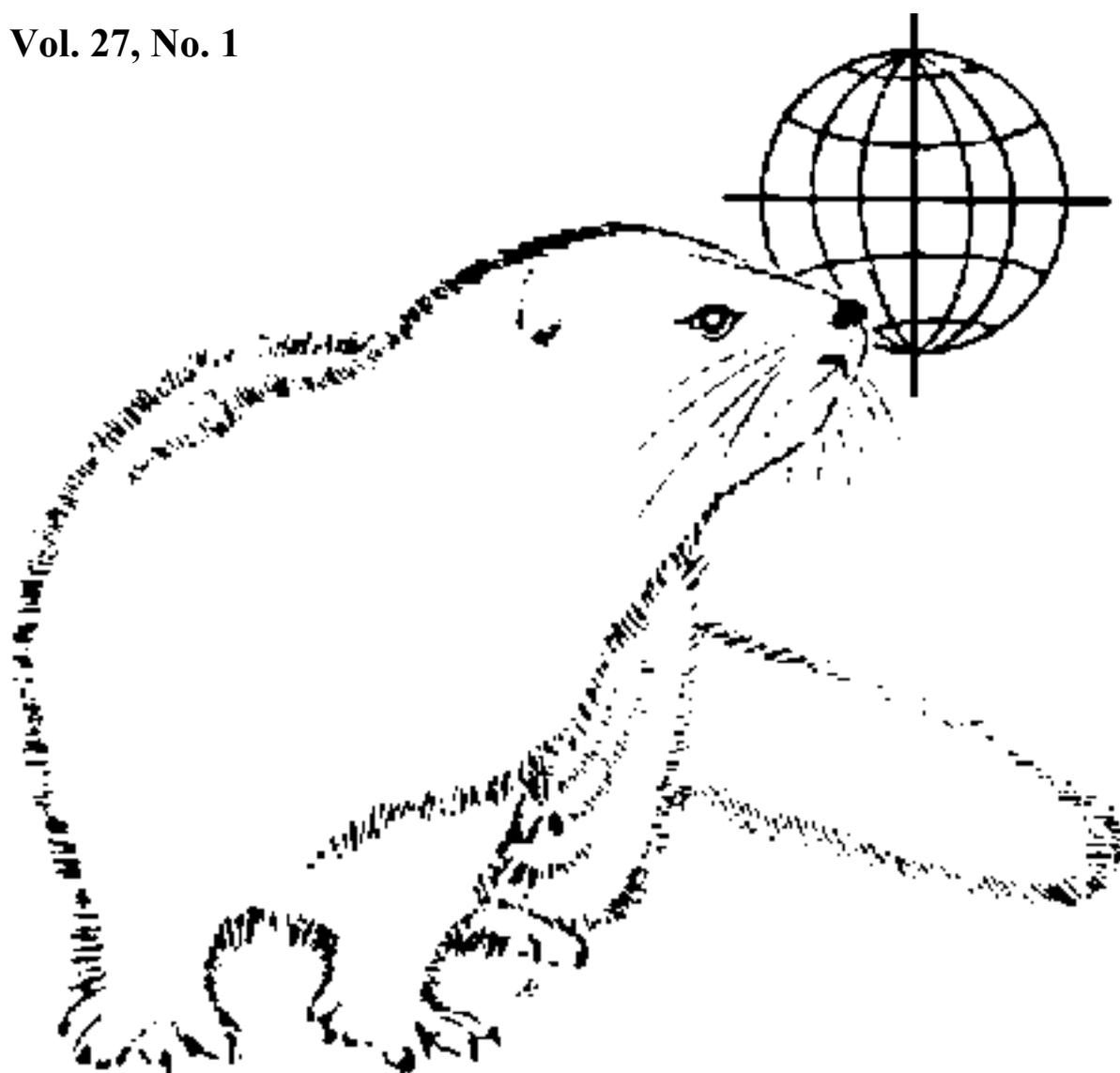


# SCIENTIFUR

SCIENTIFIC INFORMATION IN FUR ANIMAL PRODUCTION

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INTERNATIONAL FUR ANIMAL SCIENTIFIC ASSOCIATION

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## Notes from the Group of Editors

This version of Scientifur is the first issue of volume 27. For some time to come, we will continue to publish Scientifur electronically as well as in a paper version. Thus, after being published electronically, the first two issues of this volume will soon appear in a paper version which will be sent to all our subscribers.

This issue contains primarily abstracts of oral presentations as well as posters presented at the Seminar No. 354 of the Nordic Association of Agricultural Scientists, Subsection for Fur Animals. Approximately 100 participants from Belgium, Canada, Denmark, Finland, Iceland, the Netherlands, Norway, Russia and Sweden participated in the seminar which took place in Lillehammer, Norway, 8 – 10 October 2003.

Also a few abstracts presented at a meeting held at the Danish Institute of Agricultural Sciences, Research Centre Foulum, on 24 September 2003, are published. The subject of the meeting was 'Fur animal production – behaviour, health, breeding, and nutrition'.

As always, we invite our readers to submit proceedings from congresses and seminars with relation to fur animal production. We also invite you to submit short communications, abstracts and letters on fur animal production, and in particular we ask you to send us articles for reviewing.

Merry Christmas and a Happy New Year to all our readers and contributors.

On behalf of the  
Group of Editors

Birthe Damgaard





NORDIC ASSOCIATION OF  
AGRICULTURAL SCIENTISTS

## **NJF's Subsection for Fur Animals**

**NJF - Seminar no. 354  
Lillehammer, Norway  
8 - 10 October 2003**



**RAPPORTER**

## Ethology and animal welfare

### Assessing the value of different resources to silver fox males using operant methodology: preliminary results

*A.L. Hovland, G. Mason, K.E. Bøe, H.T. Korhonen, M. Bakken*

Measuring the strength of various behavioural needs in captive animals may provide a basis for monitoring animal welfare and a starting point for the construction of adequate housing systems. Applied ethologists frequently employ operant methods, a set-up in which a cost is imposed upon access to the resource by requiring the animal to perform a learned task. Evaluating the relationship between resource consumption and operant effort (the cost) through the means of microeconomic analyses allow the calculus of various indices which illuminates the strength and flexibility of a specific behavioural need.

In farmed foxes, operant methods are currently being developed to measure both environmental and social demands. Because social motivation is likely to show individual and seasonal fluctuations due to the reproductive and social biology of silver foxes (*Vulpes vulpes*) the need for methodology to map this variation is important. As a result, increased knowledge on basic characteristics of fox family dynamics and specific factors that determine the 'social profile' of an individual may form a basis for construction of alternative group housing systems.

During the last three years our research group has focused on developing an operant apparatus for measuring social motivation in farm foxes (Hovland et al. 2002a, 2002b). As a part of pretesting the apparatus, both in regard to its robustness and applicability and to obtain reference values for different environmental resources, three separate tests measuring the foxes motivation to access alternative resources was conducted.

*Proceedings from NJF - Seminar No. 354. 6 pp, 4 figs, 1 table, 8 refs. Authors' abstract.*

### The welfare effects of group size and space allocation in juvenile blue foxes

*L. Ahola, J. Mononen, T. Pyykönen, M. Mohaibes*

Juvenile blue foxes were housed in cage conditions singly, in pairs or in quartets with either 0.6 or 1.2 m<sup>2</sup> per animal. The effects of group size and space allocation on some physiological, behavioural and production-related parameters were assessed. The present results showed that, in general, space allocation had only minor effects on the measured parameters. However, the larger space allocation may, on the one hand, have negative welfare effects on the human-animal relations. On the other hand, the larger space allocation allowed the animals to maintain their individual space also in the larger groups, thus possibly affecting positively to the welfare of these animals. Further, it was revealed that social tension and a sex-related social dominance order within the groups may lead to some welfare problems in group-housed blue foxes. Potentially impaired welfare was observed in the females that had higher serum cortisol level than the males and were suffering from being bitten especially when housed in quartets. Despite these negative findings, the present results show that group housing could possibly be considered as an alternative, socially enriched way of housing farmed blue foxes.

*Proceedings from NJF - Seminar No.354 .7 pp, 11 refs. Authors' abstract.*

### The effect of housing density on reproductive performance of farmed blue foxes

*T. Pyykönen, L. Ahola, M. Mohaibes, J. Sepponen, S. Hänninen, J. Mononen*

Social factors are known to affect the reproduction of both wild red foxes and farmed silver foxes. The present study was carried out to clarify whether social factors influence the reproduction of farmed blue foxes as well.

Blue fox vixens were kept in low (in every fourth cage=E group) and in high animal densities (in every cage=C group) during two breeding seasons. The reproductive success of these groups was

compared. The primiparous females came to heat 17 days later than the multiparous females, and the reproductive performance in primiparous vixens was markedly worse than in multiparous vixens. Therefore, the differences between the E and C groups were analysed separately for these two age classes.

The primiparous females came to heat earlier when farmed in dense conditions. Moreover, they tended to deliver bigger litters but had worse cub survival. It seems that primiparous females benefit from dense farming during heat development, but from low animal density during the whelping and cub care period.

The multiparous females tended to reproduce better in low than in high animal densities. There was a lower percentage of females without signs of oestrus, less barren females and larger litter size in the E than in C group. All this summed up to 1.5 cubs more per breeding female at weaning in the E group.

