feed control feed in the growth period 2005 had a higher weight throughout the whole breeding period than females feed selection feed. Perhaps due to that the kits from these females had a higher weight day 28 and day 42 than kits from females feed selection feed until 2006. Kits from females feed control feed in the winter and nursing period 2006, were bigger day 28 and 42 than kits from females feed selection feed in the same period, no matter what feed they had received before 2006.

Annual Report 2006, 53-60, Danish Fur Breeders' Research Center, Holstebro, Denmark.

Selection and test of lines under *ad libitum* and restricted feeding

V.H. Nielsen, S.H. Møller, B.K. Hansen, P. Berg

The effect of selection for high November weight on *ad libitum* (AL) and restricted feeding (RF) and of selection for high feed efficiency on *ad libitum* feeding (FE) is studied in mink. The estimated responses in the AL-, RF-, and FE-line are 362 g, 451 g, and 97 g. Thus, November weight is increased in all cases. Furthermore, the results indicate a genotype x environment interaction. Thus as regards weight, the lines are expected to be genetically different.

Annual Report 2006, 61-64, Danish Fur Breeders' Research Center, Holstebro, Denmark.

Response to selection for feed conversion rate

B.K. Hansen, P. Berg, S.H. Møller, V.H. Nielsen

Feed is the largest single cost in mink production. However, efficiency of utilization of feed cannot be easily recorded in the growth period, as mink are normally kept in pairs. A model to describe feed conversion rate is developed, when feed is measured for pairs of animals and weights are measured individually. In this article results are illustrated from a three year selection project using this model. In the last generation the selected kits are genetically improved to use the feed 11% more efficient than the base population, corresponding to a reduction of 1,8 kg less feed per kilogram produced mink. All together the kits have a reduction of 3 kg per kg weight gain, the remaining 7% improvement being due to improved management of feed.

Annual Report 2006, 65-70, Danish Fur Breeders' Research Center, Holstebro, Denmark.

Reports on: Nutrition and feeding

Protein to mink in the gestation period

T.N. Clausen, P. Sandbøl, C. Hejlesen

To investigate the need of protein and amino acids in the gestation period (April 4 to April 26), and the possible importance of the gestation feed for milk production and early kit growth, we used 6 groups each consisting of 135 brown mink females. The females were fed with feed from the local Feedkitchen until April 6, thereafter the protein content was changed in 5 groups from 20 percent of metabolisable energy from protein (OEp) to 52 OEp (20, 28, 36, 44 and 52 respectively). After April 26

these females had 30 OEp. Day 28 in the nursing period, the protein content was raised to 45 OEp to satisfy the kits need for protein. The last group served as control and was fed 52 OEp in the whole investigation period. Only females giving birth between April 26 and May 5 was included in the investigation.

28 OEp in the gestation period, April 6 to April 26, results in a lower number of live born kits. 20 OEp in the gestation period gave furthermore a higher number of stillborn, more barren females, and a lower milk production. 36 OEp and more was sufficient for a high number of kits born and a good milk production, with the described aminoacid composition.

Annual Report 2006, 71-76, Danish Fur Breeders' Research Center, Holstebro, Denmark.

Arginin free feed for mink kits (*Mustela vison*)

P. Sandbøl, T.N. Clausen, S. Lisbjerg, C. Hejlesen

According to the literature a number of animals can not maintain normal function of the urea cycle when fed with arginin free diet. For dogs and cats this seem to be independent of age and in cats a low activity of a specific enzyme has been pointed to as the cause. In ferrets the animals reaction change with age. Earlier investigations with mink indicated that also the mink has a arginin requirement.

The present investigation was initiated in order to check the reaction of mink to a arginin free feed ± citrulline or ornithine from 7½ weeks of age and until either a lack of symptoms or the animals reached maturity.

No abnormal behaviour was observed at neither 7½ nor 8½ weeks of age when the mink were fed the arginin free diet.

We report plasma glucose, ASAT and ALAT plus amino acids from liver and plasma. Plasma arginin were similar in the group given the arginin free feed and the control group. 6 amino acids were significantly lower in plasma from the animals fed the arginin free feed. Amongst these were glutamic acid and proline.

The results are discussed in relation to newer literature. We conclude, that the results based on the used methods and conditions show, that 7½ and 8½ weeks old mink do not have arginin as an essential amino acid; but apparently are able to supply the urea cycle via glutamic acid and proline.

