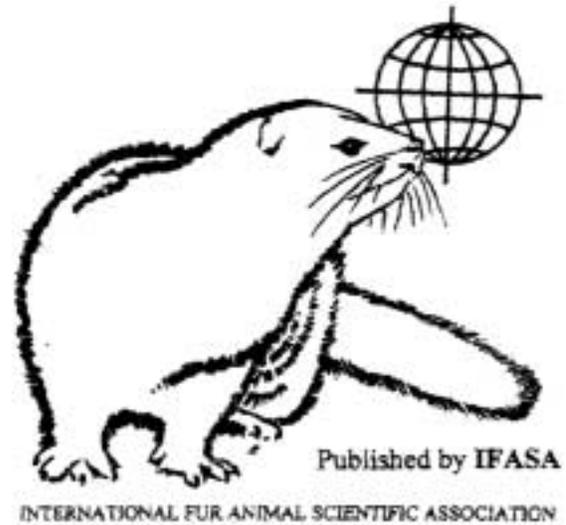


**SCIENTIFUR**  
**ISSN 0105-2403**  
**Vol. 25, No. 1**  
**August, 2001**



<b>1.</b>	<b>Contents</b>	<b>1</b>
<b>2.</b>	<b>Notes</b>	<b>3</b>
	<b>The Teething Troubles of the New Group of Editors</b>	3
	<b>Obituary, Mikko Harri</b>	4
	<b>Catalogue of Nordic Research Projects on Fur Animals</b>	5
<b>3.</b>	<b>Multidisciplinary</b>	<b>7</b>
	<b>Fur Farming in Russia: the Current Situation and the Prospects.</b> <i>N.A. Balakirev, E.A. Tinaeva, Original Report</i>	7
	<b>Inhibition of Transient LES Relaxations and Reflux In ferrets by GABA Receptor Agonists.</b> L. Ashley Blackshaw, E. Staunton, A. Lehmann, J. Dent	10
<b>4.</b>	<b>Nutrition &amp; Nutritional Physiology</b>	<b>11</b>
	<b>Our Experience in Spirulina Feeding to Minks in the Reproduction Period.</b> <i>V. Beresto, Original Report</i>	11
	<b>Physiological Changes in Mink (<i>Mustela Vison</i>) Dams Subjected to Weaning at Different Times during Lactation.</b> <i>B. Sørensen, T.N. Clausen, S. Wamberg, O. Hansen</i>	16

	<b>Connection between Levels of Vitamin A, E and Activity of Erythrocyte Super-Oxidizedismutase in Farm-Bred Mink and Polar Fox.</b> <i>V.A. Ilukha, T.N. Ilyina, T.R. Ruokalainen</i>	16
	<b>Indices of Thiamine Metabolism in Mink Blood in Pregnancy Period.</b> <i>T.N. Ilyina</i>	16
<b>5.</b>	<b>Ethology, incl. Animal Welfare, Management &amp; Production</b>	<b>17</b>
	<b>Swimming Activity of Farm Mink (<i>Mustela Vison</i>) and its Relation to Stereotypies.</b> <i>C.P. Bjælke Hansen, L. Lau Jeppesen</i>	17
	<b>Effects of Family Housing on Behaviour, Plasma, Cortisol and Performance in Adult Female Mink (<i>Mustela Vison</i>).</b> <i>V. Pedersen, L. Lau Jeppesen</i>	17
	<b>Use of Water for Swimming and its Relationship to Temperature and Other Factors in Farm Mink (<i>Mustela Vison</i>).</b> <i>C.P. Bjælke Hansen, L. Lau Jeppesen</i>	17
	<b>Effects of Space Allowance and Earthen Floor on Welfare-Related Physiological and Behavioural Responses in Male Blue Foxes.</b> <i>H. Korhonen, P. Niemelä, L. Jauhiainen, T. Tupasela</i>	18
	<b>Extent of Digging and its Possible Underlying Causal Factors in Pinned Blue Foxes</b> <i>H. Korhonen, P. Niemelä, I. Wikman</i>	18
	<b>Physiological and Behavioural Responses in Blue Foxes (<i>Alopex lagopus</i>) Comparisons between Space Quantity and Floor Material.</b> <i>H. Korhonen, L. Jauhiainen, P. Niemelä, M. Marri, R. Sauna-aho</i>	19
	<b>Determination of the Aversion of Farmed mink (<i>Mustela vison</i>) to Carbon Dioxide.</b> <i>J. Cooper, G. Mason, M. Raj</i>	19
<b>6.</b>	<b>Pathology &amp; Diseases</b>	<b>20</b>
	<b>Increasing Costs of Access to Resources Cause Rescheduling of Behaviour in American Mink (<i>Mustela vison</i>): Implications for the Assessment of Behavioural Priorities.</b> <i>J.J. Cooper, G.J. Mason</i>	20
	<b>Feeding Growing Mink (<i>Mustela vision</i>) PCB Aroclor<sup>®</sup> 1254 Does not Affect Baculum (Os-penis) Development.</b> <i>R.J. Aulerich, S.J. Bursian, A.C. Napolitano, T. Oleas</i>	20
	<b>Proliferation of Periodontal Squamous Epithelium in Mink Fed 2,3,7,8-Tetrachlorodibenzo-p-Dioxin (TCDD).</b> <i>J.A. Render, J.R. Hochstein, R.J. Aulerich, S.J. Bursian</i>	21
	<b>Proliferation of Maxillary and Mandibular Periodontal Squamous Cells in Mink Fed 3,3', 4,4', 5-pentachlorobiphenyl (PCB 126).</b> <i>J.A. Render, R.J. Aulerich, S.J. Bursian, R.F. Nachreiner</i>	21
	<b>Studies on Influenza Viruses H10N4 and H10N7 of Avian Origin in Mink.</b> <i>L. Englund</i>	21
<b>7.</b>	<b>New Books</b>	<b>22</b>