Farming in low animal densities could be recommended for both primiparous and multiparous blue fox vixens. Possibly, it would be even better if primiparous blue fox vixens could be kept in dense conditions before the mating and in lower densities after the mating. Our results, however, mainly lack statistical evidence and the results must be confirmed in field studies with a higher number of experimental animals.

*Proceedings from NJF - Seminar No. 354. 6 pp, 1 fig, 4 tables, 9 refs. Authors' abstract.*

### **Minks' motivation for access to swimming water and running wheel**

*S.W. Hansen, M.B. Jensen*

The purpose of this investigation was to quantify the priorities of mink for swimming-water and running wheel, respectively, by construction of demand curves for each of the two activities by use of operant conditioning techniques. The mink were kept in eight experimental cages equipped with either a box of swimming water or/and a running wheel. Each water box or running wheel was connected with a lever response manipuladum on

which the mink could work to get access to either the swimming water or the running wheel. The mink worked on a fixed ratio (FR) schedule FR: 5, 10, 20, 40 and 60 for access to the resources. The precise time of the responses, the number of responses and the number of rewards obtained in the form of access to the water box and the running wheel, respectively, were recorded continuously via a pc and subsequently summed each 24 h. In total, the project included 7 experiments. In the first 3 experiments, the reward duration was 1 min, and in the last 4 experiments the reward duration was increased to 2 min. The mink were tested by giving them access to one of the resource at the time, by giving them access to both resources at the same time, by giving them almost free access to the alternative resource, or by giving them access to an empty water box.

The results showed that there were no differences in the elasticity of the demand for swimming water and for running wheel, indicating that mink give the same priority to these two types of cage enrichment. However, both running wheel and swimming water were valued higher than access to an empty box. When the reward duration was increased from 1 to 2 min the intensity of the demand function for running wheel increased significantly, whereas the intensity of the demand function for swimming water was not affected by the increased reward duration. Mink did not increase their use of the running wheel as the price of swimming water increased or their use of swimming water as the price of running wheel increased. Therefore, the two resources did not substitute for each other. The mink used the running wheel as a part of their normal activity rhythm, whereas the swimming water was primarily used in the morning hours when the water bath was refilled. Based on the different diurnal rhythms and the lack of substitutability between the two resources, it is assumed that the use of running wheel could be motivated by a non-specific need to performing appetitive behaviour in the form of locomotive activity. The use of swimming water could be specifically motivated by thirst and a need for exploration.

*Proceedings from NJF - Seminar No. 354. 15 pp, 9 figs, 38 refs. Authors' abstract.*

### **The effects of swimming pool or extra space on behaviour of mink**

*M. Mohaibes, J. Mononen, T. Pyykönen*

The need of farmed mink for swimming water has been debated in Europe for several years, and the issue has been investigated in many countries. In the present study were compared the behaviour of mink with access to a swimming pool (swimming pool group) to mink with access to an extra cage (extra cage group) and to mink with traditional housing (control group).

There were 15 juvenile female mink in each experimental group. The animals were housed singly. Animals in all groups had standard cages (85 x 30 x 45 cm, L x W x H) and wooden nest boxes (27 x 31 x 39 cm, L x W x H). The experiment began in July when the swimming pools (180 l) and extra cages of the same size as the swimming pool cage (102 x 60 x 45 cm, L x W x H) were provided to the swimming pool and extra cages group. The behaviour of the mink was video-recorded in the weeks 1-2, 9-10, 11-12, 17 and 20-21 after the beginning of the experiment. In the weeks 11-12 the access to the swimming pools and extra cages was denied (deprivation), in the week 17 the pools were partially and in the weeks 20-21 totally frozen.

The mink with the swimming pools were generally less active than the animals in the extra cage and control groups. When the pools were partially frozen the pool cage offered many kinds of activity possibilities to the mink (e.g. diving, digging of sludge and playing with pieces of ice). Then the animals were more active in the pool cage, and their general activity was also as high as the activity of the mink in the two other groups.

The median time spent on swimming was less than 10 min per 24-hours, but the mink with the pools performed least, and the control animals most stereotyped behaviour. The extra cage animals were intermediate to these two groups. During the deprivation period both stereotyped behaviour and general activity increased in the swimming pool group. Stereotypies and general activity correlated positively.

Despite of the low use of the swimming pools for swimming, the access to the pools seemed to attenuate stereotyped behaviour, but the difference

to the effect of the extra cage was rather minor. It also seemed that the enrichment value of the pool was at its greatest when the pool was partially frozen and offered the possibility for many other activities than swimming. We conclude that, although the preliminary result of the present study indicate that providing mink with swimming water may have beneficial effects on their behaviour and welfare, it is possible that comparable alleviation of frustration in farmed mink can be achieved with other enrichment as well.

*Proceedings from NJF - Seminar No. 354. 6 pp, 2 tables, 8 refs. Authors' abstract.*

### **How can happiness be measured in farmed foxes?**

*R.O. Moe, H. Kingsley-Smith, S. Kittilsen, M. Bakken*

Welfare has been defined as the balance between positive (reward, satisfaction) and negative (stress) experiences or affective states (Spruijt et al, 2001). The state of this balance may range from positive (good welfare) to negative (poor welfare). Recent years research on welfare in farmed fur animals mainly paid attention to investigate indicators related to stress and poor welfare (Bakken et al., 1999; Moe, 1996). However, to form a basis for improvement of the farm environment, management practice and "mental health" there is a need to investigate indicators of good welfare.

The balance between positive and negative affective states is reflected by activity in the reward centre in the brain. It has been argued that observing behaviours during anticipation of a food reward in a Pavlovian conditioning paradigm is an easy and useful tool to assess the state of this balancing system (Spruijt et al., 2001). Behaviour during anticipation of an oncoming reward may therefore be used as a tool to assess good welfare.

Furthermore, one way to induce some form of "pleasure" or "happiness" would be adding unpredictability in a positive context into a positive predictable environment. The rationale behind this assumption is that introducing a lack of predictability during a Pavlovian conditioning not necessarily implies stress and poor welfare. In

contrary, it may involve a reward of an even better quality than expected. It has been suggested that positive emotional expressions indicating some form of pleasure may occur in such cases (Lorenz 1953, cited in Wiepkema & Koolhaas 1992; 1993).

The present study was designed to investigate potential indicators of positive welfare in farmed foxes. The aims were to identify and describe emotional and behavioural expressions during anticipation of oncoming rewards created by Pavlovian conditioning. Emotional and behavioural data are presented.

*Proceedings from NJF - Seminar No.354. 4 pp, 10 refs.*

### **Expert opinion on information value in welfare assessment reports for mink farms**

*S.H. Møller*

A welfare assessment system based on information about the housing system, management, animal behaviour and health has been developed for on-farm use as a farm advisory tool. A panel of mink experts in the fields of health, behaviour and welfare has evaluated the information in the welfare assessment report. Six mink husbandry advisers, four veterinary practitioners and six scientists were recruited to the expert panel and received a series of three questionnaires containing information about 1) the housing system and health, 2) animal behaviour and 3) management from two anonymous case reports. The relevance of the information was scored and the advisers were asked to request further information relative to each round of questionnaires. In general the presented welfare indicators for mink production were perceived as relevant. The advisers, veterinarians and scientists agreed on the welfare relevance of most indicators, although each group of experts scored information within their field (such as production, health and behaviour, respectively) slightly higher than the other groups did. With all information provided the experts requested/suggested some additional information about production details and stockmanship of which a few, like the variation in weight, can easily be included in the welfare assessment systems. The information in the welfare assessment reports provided for a good evaluation of the farm level of

welfare. However, the experts stressed that other factors than those registered in the welfare assessment reports could be important in special cases and inspections of the animals on the farm are therefore needed.

*Proceedings from NJF - Seminar No. 354. 10 pp, 9 figs, 1 table, 9 refs. Authors' abstract.*

## **Nutrition**

### **Salt content in Swedish mink diets**

*Eva Aldén*

The salt composition of mink diets is of interest especially during the lactation period when extra salt is often recommended to add to the diets. Salt is improving food taste and stimulates drinking water uptake. Sodium is lost by milk in the lactating female and is supplied with salt. Excessive salt needs water when excreted. No needs for sodium have been quantified for mink nor are special deficiency symptoms for sodium or chloride described for mink. 0,42-0,5% salt per 100 kcal ME in diets is recommended regarding health of females and kits. Diets are changing composition over time and in Sweden we have very few analyses of salt content in mink diets. 2002-2003 some analyses were made. The results gave rise to questions. What is the best suited method to analyse salt, how important is sodium and how much of the sodium in the diets is available to the animals.

*Proceedings from NJF - Seminar No.354. 7 pp, 3 tables, 14 refs. Author's abstract.*

### **Diets containing high amounts of barley for growing blue foxes**

*J. Valaja, I. Pölönen, N. Nenonen, T. Jalava*

The effects of chemical and physical treatments on the chemical composition of barley-water or barley-water-slaughter by-product mixtures were studied in a laboratory study. Mixtures were stored as such or with supplementation of lactic acid bacteria or  $\beta$ -glucanase enzyme for 24 or 48 hours at room

temperature. Fermentation started in all barley mixtures during 48 hours, but was fastest with the aid of lactic acid bacteria. However, mixtures with slaughter by-products remained rather stable during 48 hours. All treatments reduced the content of total, soluble and insoluble  $\beta$ -glucans in barley. The reduction was highest with  $\beta$ -glucanase enzyme supplementation.