Annual Report 2006, 77-86. Danish Fur Breeders' Research Center, Holstebro, Denmark.

Varied levels of phosphor in mink feed in the growing period

T.N. Clausen, P. Sandbøl, C. Hejlesen

To an investigation of tree feed rations optimised entirely to a varied phosphor content, we used tree groups each consisting of 118 male- and 118 female mink kits. Feed optimised to a low phosphor content (0.2%), was more expensive, gave shorter skins, but a better quality than feed with 0.3 and 0.4% phosphor.

Annual Report 2006, 87-90, Danish Fur Breeders' Research Center, Holstebro, Denmark.

Variations in methionin and total protein throughout the growth period

T.N. Clausen, P. Sandbøl, C. Hejlesen

To investigate the requirement of methionin for growth and furring, to series of mink with a total of 12 groups, each consisting of 120 brown male mink kits and 120 female kits, were used.

Series I: Three groups were feed 22, 26 or 30 percent of metabolisable energy from protein (MEp). These groups all had 0.31 g digestible methionin per MJ in the period July 11 to August 9, from August 9 to September 15 they had 0.38, and from September 15 to pelting the amount of methionin was 0.31.

Series II: Nine groups all had 26 MEp but a varied content of g digestible methionin per MJ on 0.24, 0.31 or 0.38 in the periods July 11 to August 9, August 9 to September 15 and from September 15 to pelting.

The results showed that 26 and 30 MEp gave better pelt length than 22, there were no difference in skin quality. Growth, pelt length and skin quality were dependent of the methionin content of the feed. 0.31 g digestible methionin per MJ in the feed in the periods july 11 to August 9 and from September 15 to pelting was sufficient for skin length and pelt quality. However 0.31 g gave reduced silkiness and flat skins.

Annual Report 2006, 91-98, Danish Fur Breeders' Research Center, Holstebro, Denmark.

Bioprotein as feed to growing mink – effects on the protein and energy metabolism

A.L.F. Hellwing, A.-H. Tauson, Ø. Ahlstrøm, A. Skrede

Bioprotein (BP) is a new high-quality protein source. BP has a high content of nuclei acid nitrogen. The objective of the study was therefore to estimate the effect of increasing dietary content of BP on the energy and protein metabolism in growing mink kits. Sixteen male mink kits of the standard brown genotype were randomly fed one of the four diets. One of the diets was a control (M1) diet without BP. In the other diets increasing levels of fish meal were replaced with BP so 20% (M2), 40% (M3) and 60% (M4) of the digested nitrogen derived from BP. During the growth period 5 balance and respiration experiments were conducted. The animals were in their respective 10th (period 1), 15th (period 2), 18th (period 3), 24th (period 4) and 29th (period 5) week of life on the first day of the respective balance periods. The intake of feed was significantly lower on M4 than the other diets. The apparent digestibility of nitrogen, fat, carbohydrate and energy decreased when increasing levels of the diet derived from BP. The retention of nitrogen was highest on M3 and lowest on M4, but the difference was non-significant (P=0.06). The heat production was the same on all diets. The retention of energy was zero on M4, which was significantly lower than the other diets. It was concluded that the protein and energy metabolism remained unaffected when up to 40% of the digestible nitrogen derived from BP.

Annual Report 2006, 99-106, Danish Fur Breeders' Research Center, Holstebro, Denmark.

Effect of the optimal ω6:ω3 relationship in feed in the pelt growing period

T.N. Clausen, S.K. Jensen, P. Sandbøl, C. Hejlesen

The optimal ratio of ω6:ω3 fatty acids in feed in the fur growing period was investigated. Five groups were used each consisting of 156 black male mink kits and 156 black female mink kits. The basic feed raw materials were low in fat. A mixture of fish oil, soya-bean oil and sunflower oil was used as fat source. The achieved ω6:ω3 ratio in the feed was 0.25, 0.83, 2.12, 8.47 and 14.2 in the groups FI, FISOY, SOYFI, SOYSOL and SOLSOY.