## The Teething Troubles of the New Group of Editors

The year 2000 was the year of the VII International Scientific Congress in Fur Animal Production. The Congress was held in Kastoria in Greece, 13 – 15 September 2000. The proceedings from the Congress were published in *Scientifur*, 2000, Vol. 4, No. 4., and are also available at the IFASA web-site (<http://www.ifasanet.org>).

On the initiative of Gunnar Jørgensen, the first issue of *Scientifur* appeared in 1976. For nearly 25 years, Gunnar Jørgensen was the editor of *Scientifur* until he decided to withdraw after the publishing of Vol. 24, No. 3, in August, 2000. We wish to thank him very much for his contribution to the success of *Scientifur*.

After his withdrawal, it has been impossible to find a person able to take over the job as editor of *Scientifur*. Therefore, a group of editors has been appointed. The group consists of Gorm Sanson from Norway, Outi Lohi from Denmark, and Birthe Damgaard from Denmark.

The Board of IFASA has decided that in 2001, *Scientifur* is to be published as a printed as well as an

electronic version. There are to be four electronic issues of *Scientifur* a year, and these issues are also to be published as two paper issues. Three issues will contain short communications, abstracts, letters, book reviews etc. The fourth issue entitled "Fur Animal Science" is to contain only reviewed articles. We hope that our readers will approve of these changes.

The group of editors very much regrets that the publishing of *Scientifur* has been delayed in 2001. The delay is due to 'teething troubles' as all the people involved in the publishing of the periodical are new and have much to learn. The fact that the editors have been preoccupied has also caused delay.

We hope for your understanding, and assure you that, in the future, we will do our best to make sure that *Scientifur* will be published without any delays.

On behalf of the  
Group of Editors

Birthe Damgaard

## Obituary

### Mikko Harri

Pioneer within research in the behaviour and welfare of fur animals in Finland, Professor Mikko Harri, has passed away. Mikko Harri who has for almost twenty years worked as professor of zoology at the University of Kuopio died on January 27, 2001 at the age of 58 after a short period of illness. Mikko Harri was born on March 27, 1942 in Seinäjoki.

Mikko Harri took his M.A. degree in philosophy in 1967 at Turun Yliopisto where he also passed his doctor's degree in 1974. In the same year he was appointed reader in animal physiology at the universities of Åbo and Kuopio. In 1974 he was appointed associate professor in physiology at the University of Kuopio where he later on worked as associate professor as well as professor. From the year of 1982 he worked first as associated professor and later as professor in applied zoology.

Mikko was a very inspiring and stimulating supervisor for the students, and he tempted many into the world of research. He also managed to work as supervisor, examiner and critic for more than twenty dissertations. With regard to research projects as well as studies it was characteristic of Mikko to question problems and solutions. In Kuopio he gathered around him a group of researchers within the field of animal behaviour and welfare, and this resulted in the first doctor's dissertations on this subject. The research in animal behaviour and welfare started in Kuopio was pioneer work in the whole of Finland and has later on been of great importance to similar research with other production animals started later on.

Mikko was a very prominent researcher in Finland as well as internationally. He also worked as a visiting researcher in Germany, Scotland and Canada over a total of three years. In the years 1992 – 1994 Mikko Harri was a member of the scientific committee of the Academy of Finland, and from 1995 he was part of the expert pool of the committee of research in natural resources and environment.

Mikko's expertise was also used in connection with the preparation of the European Council animal protection recommendations for fur animals. Without Mikko's invaluable efforts with respect to scientific fur animal research the scientific views would have been taken into account to a much lesser degree, especially with regard to the breeding conditions of foxes.

Mikko was a warm-hearted colleague whose humour could brighten up everyday life as well as festive occasions. His colourful stories on our congressional tours and his way of telling about mishaps in connection with research were the highlights of our social gatherings. Research in fur animal welfare will go on after Mikko's demise, but we will all for a long time refer to what he said and we will on innumerable occasions miss his assistance and support.

*Translated from Finnish Fur Animal Journal, March, 2001.*



**Nordic Association of Agricultural Scientists**  
*Section V: Animal Husbandry*  
*Subsection for Fur Animals*

## **Catalogue of Nordic Research Projects on Fur Animals**

*Volume V - 2000*

### **Preface**

The Nordic Association of Agricultural Scientists has had a tradition every second year to publish overviews of Nordic research projects dealing with fur animals. The present catalogue is the fifth in the series. Different from the earlier ones is that this time the total catalogue will be available in electronic form on the Internet. The catalogue can be found at the address: <http://org.nlh.no/njf/pelsdyr/prosjekt/index.html>.