Growing-furring experiment was conducted with 384 blue foxes to compare low and high barley diets. Commercial mink feed with 11% of barley was used as low barley control feed. Experimental feed contained 28% barley of which half was raw. The diet was supplemented with  $\beta$ -glucanase enzyme and stored for one week at the farm. The growth and fur quality was similar in both treatments. No visual differences were either observed in the faecal quality of the foxes. The results indicate that grain content of fox diets can be increased without adverse effects on animal performance. This gives a great potential to modern fox feed formulation, where protein content is reduced to the level that accurately covers the animal's requirements.

*Proceedings from NJF - Seminar No.354. 4 pp, 3 tables, 3 refs. Authors' abstract.*

### **Extruded peas as feed ingredient for mink in the growth period**

*Ø. Ahlstrøm, A. Skrede*

Extruded peas have a favourable price and a higher protein content than other carbohydrate sources used in wet feed for fur animals. To establish the suitability of the extruded peas as carbohydrate source for mink in the growth period it was included at the three levels: 0%, 50 % and 100 % of dietary carbohydrates, corresponding to 0, 7,5 and 15 % of the diet.. Each diet was given to 48 mink kits in the period from July- November. The pea product contained (%) 91.6 dry matter, 3.1 ash, 22.8 crude protein, 0.7 crude fat, and 65.0 carbohydrates (by difference). The dietary carbohydrate level was set to 20 % of metabolisable energy. The pea product revealed higher water binding capacity than the replaced preheated grain product commonly used in fur animal wet feed. Feed intakes and body growths were similar for all groups, but the feed conversion

rates on dry matter and ME basis were improved with the pea diets. This finding is difficult to interpret, but possible explanations may be related to differences in the metabolism of the animals, different body composition, or less likely different feed wastage. In conclusion the experiment showed that extruded pea can be fed to mink in the growing-furring period as the only carbohydrate source at levels up to 15 % of diet without negative effects on production performance or health status.

*Proceedings from NJF - Seminar No.354. 8 pp, 4 tables, 3 refs. Authors' abstract.*

### **Influence of dietary vitamin A level on growth performance and fur quality of mink and blue fox**

*N. Nenonen, I. Pölönen, T. Rekilä, J. Valaja*

Vitamin A (retinol) is a fat-soluble vitamin and is essential for animals in many physiological processes. It is important for normal vision, protein synthesis, bone and joint development, gene expression, reproduction etc (Mervyn, 1984). As a fat-soluble vitamin retinol is stored mainly in the liver. Thus preformed vitamin A is abundant in animal-derived foods, whereas provitamin carotenoids are abundant in fruits and vegetables.

In Finland vitamin A recommendation for fur animals is 3500 IU per kg DM according to Finnish Fur Breeders Association. Requirement of vitamin A and its overdose effects on joint development and on reproduction of fur animals are not very well known. Research results in dog indicate that high amounts of fat-soluble vitamins in feed induces poor weight gaining, anorexia, disturbance of bone and joint development, impaired ability to move etc (NRC, 1985). Signs of vitamin A excess is spontaneous fractures, loss of fur, exophthalmia and hyperthesia of the skin (NRC, 1982). According to NRC (1982) signs of vitamin A deficiency in fur animals are poor weight gaining, night blindness, lack of coordination and fatty infiltration of the liver.

Supplemental vitamins are expensive. Raw materials of fur animal feed contain various amounts of fat-soluble vitamins, possibly over the requirement. The amount of supplemental vitamin A

may be decreased depending on what raw materials are used.

The aim of this research was to study the influence of dietary vitamin A level on health, growth performance and fur quality of mink and blue fox.

*Proceedings from NJF - Seminar No.354. 7 pp, 2 figs, 4 tables, 9 refs.*

### **Amino acid imbalance in the growing furring period in mink (*Mustela vison*) – Influence on liver parameters**

*P. Sandbøl, T.N. Clausen, C. Hejlesen, J.B. Andersen, B.M. Damgaard*

Two trials have been carried out, to clarify the consequences of varying the essential amino acid (EAA) to total amino acid (TAA) ratio in mink feed during the growing furring period. The focus of the present paper will be the preliminary interpretation of the results of the analysis carried out on the livers of a representative number of the pelted animals. Significant differences ( $p < 0.05$ ) were found between treatments in the hepato somatic index (HSI). No significant differences were found for glycogen. When expressed per gram of tissue, there was a significant ( $p < 0.05$ ) difference between treatments of DNA, free fatty acids (FFA), triacylglycerol and triglycerides. When expressed per mg of DNA, there was a significant difference ( $p < 0.05$ ) between treatments of protein and glucose. The results are discussed in relation to their validity, their relevance in relation to the enzymatic capacity of the mink liver and to general performance results.

It is concluded, that usage of liver parameters requires a standardised procedure for euthanasia and liver sampling, more so for some parameters (glycogen and possibly FFA) than for others. That the HSI must be interpreted with caution. Excess of amino acids may cause swelling of the hepatocytes and possibly alter the amount of hepatic enzymes and thereby the total gluconeogenic capacity of the mink liver. The mink has a high gluconeogenic capacity, seen as an increased glucose content per hepatocyte with an increased excess of amino acids. Liver parameters may be

helpful in explaining performance results such as weight gain and pelt quality.

*Proceedings from NJF - Seminar No.354. 9 pp, 4 figs, 3 tables, 33 refs. Authors' abstract.*

### **Growth and skin quality of blue foxes raised on different protein and amino acid levels**

*T. Dahlman, J. Valaja*

A production trial was carried out on 125 growing-furring blue foxes (*Alopex lagopus*) to study the effects of varying dietary protein (P) level, with or without methionine (M) or lysine (L) supplementation, on growth performance and skin characteristics. Three dietary protein levels were studied: conventional, slightly lowered and clearly lowered. In the slightly and clearly lowered protein diets, methionine or lysine was added to yield the level of the respective amino acid in P30. The treatment codes were: P30, P22.5, P22.5M, P22.5L, P15, P15M and P15L. The protein contents of the diets were 29, 22, 22, 22, 16, 15 and 16 (% of ME), and the methionine contents, respectively, 0.40, 0.32, 0.44, 0.32, 0.24, 0.43, 0.22 (g per MJ ME).

Growth and skin quality were measured. According to the results, methionine is the first limiting amino acid for growing-furring blue foxes. Lysine supplementation did not give any positive responses. Addition of methionine and use of lowered protein levels for blue foxes would be beneficial in terms of reduced feed expenses and lowered nitrogen emissions to the environment, without compromising the welfare or production of the animals.

*Proceedings from NJF - Seminar No.354. 8 pp, 2 figs, 1 table, 9 refs. Authors' abstract.*

### **Formic acid preserved poultry by-products as a feed ingredient for blue fox and mink in the reproduction and early growth periods**

*Ø. Ahlstrøm, A. Skrede, H. Kingsley Smith*

Poultry by-products are well established as a feed ingredient in diets for fur animals in many countries. In the Norwegian market, however, raw poultry-by-

products have been scarce until 2001. Before that time the by-products were exploited as raw material for the meat-and-bone meal production. Most of the by-products are conserved with formic acid only, or with formic acid and sodium benzoate. The experience in Norway with acid conserved poultry by-product is limited with regards to effects of storage time and storage conditions, hygienic quality and dietary inclusion levels for foxes and mink. The main purpose of the present study was to evaluate formic acid preserved poultry by-products as protein source for blue foxes and mink during the reproduction period. A secondary aim of the study was to minimize dietary protein supply by using low levels and by using high levels of meat-and-bone meal along with the poultry by-products.

Three diets experimental diets were used. Each experimental group consisted of 23 blue fox females, and 60 standard mink females (30 brown and 30 dark genotype). The dietary inclusion of poultry by-products were 5.7, 17.3 and 29.9 % of the three diets, respectively. Corresponding values for meat-and-bone meal were 4.6, 5.8 and 7.2 %, respectively. A digestibility experiment revealed that apparent protein digestibility was 79-80 % for all three diets and approximately equal energy content (5.3-5.6 MJ/kg) and energy distribution for protein, fat, and carbohydrates (40-40-20). The pH was 5.9, 5.4 and 4.9 in the three groups, respectively. The highest inclusion level had the best hygienic quality. The reproduction results in blue foxes were generally satisfactory for all diets concerning body weights of females, growth of the cubs and mortality rates. Weaned cubs per mated blue fox female were 7.4, 4.8 and 7.1, respectively. In mink, the reproduction result was generally poor for all groups, mainly because of high percentage of barren females for all groups. Growth rates in mink kits were satisfactory for all diets. In conclusion, as much 29.9 % of formic acid preserved poultry by-products can be used for blue foxes and mink in the reproduction period.

*Proceedings from NJF - Seminar No.354. 5 pp, 2 tables, 4 refs. Authors' abstract.*

### **Individual feeding of fur animals by use of a computerized feeding machine**

*M. Sønderup*

The limiting factor to the number of mink per person is the amount of work on the farm during the suckling period in May and June. In the following a method of individual feeding of dams and litters is described and discussed. The method, among other things, makes it possible to reduce the time spent per female per litter on feeding, to optimise feeding, to do a systematic health control, and to conduct a systematic, phenotypic selection for both kit growth and for dams having an optimal lactation period. The latter describes dams that are able to maintain a good condition, while at the same time taking good care of their offspring and maintaining lactation until the kits are able to eat on their own at around six weeks of age.