The results showed that a ω6:ω3 ratio of 2.12 was enough for growth (in September), but not for a good skin quality. Vitamin E in the feed was not influenced by high amounts of fish oil, whether the samples were fresh or frozen feed. α- and γ-Tocopherol in plasma, was lowest when the ω6:ω3 ratio was low (0.25, 0.83 and 2.12). Low ω6:ω3 relationship (0.25, 0.83 og 2.12) increased the fat infiltration in the liver in kits fasted for half a day, whereas there was no effect on bleeding time. The fatty acid concentration in fat and liver tissue reflected the fatty acid concentration in the feed, for most fatty acids.

To achieve a good pelt quality, the feed in the fur growing period should have a ω6:ω3 ratio of more than 2.12, but an exact recommendation can not bee given based on the present results.

Annual Report 2006, 107-114, Danish Fur Breeders' Research Center, Holstebro, Denmark.

Content and *in vivo* digestibilities in feed ingredients for mink feed – 2006

C. Hejlesen

Danish Fur Breeders Research Center (DFBRC) has performed digestibility trails with feed ingredients used in the Danish production of mink feed. The content of dry matter, crude ash, crude protein, crude fat and crude carbohydrate is presented along with the measured apparent digestibilities of these nutrients. The content of amino acids in the ingredients and there measured apparent digestibilities is presented.

The results are used in the ongoing updating of the Table of ingredients' (Råvaretabellen), which is used by the Danish central mink feed kitchens.

Annual Report 2006, 115-120, Danish Fur Breeders' Research Center, Holstebro, Denmark.

Minerals in raw materials for mink feed

C. Hejlesen, K. Hvam, S. Lisbjerg, P. Sandbøl

In the autumn 2004 Dansk Pelsdyr Foder a.m.b.a., Analyselaboratoriet invested in equipment for mineral analysis. Followingly mineral analysis was incorporated into the analysis program of PFC, so that the results eventually can be incorporated into the Raw Material Table. Feed samples collected for phosphorous analysis, by the Fur Department of the Danish Agricutural Advisory Center in relation to the 3rd program on water environment, were included into PFC's testing program. The joint number of results are hereby presented as raw data. These and coming results are to be used in the future updates of the Raw Material Table as well as for recommendations regarding mink production.

Annual Report 2006, 121-124. Danish Fur Breeders' Research Center, Holstebro, Denmark.

Fatty acid composition of feed ingredients for mink feed – 2006

P. Sandbøl, C. Hejlesen, K. Hvam, S. Lisbjerg

Danish Fur Breeders Research Center (DFBRC) has performed digestibility trails for some years to determine the digestibility of protein, fat, carbohydrates and amino acids in raw materials used for mink feed. In the later years, Danish Fura Animal Feed, Analyselaboratoriet has been able to carry out fatty acid composition of fat or the fat fraction in feed. This analysis has therefore been added to digestibility trials, where it is expected we subsequently can calculate the fatty acid digestibilities. These calculations have not yet been carried out; but we consider the common knowledge of the fatty acid compositions to be of general interest to the industry, wherefore these informations are presented here.

The results are used in the ongoing updating of the Table of ingredients' (Råvaretabellen), which is used by the Danish central mink feed kitchens.

Annual Report 2006, 125-128. Danish Fur Breeders' Research Center, Holstebro, Denmark.

Reports on: Physiology and analytical techniques

Fasting of mink males after mating, and its influence on liver fat percent and blood ketone concentration

T.N. Clausen, P. Sandbøl

To an investigation on the effect of fasting breeding males, on liver fat content, we used 98 brown mink. The males were body scored before and after mating. After mating they were fasted for 0 to 72 hours before they were euthanized. The animals were weighed, blood samples were taken to measure ketone bodies, and liver samples were taken to determine relative liver weight and liver fat percent. Fasting up to 72 hours of male mink with normal body score (3), gave a reduction in relative liver weight within the first 48 hours. There were no change in liver fat percent after fasting, but fat male mink (body score 4), had the highest fat content in the liver. The blood content of ketone bodies increased after 24 hours.

Annual Report 2006, 129-134, Danish Fur Breeders' Research Center, Holstebro, Denmark.