The present volume is still mainly in the Scandinavian languages but the future aim is that only English is used. In all projects, however, there is an English title and more information can be received from the co-ordinator of the research. By this we hope that also the colleagues outside the Nordic countries will be able to follow the ongoing research in this part of the world.

The catalogue is a good basis to get information about:

- An overview of all Nordic research projects on fur animals
- Information about institutes collaborating within projects
- Plans for future projects
- Contact information for researchers
- References to publications

In this Volume V are included projects presently running and projects that were terminated in 1998 or 1999. New projects starting later this year are included where it has been possible.

All Nordic research institutes and organisations have contributed to the material and thus we hope that the list is as complete as possible and will be useful for researchers, fur breeders organisations, and all others interested in fur animal research.

The work is financed by the Nordic Association of Agricultural Scientists, Subsection for Fur Animals.

Oslo, November 2000

Prof. Einar J. Einarsson  
Chairman of Division for Fur Animals  
Nordic Association of Agricultural Scientists



**Nordic Association of Agricultural Scientists**  
*Section V: Animal Husbandry*  
*Subsection for Fur Animals*

### **Annual Seminar on Fur Animal Production**

The Nordic annual seminar on fur animal production will be held in Denmark, in October 2001

- Place: Borupgård, Scanticon Comwell, Nørrevej 80  
DK - 3070 Snekkersten, Denmark
- Time: 1 - 3 October 2001
- Registration fee: Subsection members: 3 500 DKR  
Others: 3 800 DKR  
Includes hotel for 2 nights and meals during the congress
- Further information: Dr. Niels Enggaard Hansen  
The Royal Veterinary and Agricultural University  
Fur Animal Production  
Grønnegårdsvej 3, DK - 1870 Frederiksberg C  
Denmark
- E-mail: nih@kvl.dk

*Original report*

## **Fur Farming in Russia: the Current Situation and the Prospects**

*N.A. Balakirev – doctor of agricultural sciences, director  
E.A. Tinaeva – doctor of biological sciences, deputy-director*

*Research Institute of Fur and Rabbit Breeding named after V.A. Afanasjev*

Fur farming in Russia is a relatively young branch of animal husbandry, started in the twenties of the XXth century. The product is the valuable fur of such farmed fur animals as mink, fox, sable, raccoon, and nutria. Nutria breeding is at the same time the source of highly nutritious diet meat. The basic object of fur farming is mink, comprising in value 90 per cent of the total production.

After World War II fur farming became an essential part of the agricultural production of the country and continued to develop successfully until the beginning of the nineties.

For many years the USSR was the world leader in the production of farmed fur animals, in some years the production reached 17 mill. skins. Over 70 per cent of the production was accumulated in Russia. The main producing areas were the north-western, central and far-eastern regions. Fur farming was one of the sources of foreign currency for the country.

The current situation in Russia is characterised by considerable changes caused by the reform of economic relations in general, including the agro-industrial sphere. In this respect, fur farming is not an exception.

Earlier the production of farmed fur animals was basically concentrated on 250 farms, 111 of them were large specialised state farms with 10,000-15,000 breeding females each, united by Zveroprom and the rest belonged to co-operatives.

In the nineties, many farms failed to adjust to the new economic realities. Among negative factors to be mentioned are the weakening of the financial situation, the cessation of all-round support from the state, the destruction of vitally important connections with the fish and meat processing industries, with factories producing granulated feed. It was followed by a sharp rise of the cost of fish and meat feeding, energy, and transportation.

As a result, the increase of production costs exceeded the growth of the market prices.

The number of animals on the farms and the production of skins have fallen (see table 1). Only about 70 farms have managed to adapt themselves to the new conditions.

In spite of the worrying figures, the scientists are sure that using the previous positive experience and subject to meeting the present socio-economic requirements, there is a possibility to stabilise and to further develop fur farming in Russia.

This can be realised by undertaking complex measures along the following lines:

- The strengthening of the feeding basis of fur farming. The increase of the production of cheaper feeding staff, produced in the country.
- The maintaining, development, and rational distribution of all genetic varieties of the

breeding stock. The improvement of organising and legislative basis.

- The improvement of administration and financing, which also involves favourable credit facilities.
- The improvement of the veterinary status of fur animals.
- The control of the fulfilment of the federal economic programs, covering fur farming.

As one of the ways out of the crisis, many farmers choose to unite their efforts and to integrate the smaller groups of farms with banks and other financial institutions. For example, JSC "Russpushnina" combines 5 large stable and healthy fur farms, confidently building up the production and quality characteristics. They are: "Saltykovsky", "Rodniki", "Vjatka", "Lesnye Kljuchi", "Krestovski fur complex" with the participation of Avtobank, Moscow. The fur farms of the Kaliningrad area, fur farms "Sudoslavski", "Gagarinski" work successfully.

The pedigree farm "Rodniki", the farm with high production results, is a experimental place for research activities of NIIPZK – the head scientific and research institution in Russia for fur farming.

Fur farming is a branch of agriculture, closely tied up with science, actively introducing into practice the latest scientific achievements at all stages of the fur production: breeding, maintenance, feeding, working on more human methods of killing the animals, the primary handling of skins.