An individual feeding method, where the registration of the need of feed is made by hand, has been practised on a practical farm for several years. This method requires a computer to control the feeding pump of the feeding machine. Because of focus on the advantages of the feeding method and its development, the method is used by more and more Danish farmers. The individual feeding of fur animals by use of a computerized feeding machine is based on the principles of this feeding method. The method is described in the paper "Individual feeding of mink in May and June – an alternative way of feeding mink" by Michael Sønderup, NJF-Seminar no.347 Vuokatti 2 – 4 October 2002. The new feeding system is developed by the producer of feeding machines, Tved Maskinbyg in co-operation with the National Department of Fur Animal Production. It has been tested on three mink farms during May and June this year.

The farmer use Copenhagen Fur Center's newly developed handheld scanner for the breeding program, CFC Avl, named the Farmpilot equipped with new software. A barcode of the scanner register the number of the animal or the number of the cage and the amount of feed is increased or decreased.

The system can be developed to be used the whole year round.

The scanner keeps the daily amount of feed delivered per cage and the data can be exported. It

means that we now have a cheap and simple method to collect feeding data per animal or per cage.

In the future it will be possible to establish a feeding bank based on individual feeding if enough farmers will use the system.

*Proceedings from NJF - Seminar No.354. 6 pp, 6 figs. Author's abstract.*

## **Development and economy**

### **Increasing effectiveness of field operations and regional development in fur farming and suggestions for developing the fur business in Finland**

#### **Fur farming expertise network project (TOSV), final report**

*M. Kerminen-Hakkio, P. Rämö, A. Alakylmänen, J. Matintalo*

A large development project, "The Fur Farming Expertise Network", was carried out in Finnish Ostrobothnia in 2002-2003. The project area consisted of 38 municipalities both in Finnish speaking and Swedish speaking districts. The project owner was Rural Academy of Central Ostrobothnia. The project was divided in two parts, the larger of which was financed within the Regional Rural Development Plan (Alma). The smaller project was financed within Northern Finland Objective 1-program. Estimated costs of the projects were respectively 956588,01 euros and 137280,54 euros. The project in the Alma area was carried out as planned. In the Objective 1 area only 80% of the planned extent was reached.

Public financing for the project was provided by European Union, the State of Finland and 38 municipalities. Private funding was provided by Pohjois-Suomen Turkuiläinten Kasvattajat ry., Svenska Österbottens Pälsdjursodlarförening rf., Finnish Fur Breeders Association and Finnish Fur Sales. Private funding was 15 % of the total cost estimate and it was fully achieved.

The Fur Farming Expertise Network consisted of five sub projects. These were expertise network,

education and counselling, new technology, better familiarity, and enhancing quality thinking. The project employed 10 people for over two years.

The target group for the project were fur farmers, 942 of whom participated in the project. This was substantially more than anticipated (730). 36 farmers received financial assistance from the state for taking over an existing farm. Nine totally new entrepreneurs started farming during the project. The number of fur farms decreased by 7,6%, which was less than anticipated. There were 1574 participants from 529 different farms on 95 courses. Students used totally 1553 days for their courses. According to the feedback from the participants we reached mark 8,4 (scale 4-10).

Individual enterprises were counselled on 765 days and group counselling was given on 757 days during the project. The "Better Familiarity" subproject gave classes in primary and secondary schools, which were attended by 5275 students and teachers in Swedish speaking schools and 4707 in Finnish speaking schools. 90 % of primary school teachers wished for the activities to continue.

The project has been extensively informed of. We informed over 200 people per month by mail and email of our activities. 1500 fur farmers were sent an educational bulletin and general information four times a year. Our project was mentioned in over 80 articles in newspapers and magazines. Our employees appeared twice in radio and TV programmes. We also developed fur farming leaflets and produced material for lessons in schools.

A development project is also a learning process. Fur farmers, special interest groups, partners and project staff have learned a lot in the course of the project. One result is adapting a project as a tool for development. Fur farmers have learned an active role in developing their businesses. Six new regional projects will be started by the end of 2003. The topics for the projects vary regionally.

Each subproject made a proposal for the arrangement of their further activities. These suggestions were presented in the final seminar of the project in Kokkola on 22nd September 2003. The Alma area project will be completed in September 2003 and the project in Objective 1 area in December 2003.

*Proceedings from NJF - Seminar No.354. 2 pp. Authors' abstract.*

*Proceedings from NJF - Seminar No.354. 1 pp. Authors' abstract.*

## **Health, physiology and pathology**

### **Physiology of weight regulation in the raccoon dog**

*P. Nieminen, A.-M. Mustonen, M. Puukka, J. Asikainen, S. Saarela, S.-L. Karonen, J.V.K. Kukkonen, H. Hyvärinen*

The raccoon dog (*Nyctereutes procyonoides*) is a middle-sized canid with profound autumnal fattening followed by winter sleep. This study investigated the effects of prolonged fasting-induced winter sleep on the fat and nitrogen metabolism of the species. Half of the animals were treated with continuous-release melatonin implants to induce artificial short photoperiod. Autumnal accumulation of fat was characterized by low plasma free fatty acid (FFA), diacylglycerol (DG) and triacylglycerol (TG) levels. After transition to winter catabolism, the circulating lipid levels increased due to enhanced lipolysis. Two months of fasting resulted in a steady 3.1 kg weight loss (28 % of body mass, 0.47 % d<sup>-1</sup>). Storage fat was mobilized during the winter sleep reflected by the elevated FFA and DG concentrations. The lowered insulin levels could stimulate TG hydrolysis. The plasma total amino acid concentrations, urea levels and urea-creatinine ratios decreased due to fasting, whereas ammonia and total protein concentrations remained stable. The plasma leptin and growth hormone (GH) concentrations were high and the ghrelin concentrations low in the winter but unaffected by fasting unlike in humans or rodents. Leptin, ghrelin and GH may contribute to effective lipolysis during winter sleep. Melatonin advanced the seasonal changes in the leptin, ghrelin and GH levels and in the voluntary energy intake. The results indicate that the raccoon dog is well adapted to long-term wintertime fasting and can maintain protein catabolism constant for at least 60 days. Decreased cortisol and thyroid hormone concentrations may contribute to protein sparing. Seasonal fasting could be used in fur farms by withdrawing food and providing the raccoon dogs with nestboxes.

### **Perinatal pup loss in the blue fox (*Alopex lagopus*) – review and historical data**

*G.H. Sanson, W. Farstad*

Perinatal pup loss in the blue fox is one of the greater challenges in modern blue fox breeding. Field studies in Norway indicate that up to 90% of the total loss may occur within the first week. And up to 60% within the first 3 days. Perinatal is usually defined as the period from 7 days before parturition till 7 days after. In most studies however, the number of pups lost is calculated till weaning. And even the loss during the period from birth till 42 days post partum may represent a great underestimate of the total loss.

Erratic management seems to be the major cause of pup loss in commercial blue fox breeding. Great effort should be made to standardize feeding procedures and care during the reproductive season.

*Proceedings from NJF - Seminar No. 354. 3 pp, 2 refs.*

## **Breeding, genetics and reproduction**

### **Selection for growth on normal and reduced protein diets: Direct and correlated responses**

*V. Hunnicke Nielsen*

Mice were selected for growth from 3-9 weeks of age on a diet with a normal protein content (19.3 %)(N) and a diet with a reduced protein content (5.1 %)(R). On each diet lines were selected for high and low growth and there were control lines. After 6 generations of selection - in generation 7 - all lines were tested on both diets (test diet TN and TR). Furthermore, feed consumption was measured on the normal protein diet. In generation 9, body composition was determined at 6, 9 and 12 weeks of age on both diets.

The results show genotype-environment interaction. For each direction of selection, the largest response on a test diet was obtained for the line selected on that diet. On the normal protein diet, food consumption and feed efficiency were positively correlated with gain in the lines. For body composition, lines with the largest gain had the largest fat and the lowest protein percent on both diets. In conclusion, growth on a normal and reduced protein diet has a rather different genetic basis, but there is no evidence that selection for high growth on a diet with a low protein content improves feed efficiency and body composition on a diet with a normal protein content.

*Proceedings from NJF - Seminar No. 354. 12 pp, 6 figs, 4 tables, 10 refs. Author's abstract.*

#### **Variation of fur felting in blue fox (*Alopex lagopus*)**

*L. Blomstedt, K. Smeds, O. Lohi*

In blue fox pelts the felting of fur is considered highly undesirable. The occurrence of the defect was followed in a blue fox population of a private fox farm in Finland in the years 2000-2002 by grading all blue fox cubs (3126) in November before pelting. No difference was found between the sexes but the defect was clearly more frequent in some families. Comparing the results between years showed a decline in the general average degree of the defect in the total blue fox stock of the farm during the three years. The preliminary estimations of heritability of the defect by VARCOMP procedure revealed a low to medium heritability ( $h^2=0.17-0.20$ ). The effect of sex was not significant.