Enzyme activity in the digestive tract and vitamin E status of mink kits around weaning

S.K. Jensen, M.S. Hedemann, T.N. Clausen

The composition of the feed is an important factor for good health and growth in the weaning period. The transition from milk to farm fed is a challenge for he mink kits and their feed consumption is often reduced in this period. At the same time it can be difficult for pancreas to maintain a proper production of digestive enzymes. The purpose of this investigation was to investigate changes in the concentration of digestive enzymes in pancreatic tissues and intestinal mucosa in the period around

weaning. The activity of amylase in pancreatic tissue did not change from 4 to 6 week, but the activity increased significantly from 6 to 8 week. The activity of trypsin showed a steep increase from 4 to 8 weeks. The activity of lipase did not change from 4 to 6 week, but doubled from 6 to 8 week, whereas carboxyl ester hydrolase showed no increase. Vitamin E concentration in plasma was stable from 4 to 8 week, whereas to content decreased in the liver. The stereochemical composition of α-tocopherol showed a steep decrease in the concentration of the biological most active natural isomer in both plasma and liver through the whole weaning period, while the biological least active 2S isomers showed a clear increase. In summary this investigation showed that it can be beneficial to optimize feed composition in the weaning period in such a way that it both fulfils the kits requirement and their physiological capacity.

Annual Report 2006, 135-142, Danish Fur Breeders' Research Centre, Herningvej 112C, 7500 Holstebro.

Taste enhancer in amino acid diet to mink

K. Hvam, C. Hejlesen, P. Sandbøl

It is often necessary to use a so-called 'synthetic' diet when the nutrient requirements of mink are investigated. Obviously it is also important that the energy intake matches the animal's requirement for maintenance. However, in the small scale experiments we have conducted so far using 'synthetic' diets the energy intake has varied and been low. An experiment was therefore conducted to investigate if addition of a taste enhancer to an amino acid diet could increase the energy intake.

The three taste enhancers used (Fish Sauce, Soya Sauce and Sweet Soya Sauce) increased the energy intake at all 3 inclusion levels. For Soya Sauce and Sweet Soya Sauce at the highest inclusion level the increase wasn't statistically different from the control group (diet without taste enhancer). For the other 7 groups (combination of taste enhancer and inclusion level) the ingestion of feed end thereby metabolizable energy matched the requirement for maintenance of the male mink used in the experiment.

Annual Report 2006, 143-146. Danish Fur Breeders' Research Center, Holstebro, Denmark.

Correlation between liver fat percent and blood ketone body (β – hydroxybutyrate) concentration

T.N. Clausen, P. Sandbøl

The purpose of this investigation was, from data collected in 2004 and 2005, to evaluate, whether a high blood content of ketone bodies can bee used to predict fatty liver in mink. Within the area of 2 to 35 percent fat in the liver, it was not possible to find any connection between blood ketone level and liver fat concentration. Whether sick animals, with a high degree of fat infiltration in the liver (40-55 percent) has a very high level of ketone bodies in the blood is not known.

Annual Report 2006, 147-150. Danish Fur Breeders' Research Center, Holstebro, Denmark.

Fasting mink kits fed different amounts of protein

T.N. Clausen

In connection with the investigation of mink kits requirement for protein and methionin to growth and furring samples of liver, intestine and blood samples were taken at pelting.

Fasting mink kits fed 22 percent of the metabolisable energy from protein (OEp) for 48 hours, gave a more pronounced fat infiltration in the liver than 26 or 30 OEp. Ketone bodies were lowest in fed kits, and increased after fasting. By the method we used in this investigation we could se no difference in percent mucosa between groups.

Annual Report 2006, 151-154, Danish Fur Breeders' Research Center, Holstebro, Denmark.

Reports on: Health

Survival of mink kits stimulated in incubator

K. Hvam

It is common praxis to collect cold and apparently lifeless mink kits for revival in an incubator. The literature does not report any results concerning survival to day 42 of mink kits revived in an incubator and whether or not this praxis is economically feasible. The present investigation was carried out in order to shed some light on the matter.

The results show, that about 10 % of the females giving birth also have kits which end up in the incubator. A total of 73 % of the kits placed in the incubator were revived. Of these almost half (42.7 %) were still alive on day 42 after birth. The survival of revived kits depended on whether they came from a female which had delivered one or more kits to the incubator. There was no difference in revival between kits coming from a female that delivered one or more kits (72.7 % and 72.5 % respectively). However, the chance of survival to day 42 was much higher for the kits coming from a female that only delivered one kit to the incubator (72.5 %) in comparison to kits coming from a female that had delivered more kits (35.1 %).

In spite of the relatively high mortality amongst kits revived in an incubator, it is conclude, that the work effort is economically feasible.