Except for NIIPZK, scientific and technical support of the fur farming is provided by VNIIOZ after professor Zhitkov in Kirov, the Institute of Biology in Karelia, the Institute of Cytology and Genetics of the Siberian Branch of the Academy of Sciences of RF. We have to mention specially the Moscow Academy of Veterinary Medicine and Biotechnology, where the research activities are combined with education, its graduates are young people, qualified to work at the farms or alternative to stay in science.

The scientists of the Kirov institute work on the problems of adaptation of fur animals to different conditions of breeding. The technological and zoohygienic parameters offered by the scientists of the institute are directed to increase resistance and productivity of the animals.

The research made in the Karelian scientific centre studies the system of physiological and biochemical monitoring in the fur farming.

The Moscow academy specialises in the technology of mutation fox breeding.

In Novosibirsk, experimentally unique mutations of mink have been received. It is suggested that selection based on the definite type of behaviour is connected with pigmentation which is influenced by the synthesis of melanin. As a result of this selection, the scientists received new mutation which they called "black crystal".

Speaking about the achieved results, it should be admitted that today NIIPZK possesses the complex of technologies sufficient to produce progeny practically from all types of farmed fur animals.

In collaboration with the Institute for Agricultural Projects in Ivanovo, we have corrected the standard sizes of cages, offered for construction of fur and rabbit farms. This work has been done in accordance with the Recommendation of the standing committee of the Council of Europe (Strassburg, 1999) directed to improve the animal's welfare.

A number of practical measures are being undertaken to keep and rationally use the available pedigree livestock.

Starting from 1997, according to the directive of the Ministry of Agriculture, the activities in the sphere of animal breeding, including fur farming, for pedigree purposes should be licensed. At present the federal license for selling pedigree livestock of fur animals throughout Russia is given to 29 farms (63% compared with 1994).

Among measures directed to pursue the state policy in the sphere of fur farming, we should mention the foundation under the auspices of the Ministry of Agriculture of Coordination Council on fur farming.

The idea was born by the Russian Fur Union, the organisation which continually takes care of the state of things in the fur breeding in Russia. One of the working groups is engaged in selection and maintenance of the pedigree livestock of fur animals.

Our institute has organised the computerised information centre which accumulated pedigree data and which is prepared to help reconstruct the branch.

In spite of the hard times only recently we have created several new colours of farmed fitch: pearl, golden, pastel and silvery type.

We realise that competitive fur farming should be based on a rational system of feeding. The main target is to reduce the cost of feeding by 40-50%, using fish and poultry by-products, dry protein feed, premixes etc. We see good prospects in the mixed type of feeding, the production of complete granulated dry feeding, the prevention of contamination caused by using doubtful feed products.

The creation of a reliable system of diagnostics, the prevention of contagious diseases, and the treatment of fur animals is very important for further development of fur farming due to the existing rather complicated epizootical situation. In this respect, the most worrying situation is caused by aleutian disease

of mink. As a whole, the situation with the diseases of fur animals remains under control, though still there are problems to solve as to the specific precautions, preventive measures and treatment of a number of diseases.

In today's everyday practice a lot of traditional biopreparations are used, but the future belongs to new products based on nuclear biotechnology and gene engineering.

Many years of research of molecular and genetic mechanisms of toxine building allowed to find a number of diagnosticums to determine toxogene microflora in the feeding material.

The usage of resident and transit microflora opens wide prospects for introduction into the body of an animal of protection and such vital ingredients as indispensable amino-acids, vitamins, ferments.

One more important aspect for the fur complex in Russia is the securing of the ecological security of the fur production, the introduction of modern technologies of fur processing.

The production facilities and the scientific potential of the fur breeding are appropriate with the challenges of today and allow the fur farming of Russia to be competitive on the world market.

**Table 1.** The production on the Russian fur farms in figures  
(According to the data of the Fur Farmers Union)

The name of the animal	Breeding females (1000)	Number of skins (1000)	Price of 1 skin in roubles	Production cost of 1 skin in roubles
<b>1966</b>				
Mink	1359,8	4379,5	130,0	148,0
Blue fox	151,5	742,9	217,0	224,0
Silver fox	93,0	290,5	453,0	399,0
<b>Total</b>	1604,3	5412,9		
<b>1997</b>				
Mink	1098,2	3682,3	137,0	179,0
Blue fox	120,0	639,6	256,0	336,0
Silver fox	70,3	250,6	459,0	433,0
<b>Total</b>	1288,5	4572,5		
<b>1998</b>				
Mink	953,4	2904,5	197,0	270,0

Blue Fox	89,2	406,9	398,0	529,6
Silver fox	71,2	193,8	522,4	620,3
<b>Total</b>	<b>1113,8</b>	<b>3505,2</b>		
<b>1999</b>				
Mink	926,4	2375,7	350,0	420,0
Blue fox	87,7	348,0	755,0	790,8
Silver fox	72,8	154,7	1156,0	1138,2
<b>Total</b>	<b>1086,9</b>	<b>2878,4</b>		