Until now the grading of blue fox pelts in the auction house has not considered fur felting as a separate defect. It has only been taken into account as one of the many factors that decide the overall quality class of the pelt. So far available information of 2376 pelts revealed only a low correlation between grading live animals for fur felting before pelting (LG1) and pelt quality graded in the auction house ( $r = 0.10$ ,  $p < 0.0001$ ). No significant correlation was found between LG1 and pelt size.

*Proceedings from NJF - Seminar No. 354. 6 pp, 5 tables, 3 refs. Authors' abstract.*

#### **Genetic parameters for fertility traits and animal size of blue fox (*Alopex lagopus*)**

*J. Peura, I. Strandén, K. Smeds*

During the last decade skin size of blue fox has increased considerably in Finland. This may have led to decreased fertility through unfavourable genetic correlation. The average number of pups per mated females has slightly decreased after the mid-90's. The objective of this study was to estimate the genetic parameters of the first three litter sizes, female age at first insemination and animal size using REML with animal model. Heritability estimates were 0.08, 0.07 and 0.03 for first, second and third litter size, respectively. Heritability estimates for age at first insemination and animal size was 0.15 and 0.27, respectively. There was no noticeable genetic correlation between animal size and age at first insemination. The genetic correlation between animal size and first, second and third litter size were -0.33, -0.40 and 0.13, respectively. Genetic correlations between first and second litter size were 0.73, between first and third 0.56 and between second and third 0.82.

*Proceedings from NJF - Seminar No. 354. 6 pp, 4 tables, 8 refs. Authors' abstract.*

#### **Correlated responses in reproductive performance of blue foxes in a selection experiment for confident behaviour**

*H. Kenttämies, K. Smeds*

In a Finnish selection experiment for confident behaviour, correlated responses for reproduction performance was studied in blue foxes. The experiment was done in 1995 to 1998 on a private farm. The selection experiment was a part of a Nordic project "Selection for more confident farm foxes". Low estimates of heritability were found for the reproduction traits of blue foxes ( $h^2 = 0.08 \pm 0.04$  for whelping result,  $h^2 = 0.06 \pm 0.03$  for litter size, and  $h^2 = 0.07 \pm 0.05$  for whelping success). The

estimates for conception rate and cub mortality rate were very low. Within 3 years of selection for confidence as a cub, the selected females produced fairly large litters compared to the control animals. Based on correlated responses, the selected females gained 0.31 cubs in whelping result, 0.09 cubs in litter size and 2 % in whelping success. The corresponding figures for the control females were 0.08 and 0.001 cubs, and 1%. A tendency for an improved conception rate and an increased cub mortality rate was seen in the selection line, in contrast to the control line. (Co)variances for breeding values were estimated with REML and multitrait animal models using VCE4 and Pest programs. Besides confidence, the graded body size was included as a covariate in the estimation of each reproduction trait.

*Proceedings from NJF - Seminar No.354. 9 pp, 1 fig, 4 tables, 15 refs. Authors' abstract.*

### **Collaboration between mink farms improves response to selection**

*B. Krogh Hansen, P. Berg*

The objective of this project is to test alternative breeding strategies for rate of genetic gain in mink production. Presently each mink farm is a single population, and the main part of the breeding animals are selected from own stock. Genetic gain in small populations is lower relative to large populations. Collaboration between farms by exchanging breeding animals would increase the population size and result in improved genetic gain.

The project is carried out in two parts. In the first part a simulation-package is extended to simulate collaborating mink populations. In the second part models for collaboration between farms in a Breeder group are studied using the simulation programme with respect to genetic gain and rate of inbreeding. In this paper we present the different modules included in the simulation, the assumed genetic parameters of the traits involved and the basis for the economic value of the traits together with the scenarios studied.

*Proceedings from NJF - Seminar No. 354. 8 pp, 1 fig, 4 tables, 12 refs. Authors' abstract*

### **Time of birth can be postponed by selection in mink (*Mustela vison*) - Provisionally results**

*M. Fredberg, P. Berg, B. Krogh Hansen*

In autumn 2001, a selection experiment for changing time of birth in mink was carried out on the Danish Institute of Agricultural Sciences. Two selection lines were established. The first line consisted of animals born Early (23rd – 28th of April) – line E, and the second line consisted of animals born Late (2nd of May and later) – line L. Matings were started one week later in line L than in line E.

Both lines showed relatively high response to selection, especially in the first year. From the model fitted, a maternal genetic effect and a direct genetic effect of the kits were estimated. Heritabilities for maternal and direct genetic effects for time of birth were estimated to be 0.47 and 0.03 respectively, indicating that time of birth is a hereditary character. A negative genetic correlation (–0.58) was found between maternal effect and direct effect. Phenotypic differences in time of birth between the two lines were 3.1 days in 2002 and 4.6 days in 2003. Genetic differences in time of birth between the two lines were 1.7 days in 2002 and 2.2 days in 2003. In year 2003 the offspring were on average born the 28th of April in line E and the 3rd of May in line L. There were no significant differences in the litter sizes between the two selection lines. Litter sizes at birth were 6.9 for yearlings and 8.1 for 2-year old females in line E and 6.7 for yearlings and 8.2 for 2-year old females in line L. Line L had a shorter pregnancy compared with line E. Provisionally results from this study reveal that time of birth can be changed by selection.

*Proceedings from NJF - Seminar No. 354. 12 pp, 4 figs, 5 tables, 20 refs.*

## Posters

### Correlated responses in production traits in blue foxes (*Alopex Lagopus*) selected for confident behaviour

*N.V. Nordrum, U. Tutein Brenøe, K.R. Johannessen, M. Bakken.*

This study was a part of the Nordic project "Selection for more confident farm foxes". Earlier studies suggest that selection for increased confidence create a response. Correlations between confident behaviour and litter size (at birth and three weeks) approached zero, and slightly negative associations were found between confidence and the exterior traits (body size and pelt quality), however non-significant. Animals bred traditionally showed stronger response for the production traits compared to the animals bred for increased confidence, probably due to a more intense selection. This study compared two breeding goals, increased confidence versus traditional, on blue foxes during a four years selection experiment on seven private farms cooperating in a fox circle. Data comprised of 3791 cubs tested for confidence, 4086 live graded cubs, and 1388 mated females. (CO)variances were estimated in multitrait animal models using Vce4 and Pest programs.

*Proceedings from NJF - Seminar No.354. 5 pp, 1 fig, 2 tables, 13 refs. Authors' abstract.*

### Iceblue - a new colour mutant of fox (*Vulpes vulpes*)

*K.-R. Johannessen, O. Lohi*

The earlier described grey colour types of fox are all due to recessive mutant genes (Nes et al., 1988). In 1996 a new grey mutant was born in Oppdal, Norway. Investigation of 91 litters from crossings between the new mutant type and ordinary silver fox showed that 45% of the total of 381 cubs was grey coloured and 44% were silver fox coloured. In 11% of cases it was not possible with certainty to decide the genotype of the cub by its phenotype. In combinations with gold fox and different types of cross fox the colour of black hairs was changed to grey, the red coloured areas were brownish red as in Dakota gold, and the yellowish colour was often

bleached to creamy colour. The authors conclude that in this case the grey colour is due to a dominant autosomal gene. The large variation in colour and the 11% of undefined phenotypes indicate that other genes can modify the effect of this gene. Iceblue (in Scandinavian "Isblå") is suggested as the official name for this mutant. The relation to other existing mutants has not been investigated and therefore a gene symbol is not yet suggested.



*Proceedings from NJF - Seminar No. 354. 4 pp, 4 figs, 2 tables, 2 refs. Authors' abstract.*

### Fibre as a satiety factor in mink feed

*C. Hejlesen, P. Sandbøl*

Prior to a large-scale experiment on the research farm it was investigated if barley hulls and barley straws could prolong the time a mink spent eating a restricted quantity of energy. Three groups of 5 males each were fed either a control diet, a diet including barley hulls or a diet including chopped barley straw.

Inclusion of barley straw had an aversive effect. After a habituation period the inclusion of barley hulls prolonged the time the animals spent eating the restricted quantity of feed.

*Proceedings from NJF - Seminar No.354. 4 pp, 2 tables, 6 refs. Authors' abstract.*

### **Fibre in mink feed in the winter period**

*S.W. Hansen, T.N. Clausen, J. Malmkvist, B.M. Damgaard*

Three groups of female mink were fed a wet diet with different content of fibres. The energy supply was 220, 190 and 170 kcal/100g to group LF (low fibre), MF (med. fibre), and HF (high fibre), respectively. Each of the three groups received the same energy per mink per day, and consequently group HF received most grams of food per day. The three groups were fed the experimental feed from January 1 to February 24. The time spent without available food and the behaviour of the mink were observed. All the mink were weighed on January 2 and February 13, and 20 young females from each of the groups were weighed regularly through the experimental period.

The young females in group LF lost weight during the experiment, whereas the other groups increased or maintained their starting weight. The time spent without available food was 18 hours in group LF and 12-14 hours in groups MF and HF. About 30-40% percent of the old females performed stereotypies already before the start of the experiment, whereas less than 10% of the young females did. After two weeks on the experimental feed, the percentage of stereotyping young and old females in group LF increased, whereas the percentage of stereotyping animals in the two other groups remained unchanged. Immediately before the flushing period the percentage of stereotyping females was 40-50% for all groups and there was no difference between young and old females. On April 1, when all mink were fed ad libitum, the level of stereotyping young females was back to normal (less than 10%) and also the number of stereotyping old females was reduced.