Annual Report 2006, 155-158, Danish Fur Breeders' Research Center, Holstebro, Denmark.

Prevalence of Mink Astrovirus (MiAstV) in faecal samples in mink kits during the pre-weaning period

K. Ullman, A.S. Hammer, K.-O. Hedlund, P. Thorén, G. Czifra

We systematically followed the course of disease on three Danish farms during outbreaks of "greasy kits" syndrome during the pre-weaning period 2006 and recorded all clinical signs of the disease. Faecal samples were collected from all 105 litters investigated and the samples were analysed with a recently developed mink astrovirus (MiAstV)-specific PCR and electron microscopy (EM).

This longitudinal study confirmed that MiAstV infection is very common on Danish mink farms experiencing the "greasy kits" syndrome. The highest prevalence of MiAstV was observed in 20 to 25 days old mink kits. On two out of three farms MiAstV was detected 2 to 3 days before typical signs of the pre-weaning diarrhoea were observed in the affected litters. In many litters shedding of MiAstV continued for at least 20 days.

On the third farm calicivirus was detected with EM in diseased but MiAstV-free kits before the MiAstV infection started. The finding suggests that calicivirus must also be considered while investigating possible causes of the pre-weaning diarrhoea. It was also concluded that diarrhoea or other clinical signs have no differential diagnostic value.

Annual report 2006, 159-164, Danish Fur Breeders' Research Center, Holstebro, Denmark

Astrovirus infections in mink kits – virological and pathological findings in mink kits with pre-weaning diarrhoea submitted for diagnostic investigation

A.S. Hammer, K. Ullman, G. Czifra

During the pre-weaning season 2006 a novel mink astrovirus (MiAstV)-specific PCR was for the first time applied routinely in the diagnostic evaluation of mink kits submitted for autopsy at the Danish Food and Veterinary Research.

Here we present the results of virological and pathological analyses of 95 mink kits submitted for diagnostic investigation during the pre-weaning seasons 2005-2006.

The results confirm that astrovirus infections are highly prevalent among kits during outbreaks of pre-weaning diarrhea ("greasy" or "sticky" kits) and indicate that astrovirus may be the cause of the majority (62 %) of the outbreaks included in this investigation, while remaining outbreaks may be due to other causal factors (eg. enteric viruses or dietetic factors). Gross pathological and

histopathological findings related to pre-weaning diarrhea do not seem to have any differential diagnostic value in relation to causal factors. Virological and histopathological findings in organ samples from mink kits are consistent with previous studies of astrovirus infections in other species, where astrovirus cause enteric infections in juvenile animals, with diarrhea characterized by absence of signs of inflammation and cell death. Real-time RT-PCR of faecal samples has proven to be a fast and useful method for diagnostic detection of astrovirus infection in mink kits with pre-weaning diarrhea.

Annual Report 2006, 165-170, Danish Fur Breeders' Research Center, Holstebro, Denmark.

Ammoniumchloride, Na-bisulfate, benzoic acid and adipic acid to mink kits in early growth

T.N. Clausen, P. Sandbøl, C. Hejlesen

The effect of ammoniumchloride, Na-bisulfate, benzoic acid and adipic acid on urinary pH, in the early growth period of mink kits were tested. Further the validity of feed base excess (BE) as a predictor of urinary pH, where acids are used as additives, was evaluated.

The results showed that 0.5 % Na-bisulfate or 0.2 % ammoniumchloride were the best of the investigated additives in reducing urinary pH, without reducing early kit growth significantly. 0.34 % adipic acid also reduced urinary pH, whereas 0.1 % benzoic acid had no effect compared to the control group. Urinary pH could not be predicted by calculating feed BE in this investigation.

Annual Report 2006, 171-176, Danish Fur Breeders' Research Center, Holstebro, Denmark.

Adipic acid and benzoic acid to mink in the growing period

T.N. Clausen, P. Sandbøl, C. Hejlesen

To investigate the effect of Adipic acid and Benzoic acid on urinary pH and acid base balance of the animals, tree groups of 55 black male siblings were used. The trial feed was given from mid July to pelting. One group (KON) had control feed, one group (ADP) had control feed with the addition of 0.34 % Adipic acid, and the last group (BEN) had control feed with 0.1 % Benzoic acid.