### **Inhibition of Transient LES Relaxations and Reflux in Ferrets by GABA Receptor Agonists**

*L. Ashley Blackshaw, E. Staunton, A. Lehmann, J. Dent*

Transient lower esophageal sphincter (LES) relaxation is the major mechanism of gastroesophageal reflux. This study uses an established ferret model to evaluate GABAB receptor agonists' ability to reduce triggering of transient LES relaxations. One hundred sixty manometric/pH studies were performed on 18 conscious ferrets. In untreated animals, intragastric infusion of 25 ml glucose (pH 3.5) led to  $2.0 \pm 0.6$  reflux episodes over the first 30 min. Twenty-nine of forty-seven reflux episodes occurred during transient LES relaxation, and 18 occurred after downward drifts ( $<1$  mmHg/s) in basal LES pressure. The GABAB receptor agonists baclofen (7  $\mu\text{mol/kg}$  ip), CGP-44532, and SKF-97541 (both  $\text{ED}_{50} < 0.3$   $\mu\text{mol/kg}$ ) reduced reflux episodes and transient LES relaxations. The putative peripherally selective GABAB receptor agonist 3-aminopropylphosphinic acid (80-240  $\mu\text{mol/kg}$ ) was ineffective, as was the GABAA receptor agonist muscimol (5  $\mu\text{mol/kg}$ ). Baclofen's inhibition of transient LES relaxations and reflux was unaffected by low-affinity GABAB receptor antagonists CGP-35348 and CGP-36742 at 100  $\mu\text{mol/kg}$  but was reversed by higher-affinity CGP-54626 and CGP-62349 (0.7  $\mu\text{mol/kg}$ ) or by CGP-36742 at 200  $\mu\text{mol/kg}$ . Therefore, GABAB receptor inhibition of reflux shows complex pharmacology. Our and other data indicate the therapeutic potential for these drugs.

*American Journal of Physiology-Gastrointestinal and Liver Physiology, 277: G867-G874, 1999, 6 figs., 37 refs.*

*Original Report*

## **Our Experience in Spirulina Feeding to Minks in the Reproduction Period**

***V. Berestov***

*Ryazan Agricultural Academy, 390040 Russia, Ryazan, Kostycheva Str., 1*

Most widely applied in biotechnology *Spirulina platensis* (nordst) Jeilt is a filiform waterplant. The walls of its cells have mucopolymer murein that is easily digested by the digestive juices of human and monogastric animals unlike, for example, unicellular green waterplant *Chlorella* that has cellulose coat, it can digest only microflora of cicatrix of ruminant. More over, in the cellular wall of *Spirulina* there are alginates – unique biocompatible polyanionic (acid) polysaccharides, which are enable to free living organism of radionuclides and heavy elements like lead. In the powder of this waterplant there are: 60 – 70% of protein (containing all the indispensable amino acids in optimal proportion), 10 ...20% easily digested saccharum and about 8% fat including all the important fatty acids (Table 1). Besides *Spirulina* is rich in macro and micro elements necessary for normal metabolisms in the organism. It is important to notice that it is concentrated there in optimal proportion all the natural vitamins (unlike pharmacy synthetic preparations) synthesised by living cells which effectiveness is much higher.

We examined *Spirulina* on three mink-farms as a microaddition to the food allowance in the reproduction period.

On the farm 1 the experiment was carried out since February 20<sup>th</sup> till June 5<sup>th</sup> 1998 according to the following scheme: the 1<sup>st</sup> group (dark-brown mink) – 50 mg of *Spirulina* per 1 head a day; the 2<sup>nd</sup> group (dark-brown mink) – 200 mg of *Spirulina* per 1 head a day; the 3<sup>d</sup> group (sapphire mink) – 200 mg of

*Spirulina* per 1 head a day. All the experimental groups were formed on the basis of three different departments before beginning of the experiment. The control animals in every group were the least animals in their own department. To show the experimental background of feeding we made a list of average contents of the food allowance for the period of February – May (Table 2).

During the experiment we took into account the copulation, the quantity of empty, abortive and unsuccessfully-whelped females, the quantity of the stillborn young, recovering of the young from the moment of birth till their leaving the mothers, the social outlet at a rate per 1 successfully whelped and copulated female. The given data are presented in Table 3. As it is shown, addition of *Spirulina* into the food allowance has no negative reproduction index. In group 3 the social outlet is 0.49 whelp or 11% more than in the control group; in group 2 – it is accordingly 0.66 and 13% more; and in group 1 – it is 0.11 and 2% more. In the first and in the second cases the difference is statistically reliable.

During the second experiment carried out on the other fur-farm *Spirulina* was given to the sapphire minks (615 females). They had a preparation as a prepared feed-mixture in the quantity of 200 mg per animal a day (since February 20<sup>th</sup> till March 31<sup>st</sup>), and from the 1<sup>st</sup> of April till the 1<sup>st</sup> of May – 400 mg a day.

During the whole experiment it was noticed that the animals ate this feed very well, they started copulating

actively, the pregnancy and whelping were without any complications, infant-feeding was also very good.

The analysis of whelping results among females that took Spirulina were considerably less unsuccessfully-whelped and abortive females (2.3%) than in the control group that didn't take Spirulina (9.2%) (Table 4). The experimental females had less stillborn young (0.9%) than in the control group (3.1%). As the result every female that had Spirulina gave birth at an average to 0.45 more whelps than the control one (Table 4). At the same time it was noticed no abscess of females widely spread out in the herd of minks, this shows the raise of resistance index of the animal (in this case to the staphylococcal infection)

On the third fur-farm the experiment began on the 15<sup>th</sup> of March and was over on the 15<sup>th</sup> of May 1999.