There was no significant difference between groups in number of live kits per fertile female or number of kits at 40 days of age. However there was an insignificant tendency to fewer barren young females in group LF compared to group MF and HF.

It was concluded, that high fibre feed reduced the time spent without available food and the occurrence of stereotypies in mink. However, feeding mink high fibre feed during the winter period had no negative effect on the number of kits per fertile female.

*Proceedings from NJF - Seminar No. 354. 10 pp, 8 refs. Authors' abstract.*

### **Amino acid profiles in the furring period of mink (*Mustela vison*)**

*P. Sandbøl, T. Clausen, C. Hejlesen*

The optimal amino acid profile of an ideal protein changes with the demand for different manifestations of life (gain, maintenance, reproduction and lactation). Whole body amino acid profiles have been shown to be a good basis for the determination of the amino acid profile of the ideal protein. An attempt was made to produce three feeds for the furring period of mink (*Mustela vison*) based on the amino acid profiles of the present norm for mink (N), cat (C) and the whole body composition of mink (M). This resulted in 3 different amino acids profiles, though not quite as intended.

The feeds were fed to 3 groups of 50 full sibling male mink kits each (wild colourtype), during the furring period. The profiles M and C gave significantly better ( $p=0.005$ ) live weight gain (626 g and 660 g) from September to pelting as compare to the profile N (544 g) and significantly ( $p=0.02$ ) longer pelts (M, 87.5 cm; C, 87.3 cm) as compared to N (86.3 cm). There was no significant differences with regards to fur quality, colour, silkiness or wool quality. Group M had significantly ( $p=0.003$ ) less red furs.

The results indicated that an amino acid profile different from the present norm may give equal or better performance results. Further, that the requirement for methionine per se in the furring period is not above 0.31 g digestible/MJ and that 22 % of the metabolizable energy from protein could be sufficient in the furring period.

*Proceedings from NJF - Seminar No.354. 5 pp, 5 tables, 9 refs. Authors' abstract.*

### **Methionine and methyl donors for mink (*Mustela vison*) in the furring period**

*P. Sandbøl, T.N. Clausen, C. Hejlesen*

The sulphur containing amino acids methionine and cystine have been established as first limiting in typical Scandinavian mink feed. The possible use of methionine as a methyl donor has not been investigated in mink.

A preliminary trial was set up to clarify the consequences of substituting a 20 % methionine deficit - as compared to the norm - with either dl-methionine, Methionine Hydroxy Analog or Betaine.

It is concluded, that substituting 20 % of the methionine (included as dl-methionine and only l-methionine given nutritional value) with either MHA or Betaine had no negative consequences for the live weight gain from September to pelting nor for the pelt length. There was an improved quality when substituting the dl-methionine with Betaine. The group receiving Betaine had longer pelts (NS) and a better quality ( $p=0.0007$ ) than the group receiving dl-methionine. This indicates that the requirement for methionine per se in the furring period, is fulfilled at 0.31 g of digestible methionine/MJ. The results further indicate that a balance of 60:40 between methionine and cystine should be sufficient.

*Proceedings from NJF - Seminar No.354. 6 pp, 3 tables, 19 refs. Authors' abstract.*

### **Digestibility of different sources of starch**

*C. Hejlesen, P. Sandbøl*

The increasing environmental restrictions can make it necessary to reduce the dietary protein content. Hence, the focus on carbohydrates increases. In an experiment we focused on the glycemic index and starch digestibility in 7 different starch sources. We were not successful in determining the glycemic index, and the method used for analysis of starch content was insufficiently accurate.

Among the tested starch sources, different digestibility of crude carbohydrate was measured.

But it is not revealed whether this was caused by processing and storage or different contents of NSP or amylose and amylopectine composition of the starches.

*Proceedings from NJF - Seminar No.354. 4 pp, 3 tables, 4 refs. Authors' abstract.*

### **Influence of low protein level and supplementary methionine on growth performance and fur quality of blue fox. A field trial**

*N. Nenonen, T. Dahlman, I. Pöölönen, J. Valaja, L. Blomstedt, T. Rekilä*

*Proceedings from NJF - Seminar No.354. 10 pp, 3 figs, 7 tables, 5 refs. In Swedish.*

### **Physiology of weight regulation in the raccoon dog**

*P. Nieminen, A.-M. Mustonen, M. Kuukka, J. Asikainen, S. Saarela, S.-L. Karonen, J.V.K. Kukkonen, H. Hyvärinen*

The raccoon dog (*Nyctereutes procyonoides*) is a middle-sized canid with profound autumnal fattening followed by winter sleep. This study investigated the effects of prolonged fasting-induced winter sleep on the fat and nitrogen metabolism of the species. Half of the animals were treated with continuous-release metatonin implants to induce artificial short photoperiod. Autumnal accumulation of fat was characterized by low plasma free fatty acid (FFA), diacylglycerol (DG) and triacylglycerol (TG) levels. After transition to winter catabolism, the circulating lipid levels increased due to enhanced lipolysis. Two months of fasting resulted in a steady 3.1 kg weight loss (28% of body mass,  $0.47 \% d^{-1}$ ). Storage fat was mobilized during the winter sleep reflected by the elevated FFA and DG concentrations. The lowered insulin levels could stimulate TG hydrolysis. The plasma total amino acid concentrations, urea levels and urea-creatinine ratios decreased due to fasting, whereas ammonia and total protein concentrations remained stable. The plasma leptin and growth hormone (GH) concentrations were high and the ghrelin concentrations low in the winter but unaffected by

fasting unlike in humans or rodents. Leptin, ghrelin and GH may contribute to effective lipolysis during winter sleep. Melatonin advanced the seasonal changes in the leptin, ghrelin and GH levels and in the voluntary energy intake. The results indicate that the raccoon dog is well adapted to long-term wintertime fasting and can maintain protein catabolism constant for at least 60 days. Decreased cortisol and thyroid hormone concentrations may contribute to protein sparing. Seasonal fasting could be used in fur farms by withdrawing food and providing the raccoon dogs with nestboxes.

*Proceedings from NJF - Seminar No.354. 1 pp. Authors' abstract.*

#### **Seasonal reproductive endocrine profile of the raccoon dog (*Nyctereutes procyonoides*); Effects of melatonin and food deprivation**

*J. Asikainen, A.-M. Mustonen, H. Hyvärinen, P. Nieminen*

The raccoon dog (*Nyctereutes procyonoides*, Canidae, Carnivora) is a middle-sized omnivore with excessive autumnal fattening and winter sleep. We studied adaptation of the species to boreal climate and photoperiod by following the plasma reproductive and thyroid hormone concentrations of farm-bred raccoon dogs (n=32) for 12 months. On August 16, 2000, and February 8, 2001, half of the raccoon dogs received continuous-release melatonin implants (the MEL group). The other half was sham-operated (the SHAM group). Between November 27, 2000, and January 25, 2001, half of the animals of both groups were fasted. The plasma testosterone concentrations of the MEL males peaked in February, a month earlier than in the SHAM males. Autumnal melatonin treatment also advanced the gestation period reflected by the plasma progesterone concentrations by seven weeks. Food deprivation in winter seems to accentuate the sex steroid response during the mating season as the fasted males had higher testosterone concentrations than the fed males in February and March. In the case of the thyroid axis (T3, T4), the species is able to respond quite rapidly to changes in its milieu.

*Proceedings from NJF - Seminar No.354. 1 pp. Authors' abstract.*

#### **Dietary phytosterol supplement and mink reproduction**

*A. Ryökkynen, P. Nieminen, A.-M. Mustonen, T. Pyykönen, S. Hänninen, J. Asikainen, J. Mononen, J.V.K. Kukkonen*

Phytosterols (PS) and phytoestrogens are plant-derived compounds used extensively in humans to lower serum cholesterol levels. They are also present in soy products and thus in diverse animal feeds. The study investigated the effects of  $\beta$ -sitosterol, a PS at 50 mg/kg/d, and genistein, a soy isoflavone at 8 mg/kg/d, on the reproduction of mink (*Mustela vison*) during a two-generation exposure. 60 juvenile minks were randomly assigned either into the control group or into the phytoestrogen groups and given the compounds mixed into their regular feed between Aug 2002 and June 2003. The plasma testosterone levels of the adult male minks increased in both exposure groups compared to the control group when measured before mating. The semen analyses revealed no specific effects of either substance. The litter size was significantly increased due to sitosterol supplement, but there were no effects on kit survival or health. The female minks of the PS and genistein groups were significantly heavier immediately after giving birth than the control females. The relative testicular and prostate masses were higher in the PS kits compared to the control kits at the age of 21 d, while the uterine weights of the female kits were reduced. The observed effects could be potentially deleterious in nature, but on fur farms the observed increase in litter size could be of economical benefit.