0.34 % Adipic acid and 0.1 % Benzoic acid in the feed to mink kits in the growing period had no effect on the blood acid-base balance of the animals at pelting. Adipic acid increased skin length, and reduced urinary pH compared to the control group. Benzoic acid only reduced urinary pH slightly and not continuously.

Annual Report 2006, 177-180, Danish Fur Breeders' Research Center, Holstebro, Denmark.

Reports on: Management

Body score of females in the winter and breeding period

T.N. Clausen, P. Sandbøl, C. Hejlesen

Preliminary investigations among black mink females in the breeding period 2005 and brown females in the breeding period 2006 on the connection between the females body score in the winter period, her weight development and the breeding results were carried out.

Females getting too fat up to birth get fewer live borne kits than females in normal body score. Females that are very fat in November, requires very restrictive feeding in the winter period to be in a normal body score at breeding. After that, they easily regain weight, and are very difficult to keep at a normal body score.

Annual Report 2006, 181-184, Danish Fur Breeders' Research Center, Holstebro, Denmark.

Connection between early kit mortality and the body condition of the females and feed consumption from January to birth

H. Bækgaard, M.U. Hansen, M. Sønderup, T. Clausen

The purpose of this field investigation was to examine the connection between early kit mortality and the body condition of the females and the feed consumption from January to birth. 12 farms with a total of 5338 first year females were included in the investigation. The females were divided between wild type, pearl and white. The body condition of the females was scored on a 6 scale within the periods; 18 – 31 of January, 20 – 24 of February, 20 – 24 of March and as pregnant females 18 – 21 of April. Moreover, some females were evaluated immediately after birth. Dead kits were noted within the first three days after birth, whenever possible. Feed allocation were registered with help of individual feeding with palm pilot and divided into two periods; implantation (25 of March – 6 of April) and pregnancy (7 of April – 24 of April). We did not find any correlation between the feed consumption and number of kits in any of these periods. However, we found a good correlation between the body condition of the females and the number of both living and dead kits. The body condition of the females had a significant influence in February, March and April and right after birth. We did not find any significant influence of the female's body condition in January. Generally speaking, females that are in a medium body condition show the best results. Females that are too fat in March and April had more dead and fewer living kits. As expected the majority of the females gain weight from February to March. Those females that stay in a similar body condition or gain 1 score in body condition, have more living kits than those that gain 2 or more grades in the score. A decrease in body condition from March to April gives fewer living kits. A decrease of 2 or more grades gives furthermore a higher number of dead kits. We conclude that a conditioning of the females in February, March and April seems to be able to help the females in having more live and fewer dead kits per female

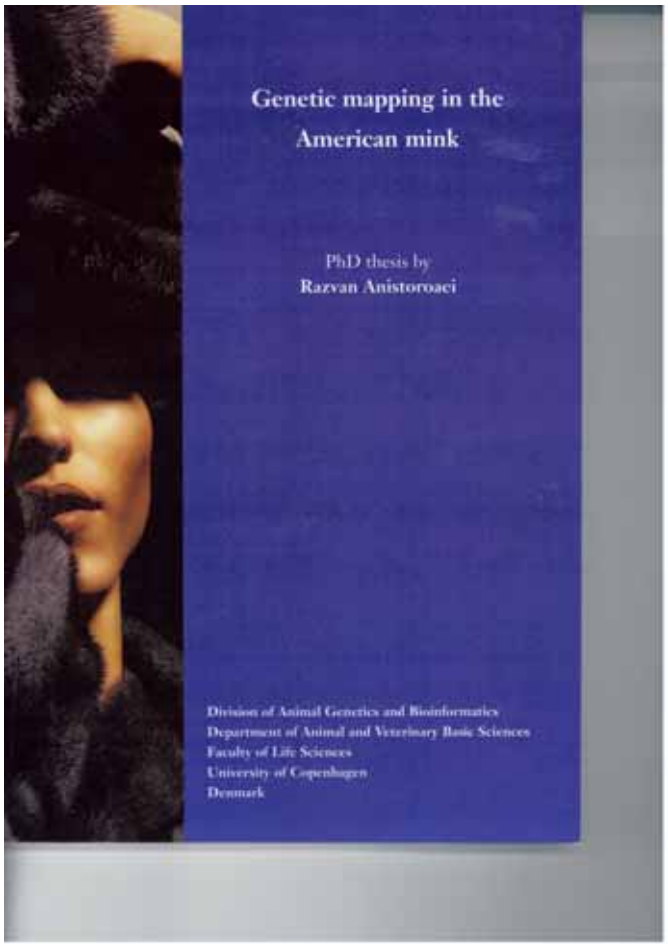
Annual Report 2006, 185-192, Danish Fur Breeders' Research Center, Holstebro, Denmark.