Before the beginning of the experiment there were formed experimental and control groups (102 females in each group) from the animals of standard dark-brown colour. The animals of the experimental group were given daily 200 mg of Spirulina powder per 1 head with the food allowance in the morning. The

control minks were not given Spirulina. The animals were kept under the usual conditions and had their usual food allowance.

The results of whelping showed that in this case as well as in the previous ones the addition of Spirulina into the food allowance in the quantity of 200 mg per animal a day had a positive influence on the reproduction indices. The fertility of females in this group had an average index of 6.75 whelp per female, and in the control group it was 5.98. There were born 563 living whelps, and in the control group – 508 whelps.

The given results of the experiments testified only the positive influence of Spirulina on the organism of pregnant mink-females. The results showed the importance of Spirulina use in the fur-farming in the period of reproduction (from the 15<sup>th</sup> of January till the 1<sup>st</sup> of June). Spirulina can undoubtedly be used for fur-bearing animals during the other biological periods too. The research is going on.

The author would be very grateful to anyone who could share his experience of Spirulina use in the fur-farming.

**Table 1.** Biochemical contents of microwaterplant SPIRULINA PLATENSIS

Amino acids	%	Nutritive	%
Isoleucine	5.7	Protein	60-70
Leucine	8.7	Carbohydrate	10-20
Lysine	5.1	Fat	5
Methionine	2.6	Ash content	7
Phenylalanine	5.0	Cellulose	2
Threonine	5.4	Humidity	6
Tryptophan	1.5	Pigments	%
Valine	7.5	Carotinoid	0.22-0.34
Alanine	7.9	Chlorophyl	0.80-1.00
Aspartic acid	9.1	Phycocyanin	15.0-20.0
Cystein	0.9	Vitamins	mg/kg
Glutaminic acid	12.7	B-carotin (provitamin A)	1,700
Glycine	4.8	B 12	1.6
histidine	1.5	B 5	11
Proline	4.1	BC	0.5
serine	5.3	Inositol	350
Tyrosine	4.6	Niacin (PP)	118
Arginine	6.5	Pyridoxine (B 6)	3
Fatty acids	%	Tiamine (B1)	55
laurinic C 12	200	Tocopherol (E)	190
Myristic C 14	600	Minerals	mg/kg
Palmitic C 16	16,500-21,141	Calcium	1,180
Palmitoleinic C 16	1,490-2,035	Phosphorus	8,280
Palmitolinolic C 16	350	Iron	528
Heptanodecanic C 17	90-142	Sodium	34
Steaic C 18	0-353	Chlorine	4,200
Oleic C 18	1,970-3,009	Magnesium	1,663
Linolic C 18	10,920-13,784	Zinc	3
Gamma-linolic C 18	8,750-11,970	Potassium	14,353
Beta-linolic C 18	160-427	Copper	5
Others	7,000-699	Iodine	3
		Selenium	2
Others			%
RNA			3.6
DNA			0.8
Assimilation of lysine			85
Digestibility by pepsin			85
Permitted mistake			2.4
Use of pure protein			57

**Table 2** Monthly contents of mink food allowance in the period of Spirulina use

Index	Quantity, g/ 100 Kcal of metabolic energy			
	February	March	April	May
Contents of food allowance:				
meagre beef	-	0.2	-	1.8
liver	2.8	3.6	3.6	3.3
blood	-	-	-	0.2
soft beef subproducts	20.1	21.2	19.7	18.2
freshly crushed bone	8.0	7.8	9.6	8.9
paltus	24.9	19.1	16.6	20.0
fish stuffing (cod)	8.2	10.0	10.7	12.7
unskimmed milk	8.2	8.9	11.1	8.0
meagre cottage cheese	0.1	0.8	3.2	3.9
melange	6.7	8.0	8.7	6.5
barley	9.1	8.8	8.6	8.7
pressed bakery yeast	-	0.3	0.9	0.6
natural fat	0.3	0.1	-	0.3
fish garbage	5.0	4.8	-	-
Digestible substances:				
protein	10.2	10.2	10.3	10.5
fat	3.8	3.8	3.7	3.6
carbohydrate	4.7	4.6	4.7	4.7

**Table 3** The result of whelping of experimental and control minks

Group	The amount of females for April 1 <sup>st</sup> 1998	From females left for the 1 <sup>st</sup> of April			Born whelps at a rate per successfully whelped female		Dead whelps before the registration, %	Stillborn and dead whelps before the registration, %	Whelps per standard female
		empty	unsuccessfully whelped and abortive	dead	in the whole	living whelps			
1*	48	10.4	-	2.1	7.2	6.6	10.6	18.5	5.13
	329	11.6	1.2	0.9	6.9	6.6	10.9	16.2	5.02
2	49	4.1	-	-	7.3	6.6	12.5	22.8	5.65
	328	9.1	-	2.7	7.5	6.8	15.1	24.0	4.99
3	46	-	4.3	2.2	6.5	6.4	16.4	18.6	4.96
	343	5.5	1.7	1.5	6.4	6.0	17.1	23.2	4.47

\* In each group the first line is the index of experimental minks, the second line – control minks