*Proceedings from NJF - Seminar No.354. 1 pp. Authors' abstract.*

#### **The blue fox (*Alopex Lagopus*) as a model of canid starvation**

*A.-M. Mustonen, T. Pyykönen, J. Asikainen, S. Hänninen, J. Mononen, P. Nieminen*

The aim of the study was to record the endocrine response to fasting in the blue fox (*Alopex lagopus*) during long-term, periodic wintertime food deprivation by following the circulating levels of numerous weight-regulatory hormones and blood metabolites. Sixteen blue foxes were fed throughout

the year and thirty-two blue foxes were fasted for three wks in Nov-Dec 2002. Half of these fasted blue foxes were food-deprived again for three wks in Jan-Feb 2003 after a recovery period of four wks. Both three-wk fasts caused a 20.5 % reduction to the body masses of the blue foxes (0.95 % d<sup>-1</sup>). Fasting increased the blood haemoglobin (Hb), triacylglycerol (TG), glycerol, bilirubin, growth hormone (GH), ghrelin and glucagon concentrations and the activities of alkaline phosphatase (AP) but decreased the levels of glucose, total cholesterol (Chol), low density lipoprotein-Chol, high density lipoprotein-Chol, total protein, urea, ammonia, uric acid, insulin, cortisol, triiodothyronine and thyroxine. Also the body temperatures of the blue foxes decreased by fasting but their locomotor activity was not affected.

The rate of weight loss of the fasting blue foxes was slower than observed previously in wild arctic foxes, probably resulting from the higher body fat content of the farm-bred animals. The fasting-induced rises in the blood TG and glycerol levels indicate stimulated hydrolysis of subcutaneous and retroperitoneal white adipose tissue providing the major metabolic fuel during fasting. GH seems to be the main lipolytic hormone responsible for efficient fat mobilization. After the rapid degradation of the tissue glycogen stores during the first 48 hrs of fasting the dependence on hepatic and renal gluconeogenesis caused hypoglycaemia. The decreases in the blood Chol levels may have resulted from suppressed Chol absorption or decreased hepatic Chol synthesis. The observed rise in the blood Hb levels may have resulted from hemoconcentration.

The documented decreases in the parameters of nitrogen metabolism indicate a limited rate of proteolysis. Suppression of the activity of the thyroid gland may have enabled protein conservation. The rise in the blood bilirubin levels after three wks of fasting was not caused by stimulated degradation of erythrocytes. It may have resulted from fasting-induced transient liver damage supported by the increased AP activities. For this reason only wintertime fasts extending 1-7 days can be safely recommended for farmed blue foxes.

*Proceedings from NJF - Seminar No.354. 1 pp. Authors' abstract.*

### **Faecal steroid hormone profiles and ovarian activity in farmed blue fox (*Alopex lagopus*) females during late pregnancy, parturition and the onset of lactation**

*G. Sanson, J.L. Brown, W. Farstad*

The serum profiles of reproductive hormones in farmed blue foxes in oestrus and during gestation have been well characterized. Blood sampling is labour intensive, invasive and requires restraint of the animals; thus it usually cannot be done daily. Alternatively, faecal sampling is non-invasive and does not cause any stress to the animals, allowing animals to be evaluated frequently over long periods of time.

The purpose of the study was to validate a non-invasive method to monitor hormone concentrations during pregnancy in the blue fox.

Faecal steroid hormone profiles for oestrogen and progesterone metabolites showed similar patterns to those obtained by analyses of fox sera. Thus, faecal steroid analysis can be used to non-invasively monitor steroid hormone concentrations during pregnancy in farmed blue fox females.

*Proceedings from NJF - Seminar No.354. 1 pp.*

### **Growth and development of mink as a function of different plant or fish oils included in mink feed in the gestation and nursing period**

*C. Bjerregaard, T.N. Clausen, T.M. Lassen, K. Mortensen, H. Sørensen, J.C. Sørensen, S. Sørensen*

Lipids of plant origin, soybean oil, sunflower oil, two different types of rapeseed oil, and two different types of commercial available fish oils have been analysed and used in mink feed during the gestation and nursing period. Supercritical Fluid Techniques (SFT) have been used for extraction (SFE) of lipophilic lipids as triacylglycerols (TAGs) and addition of ethanol as modifier to the SFE allowed extraction of amphiphilic lipids. SFTs used for chromatographic analyses (SFC, EFLC-ELSD) of intact TAGs were supplemented with GLC, MECC and spectroscopy investigations of fatty acids (FA) lipid soluble vitamins, phenolics/antioxidants and other amphiphilic lipids. Appreciable differences

were found with respect to the composition of the lipids/oils; for both of the fish oils a considerable amount of the TAGs was degraded, but to a different degree, and the two types of rapeseed oils differed especially with respect to their content of natural antioxidants as carotenoids and phenolics. One of the rapeseed oils produced by traditional oil mill techniques had thus an insignificant carotenoid content as also found for the soybean and sunflower oils, both produced by traditional oil mill techniques.

During the gestation and nursing period, female mink and mink kits were fed with diets differing only with respect to the lipid types. The lipid and FA composition of the feed, the milk and body fat of the kits were determined. Growth and development of the mink were different for those fed the different lipid types, and the results thus obtained have been discussed with focus on essential FA and opportunities for production of mink feed containing the expected need for long chain polyunsaturated fatty acids (LCPUFA).

*Proceedings from NJF - Seminar No.354. 17 pp, 11 figs, 3 tables, 20 refs. Authors' abstract.*

### **Supercritical fluid techniques as preparative- and analytical tools in the "analytical grey area" between volatiles and hydrophilic compounds**

*C. Bjerregaard, S. Buskov, H. Sørensen, J.C. Sørensen, S. Sørensen*

Supercritical fluid techniques (SFT) comprising supercritical fluid extraction (SFE) and supercritical fluid chromatography (SFC) have proved efficient in the isolation and analysis of lipophilic-amphiphilic compounds as: intact triacylglycerols, chlorophylls, carotenoids, phenolics and other oil constituents. This paper includes an example of SFC separation of intact triacylglycerols from various plant materials.

#### **Supercritical Fluids**

Supercritical fluid techniques use high density gases/fluids, which are formed when the pressure and temperature of the gas are higher than the critical point.

SFE and SFC mainly employ a mixture of a compressed gas, like CO<sub>2</sub>, and a modifier, like alcohols, as the solvent / mobile phase, of which the modifier acts to enhance the solvent strength of the fluid. Some of the advantages of the supercritical fluids are the lower viscosity and higher diffusivity and selectivity compared to liquids in addition to gentle working conditions.

#### **Experimental**

SFE was performed using a Spe-ed SFE (Applied Separations, Allentown, PA). Grounded seeds were extracted at 75 °C and 60 MPa using pure carbon dioxide (99.7%). The total extraction time was 20 to 30 min. (Buskov et al. 1997). Before qualitative analysis by SFC, the oils were diluted in hexane to a concentration of approximately 3 mg/mL. The analyses were performed on a standard Gilson SF3 Supercritical Fluid Chromatography system. Separation conditions were as follows: Flow rate: 1.5 mL/min; Mobile phase: 96% carbon dioxide (99.998%) and 4 vol% (3.4 mol%) acetonitrile; column outlet pressure: 30 MPa; column temperature: 40 °C. The separation column was a Spherisorb S3 ODS2 (150 x 4.6 mm, 3µm particles) and UV detection was performed at 205 nm (Buskov et al. 1999).

#### **Triacylglycerols**

The dominating triacylglycerols in high erucic acid rape seed and *Brassica campestris* are O-O-E, O-E-E and E-E-E, (O = 18:1; E = 22:1) whereas the soy bean oil are dominated by triacylglycerols acids, like L-L-L, L-L-Ln, P-L-L and O-L-L (P = 16:0, L = 18:2, Ln = 18:3). Double low rape seed oil contains triacylglycerols as: O-L-Ln, O-L-L, O-O-Ln, O-O-L and O-O-O. Identification of the individual triacylglycerols can be done using preparative SFC combined with GLC for fatty acid analysis (Bjerregaard et al. 2000)

*Proceedings from NJF - Seminar No.354. 3 refs. Authors' abstract.*

### **Starch for mink. Development of analytical methods for characterisation different types of starch**

*K.E. Andersen, C. Bjerregaard, H. Sørensen, J.C. Sørensen, S. Sørensen*

Recent years feeding trials with mink, using relatively high levels of various carbohydrate sources as energy, have revealed variations with respect to performance of mink, depending on the specific carbohydrate source fed (Clausen & Hejlesen, 1999; Hejlesen & Clausen, 2001, 2002; Clausen et al. 2003). Minks, having a relatively short digestive tract, may thus be especially sensitive to variations affecting the effectiveness of utilization of the carbohydrate fraction added to the feed.

Polysaccharides (starch and dietary fibres; DF) are important feed constituents, both from a qualitatively and quantitatively point of view. The properties of both DF and starch are found to vary very much depending on their source; type of plants, plant parts, various micro organisms as well as processing used for production of the matrix systems containing these polysaccharides. The variation in physico-chemical and nutritional properties of different types of starch, when used to mink and other monogastric animals, especially seems to depend on the relative amounts and types of amyloses and amylopectins (high degree of branching) (Noda et al., 1997; Petterson & Lindberg, 1997; Frigård et al., 2002). The properties of starch and DF are thus defined both by their content of  $\beta$ -glycans and of DF associated constituents which comprise lipids, proteins and various types of allelochemicals and xenobiotics.