Genetic mapping in the American mink

PhD thesis

by

Razvan Anistoroaei



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The ability to map and sequence genomes is one of the most important developments in biological science. This will provide us with an insight into the genetic background of phenotypic traits, such as disease resistance, reproduction and growth and also makes it feasible to study the processes of genomic evolution.

The main objective of this PhD thesis has been to create the first linkage map of the North American mink (*Mustela vison*) genome. In the introductory part of the thesis, theoretical and practical background in gene mapping developed in the last years, emphasizing those which provided the largest and the fastest progress in gene discovery are

introduced. Aspects and aims of gene identification and gene mapping in livestock species, with emphasis on mink, are described. A brief resume of the actual stage of genetic and gene mapping in the mink is given.

The development of a genomic map initially relies on genetic markers. The construction of two mink genomic libraries and the development for more than 100 new microsatellite markers for the mink is described in detail here, as most of the results are presented in Papers I and II. In conjunction with the development of the genomic library for microsatellites development, random sequencing has generated a fairly large mink sequence resource dataset which was released into public databases. Based on these sequential data and bio-computational approaches short and long interspersed repetitive elements are described and partially characterized by sequence and by distribution.

Segregation studies using microsatellite markers resulting in construction of the first genetic map were based on segregation in five half sib families comprising 92 F1 individuals. A total of 85 microsatellite markers are distributed into 17 linkage groups that are present on all but two of the mink autosomes. The assignment was made by means of a mink/hamster somatic hybrid cells panel available at the Russian Institute in Novosibirsk, part of the international collaboration within the project. The map developed spans 690 centiMorgans (cM) which together with 60 unlinked markers cover 1650 cM and can yield an estimate of 2800 cM for the entire mink genome.

Based on this genetic map, linkage of gene for "SILVER" colour in mink has been established to two markers, and is probably physically mapped and associated with the melanophilin gene in dog.

Cross hybridization experiments by fluorescence *in situ* hybridization (FISH) in mink can provide good comparative mapping views for genes contained in large-insert vectors, e.g. bacterial artificial chromosomes (BACs) and few results are introduced here. A somatic hybrid panel, developed by us but as yet uncharacterized, is described as providing alternative to the physical anchorage of the genetic map. This can be done by FISH utilizing hybrid DNA onto mink metaphase spreads and associating the results with those given by the PCR amplification of the linked markers.

As the mink microsatellite markers development progressed, a potential utilization of them in the ferret (*Mustela putorius furo*) was investigated, as the two species are phenotypically very similar. The results suggest that at least at the repeat site, there is quite a great difference between the two species therefore the cross utilization of the markers can provide minor results only.

Perspectives and goals based on this piece of work are concluding the thesis.

The experimental work, which is the essence of this thesis, is enclosed in publications and manuscripts as following:

Paper I and II: "Isolation and characterization of 79 microsatellites markers for the American mink (*Mustela vison*)" and "Characterization of microsatellite markers isolated from the American mink (*Mustela vison*) genome" are two resource publications describing the development and characterization of microsatellites from mink genomic libraries.

Paper III: "Characterizing SINE and LINE elements in the North American mink (*Mustela vison*) from sequence information and *in situ* hybridization" describes short and long interspersed elements among *Mustela vison* genome and *in situ* hybridization by these elements.

Paper IV: "The first linkage map of the American mink (*Mustela vison*) genome" describes the development of a first generation linkage map for the American mink based on 145 informative microsatellite markers wide-distributed on all but 2 of the mink autosomes.

Paper V: "Mapping of silver gene in mink and its association with dilution gene in dog" describes the chromosomal assignment of the clone containing melanophilin gene from a dog clone to the mink chromosome 3, this confirming the linkage results which link the "SILVER" gene to the same chromosome.

Paper VI: "A test of mink microsatellite markers in the ferret: amplification and sequence comparisons" was intended as a cross-amplification test to

investigate the option of utilizing markers or other genetic resources from ferret in mink and vice-versa.

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