**Table 4** The results of copulation and whelping of the sapphire minks that were given Spirulina and were not given it (1998)

Groups		Experimental	Control	
Total number of females on the 1 <sup>st</sup> of April 1998		615	1,567	
From the females on the 1 <sup>st</sup> of April 1998	empty	heads	180	
		%	11.5	
	abortive, unsuccessfully whelped	heads	144	
		%	9.2	
	dead	heads	8	
		%	0.5	
	females without offspring	heads	332	
		%	21.2	
	successfully whelped	heads	1,235	
		%	78.8	
	Whelps of successfully whelped females	living		6,033
		dead		193
total		6,226		
per 1 female		living	4.88	
		living & dead	5.04	
Dead whelps before the registration		517		
		8.3		
Unsuccessfully whelped and dead before the registration		710		
		11.4		
Registered whelps	quantity of registered whelps		5,516	
	per successfully whelped female		4.47	
	per permanent female		3.52	

### **Physiological Changes in Mink (*Mustela Vison*) Dams Subjected to Weaning at Different Times during Lactation**

*B. Sørensen, T.N. Clausen, S. Wamberg, O. Hansen*

The influence of time of weaning on weight changes, and on hormone and electrolyte status in domestic mink (*Mustela vison*) dams raising  $\geq 5$  kits/litter was examined. The kits were weaned either at day 42 (group 1) or 49 (group 2) after birth. The dams were weighed and urine and blood were sampled from day 29 through day 56 after delivery. A considerable loss of dams' body weight constituting 6.3% in group 1 and 8.1% in group 2 was noticed the day after weaning pointing to a much reduced food consumption at the day of weaning. No changes in plasma aldosterone and no significant decrease in urinary sodium concentration were seen in dams after removal from their litters, whereas, irrespective of time of weaning, urinary sodium and chloride concentrations were halved a few days after weaning compared to the other group. The plasma cortisol concentration was high before and during weaning and was nearly halved one week after weaning implying less strain on the dams after weaning. It is concluded that the weaning period is a most vulnerable and stressful period to the dams irrespective of the actual time of weaning.

*Acta Agriculturae Scandinavica, Sect. A, Animal Sci., 2001: 51, 148-154, 3 tables, 2 figs., 13 refs.*

### **Connection between Levels of Vitamin A, E and Activity of Erythrocyte Super-Oxidizedismutase in Farm-Bred Mink and Polar Fox**

*V.A. Ilukha, T.N. Ilyina, T.R. Ruokalainen*

The aim of our investigation was to determine the levels and connection between the concentrations of some non-enzymatic antioxidants (vitamin E, and

vitamin A) in the blood serum and CuZn-superoxidizedismutase (SOD) in erythrocytes of healthy fur animals in relation to different period of the life cycle (mating, lactation, moulting and anestrus). Both vitamins and the enzyme displayed seasonal variation in mink and polar fox. Vitamin E and SOD activity changed similarly in both species while the changes of vitamin A differed. Direct correlation between SOD activity and vitamin A and E levels in polar fox in mating and lactation period was demonstrated. No differences were recorded in the vitamins and the SOD levels between young male and female minks in the moulting period and anestrus.

*7<sup>th</sup> symposium on Vitamins and Additives in the Nourishment of Humans and Animals, 22 – 23 September, 1999, Jena/Thüringen, 2 figs., 1 table, 11 refs.*

### **Indices of Thiamine Metabolism in Mink Blood in Pregnancy Period**

*T.N. Ilyina*

The specific biochemistry indices of vitamin B<sub>1</sub> (thiamine) metabolism were studied during pregnancy period in the minks females blood in conditions of various provision by thiamine. The researchers have shown that the moderate vitamin deficiency was detected in the mink group with alimentary thiamine deficiency and the level of physiologically active forms of thiamine decreased. the pregnancy period in all groups of minks was characterized by the change of thiamine metabolism at a level of vitamin phosphorylated form and enzymes of biotransformation as the reaction of the organism to the pressure connected with reproduction.

*7<sup>th</sup> symposium on Vitamins and Additives in the Nourishment of Humans and Animals, 22 – 23 September, 1999, Jena/Thüringen, 2 figs., 1 table, 6 refs.*

### **Swimming Activity of Farm Mink (*Mustela Vison*) and its Relation to Stereotypies**

*C. P. Bjælke Hansen, L. Lau Jeppesen*

Eighty farm mink were used to investigate whether access to swimming water and/or difference in cage size led to a difference in the level of stereotypies. Half of the animals grew up with free access to swimming water, and the other half without. In addition, two different cage sizes were used. Over 2 weeks the animals were scanned a total of 141 times. Animals in small cages had a higher level of stereotypies and were more active than those in large cages. No difference between animals with swimming water and animals with an empty basin was detected. The level of activity was lowest in animals in large cages, although not significantly so when water was present. The results presented here do not offer any support for the claim that farm mink with access to swimming water have a lower level of stereotypies than mink with access to an empty basin. Whether swimming is a behavioural need in farm mink is still debatable.