Methods for characterisation of the carbohydrate fraction are crucial for interpretation of results obtained in feeding trials with various carbohydrate sources. The present study has comprised development of methods based on colorimetry, enzymatic and liquid chromatographic (LC) techniques useable to reveal the structures of different types of carbohydrates, especially starch. The proportion of amylose/amylopectin was determined by use of a colorimetric method, based on potassium iodide, the results showing marked differences in colour response, depending on specific carbohydrate source. Further structural characterisation was based on enzymatic techniques

using isoamylase and a thermostable amylase (Termamyl), found to be efficient with respect to catalysis of starch hydrolysis. Termamyl is also an important enzyme used for preparation of DF. As starch is only partly hydrolysed to glucose by the Termamyl treatment, a complex mixture of oligosaccharides is produced. Mixtures of both non-reducing and reducing oligosaccharides was analysed for the individual components by micellar electrokinetic capillary chromatography (MECC) (Andersen et al., 2003a,b). For further structural determinations, LC-MS and NMR method have been applied.

*Proceedings from NJF - Seminar No.354. 9 refs. Authors' abstract.*

**Meeting at the Danish Institute of Agricultural Sciences, Research Centre Foulum,  
on 24 September 2003 on the subject**

**'Fur animal production – behaviour, health, breeding, and nutrition'**

*Internal Report 2003, no. 185 (in Danish)*

The meeting hosted 8 presentations of which some were also presented at the NJF Seminar in Lillehammer, 8 – 10 October 2003 (cf. above). The presentations hosted were as follows:

**Fear in farm mink – causality and welfare implications**

*J. Malmkvist, S.W. Hansen*

In recent years, several studies have focused on fear in animal husbandry, including the farm mink production. The main reasons for focussing on this emotional state are the potential negative impact fear may have on (i) handling, (ii) reproduction, and (iii) welfare. No systematic investigations of correlations between fear and handling in mink have been performed, but a number of results show possible effects of fearfulness on reproduction and mink welfare. We have proven that it is possible to reduce the number of fearful mink over generations by behavioural selection, using a simple stick test (1987-2002). The stick test has been validated experimentally as well as on farms. In contrast to e.g. early handling, the stick test selection is an effective tool to reduce the general fearfulness towards a whole range of stimuli. Besides changing the fear related behaviour, experiments have demonstrated that behavioural selection also has an impact on several physiological measures related to stress, and that the neurotransmitter serotonin may be involved in the regulation of fear in mink. At present, not much is known about the effects of the pre- and post-natal maternal environment on the development of fear in adult mink; preliminary results from on-going experiments into these matters were presented.

*Meeting at DIAS, Research Centre Foulum, 24 September 2003 on the subject 'Fur animal production – behaviour, health, breeding, and nutrition.' Internal Report 2003, no. 185 (in Danish). 11 pp, 2 figs, 1 table, 27 refs. Authors' abstract.*

**Minks' motivation for access to swimming water and running wheel**

*S.W. Hansen, M.B. Jensen*

Cf. above (NJF Seminar No. 354).

*Meeting at DIAS, Research Centre Foulum, 24 September 2003 on the subject 'Fur animal production – behaviour, health, breeding, and nutrition.' Internal Report 2003, no. 185 (in Danish). 12 pp, 9 figs, 17 refs. Authors' abstract.*

**Expert opinion on information value in welfare assessment reports for mink farms**

*S.H. Møller*

Cf. above (NJF Seminar No. 354).

*Meeting at DIAS, Research Centre Foulum, 24 September 2003 on the subject 'Fur animal production – behaviour, health, breeding, and nutrition.' Internal Report 2003, no. 185 (in Danish). 10 pp, 9 figs, 1 table. Author's abstract.*

### **In vitro methods for determination of digestibility of feedstuffs and feed in mink - prospects and limitations**

*H.N. Laerke, S. Boisen, C. Hejlesen*

In a joint project between Danish Fur Breeders Research Center (DFBRC) and the Danish Institute of Agricultural Sciences (DIAS) an in vitro method for determination of the content of digestible protein in feedstuffs and mixed feeds has been developed.

The method simulates digestion processes in the gut by the use of commercially available enzyme preparations and correction for the content of ash and crude protein. For most conventional feedstuffs and for all tested mixed feeds there is a good agreement between the in vitro determined and in vivo determined values. The method is suitable for determining variation within different types of feedstuffs. For practical purposes the method can be used for optimisation of stable and dry feedstuffs. For all types of feedstuffs and mixed feeds the method can – with a few exceptions – be used for quality control of nutritional value.

A similar method for determination of digestible carbohydrates is also being developed. When thoroughly tested, this method can be used to analyse the content of digestible carbohydrate in feedstuffs including the effect of processing on digestibility.

In combination, the in vitro methods for determination of digestible protein and carbohydrate together with table values of digestible fat, can then be used to estimate the content of metabolisable energy.

*Meeting at DIAS, Research Centre Foulum, 24 September 2003 on the subject 'Fur animal production – behaviour, health, breeding, and nutrition.' Internal Report 2003, no. 185 (in Danish). 9 pp, 2 figs, 8 refs. Authors' abstract.*

### **Mink distemper**

*H.H. Dietz, A.S. Hammer, Ths. Holmen Andersen*

*Meeting at DIAS, Research Centre Foulum, 24 September 2003 on the subject 'Fur animal production – behaviour, health, breeding, and nutrition.' Internal Report 2003, no. 185 (in Danish). 4 pp, 1 table.*

### **Selection for growth on normal and reduced protein diets: Direct and correlated responses**

*V. Hunnicke Nielsen*

Cf. above (NJF Seminar No. 354).

*Meeting at DIAS, Research Centre Foulum, 24 September 2003 on the subject 'Fur animal production – behaviour, health, breeding, and nutrition.' Internal Report 2003, no. 185 (in Danish). 12 pp, 6 figs, 4 tables, 9 refs. Author's abstract.*

### **Time of birth can be postponed by selection in mink (*Mustela vison*) - Provisionally results**

*M. Fredberg, P. Berg, B. Krogh Hansen*

Cf. above (NJF Seminar No. 354).

*Meeting at DIAS, Research Centre Foulum, 24 September 2003 on the subject 'Fur animal production – behaviour, health, breeding, and nutrition.' Internal Report 2003, no. 185 (in Danish). 10 pp, 2 figs, 5 tables, 15 refs. Authors' abstract.*

**Collaboration between mink farms improves response to selection**

*B. Krogh Hansen, P. Berg*

Cf. above (NJF Seminar No. 354).

*Meeting at DIAS, Research Centre Foulum, 24 September 2003 on the subject 'Fur animal production – behaviour, health, breeding, and nutrition.' Internal Report 2003, no. 185 (in Danish). 10 pp, 1 fig, 4 tables, 12 refs. Authors' abstract.*

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Kotieläinryitsemus – Animal Nutrition



**Protein and Amino Acids in the Nutrition of  
the Growing-Furring Blue Fox**

Tiina Dahlman

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This thesis evaluates the protein and amino acid requirements of the modern growing-furring blue fox (*Alopex lagopus*). The effects of dietary protein and the supplemented amino acids, methionine and lysine, on nitrogen (N) retention, nutrient digestibility, growth performance, health, and fur characteristics were estimated in digestibility and N balance trials and production experiments. As well as visual grading of the skin, objective physical determinations of the leather were conducted to provide a complete picture of both the fur and the leather properties. In addition, the ideal pattern and the limiting order of some essential amino acids were determined.

An insufficient dietary content of methionine impaired the digestibility of the diet. Supplementing low-protein diets with methionine may therefore increase the metabolisable energy (ME) value of the diet. The DL-form of methionine was effectively utilized by the growing-furring blue fox. In this respect, blue foxes, like dogs, differ from mink. A level of 21-22% protein of ME with 0.40 g DigMet (digestible methionine)/MJ ME (0.50 g of digestible methionine and cystine, SAA) was found to satisfy the requirement for growth, normal hair priming and production of high-quality skins with firm and elastic leather. Even 15-16% protein of ME (with 0.40 g DigMet/MJ ME) may be adequate for the blue fox during the later phases of the growing-furring period. Methionine supplementation improved guard hair quality. The effects of lysine supplementation in low-protein diets, 15% or 22% protein of ME, were inconsistent. At 15% protein of ME, and about 0.60 g digestible lysine/MJ ME, supplementation of lysine did not improve performance of the growing-furring blue fox.

The dietary deletion of SAA in the N balance trial resulted in severe responses of young blue foxes, exceeding those to the deletion of any other amino acid (lysine, threonine, histidine, tryptophan (not necessarily in that order) and, finally, lysine.

The ideal pattern of amino acids was: lysine = 100, SAA 77, threonine 64, histidine 55, and tryptophan 22. As this pattern is based on measurements conducted on young weaned blue foxes, the relative SAA requirement of blue foxes is likely to be higher later in the growing-furring period (from September onwards) due to the development of winter fur.

Neither disturbances in clinical health nor mortality related to experimental diets were found. At the lowest level, 15% protein of ME, the relative weight of liver was increased. This could be prevented by methionine supplementation up to 0.40 g DigMet/MJ ME. The blue fox seems able to adapt to changes in dietary protein and amino acid supply to a greater extent than mink, which is a strict carnivore. Blue foxes use protein primarily for tissue synthesis, not as an energy source. Nitrogen excretion can be declined by 2-3 g per blue fox per day by reducing the dietary protein level from about 25-30% to 22% of ME. The practical application of low-protein diets, with supplemental methionine when required, is recommended. This would be beneficial in terms of reduced feed expenses and lower N emissions to the environment, without compromising the welfare and performance of the growing-furring blue fox.

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