*Acta Agriculturae Scandinavica., Sect. A, Animal Sci., 2001: 51, 71 – 76, 2 tables, 44 refs.*

### **Effects of Family Housing on Behaviour, Plasma Cortisol and Performance in Adult Female Mink (*Mustela Vison*)**

*V. Pedersen, L. Lau Jeppesen*

Various behavioural, physiological and production-related parameters were examined in 200 adult female pastel and pearl mink either family housed in three-room cages with no weaning or housed singly in one-room cages after normal weaning procedures. Scanning observations of behaviour and use of the cages were performed in the nursing period and several parameters related to reproduction were registered. The adult female mink were weighed when kits were 16 weeks old (September) and again at pelting time (November). Blood samples were collected from all adult female mink in September at which time the teat condition and fur damage were evaluated. After pelting, bite marks on the leather side

of the skin were counted, fur damage was graded after severity and the fur size was measured. Some positive consequences of being family housed were revealed. The family-housed adult female mink showed a lower level of stereotypies and a higher level of defensiveness and curiosity than the adult female mink in one-room cages during the nursing period. In September and November, family-housed adult females were heavier than singly housed adult females. However, most of the physiological or production-related parameters pointed in a negative direction for family-housed adult female mink. Reproductive success was somewhat reduced, although not significantly. Plasma cortisol levels were elevated in September, indicating higher levels of stress in these females. They showed a generally poor teat condition in September, with a high proportion of swollen or bitten teats. A high proportion of these adult females showed fur damage in both September and November, and a high number of bite marks was found on the leather side of the skins of these females, indicating that family housing had a high cost for the adult female mink. In conclusion, there seem to be some benefits, at least on the behavioural level, in keeping adult female mink in three-room cages during the nursing period, but both physiological and production-related parameters indicated that the welfare of the adult female mink was threatened if she was continuously cohoused with her litter past the normal age of weaning.

*Acta Agriculturae Scandinavica, Sect. A, Animal Sci., 2001: 51, 77 – 88, 7 tables, 31 refs.*

### **Use of Water for Swimming and its Relationship to Temperature and Other Factors in Farm Mink (*Mustela Vison*)**

*C. P. Bjælke Hansen, L. Lau Jeppesen*

An investigation into swimming behaviour and its relationship to outdoor temperature was conducted in 40 ranch mink. Two different cage sizes were used and all animals had access to a basin filled with water 15cm deep. During the years 1994–1998, water lost from the basin and temperatures at a nearby weather station were recorded once a week. In the last year II mink were video-recorded for 24 h. Using the monthly average daily water loss as an indicator, swimming activity showed a clear annual variation

over 4 years and was positively correlated with average monthly temperature. With regard to swimming activity, a large individual variation existed: average water loss varied from 10 ml to nearly 4 litres per day, with those in large cage units having the greatest water loss. The video-recordings confirmed this variation: the number of swims ranged from zero to 177 during 24 h and there was an indication of more swimming bouts in the mink in the large cage units. The duration of swims varied from 2 to 55 s per bout. The relationship between swimming and general activity is discussed, along with the importance of water for swimming as a means of thermoregulation.

*Acta Agriculturae Scandinavica, Sect. A, Animal Sci., 2001: 51, 89 – 93, 2 figs., 1 table, 13 refs.*

### **Effects of Space Allowance and Earthen Floor on Welfare-Related Physiological and Behavioural Responses in Male Blue Foxes**

*H. Korhonen, P. Niemelä, L. Jauhiainen, T. Tupasela*

Welfare-related physiological and behavioural responses were studied in farm-bred male blue foxes (*Alopex lagopus*). Three different-sized cages (80-cm long [CL80], 120-cm long [CL120], and 240-cm long [CL240]; each 105-cm wide x 70-cm high) with wire-mesh floors and one enlarged cage (CL240E) with both wire-mesh floor (240-cm long x 105-cm wide x 70-cm high) and earthen floor (80-cm long x 105-cm wide x 70-cm high) were compared.  $N = 30$  males for each group. The experiments lasted from weaning in July to pelting in December. Statistical analyses were based on the models accounting for litter as a block effect. Breaking strength of tibia was highest for foxes having access to both wire-mesh and ground floors (CL240E). Stress-induced hyperthermia was evident during capture and immobilisation. The highest rectal temperature (mean  $\pm$  SEM) was found in CL240E (capture:  $39.6 \pm 0.09^\circ\text{C}$ , restraint:  $40.0 \pm 0.09^\circ\text{C}$ ) and the lowest in CL80 (capture:  $39.1 \pm 0.09^\circ\text{C}$ , restraint:  $39.7 \pm 0.09^\circ\text{C}$ ). Likewise, capture time (median; interquartile range) in the home cage was highest in CL240E (29; 18 to 44) and lowest in CL80 (12; 9 to 14). During capture, foxes tended to withdraw to the farthest site within the cage. CL240E foxes typically

showed the most fear towards human. The most confident animals were found in CL80. The cortisol:creatinine ratio (median; interquartile range) obtained from circadian urine did not reveal statistically significant differences among CL80 (3.5; 2.6 to 4.1), CL120 (2.3; 1.5 to 3.8) and CL240 (2.3, 1.5 to 3.7). The earthen flooring complicated the urine sampling and conclusions for CL240E (1.7; 1.2 to 2.2). CL240E foxes were the most active and explorative on both wire-mesh - and ground-floored open-field arenas. Altogether, 53% of furs from CL240E were classified as very dirty. Dirtiness of furs in other test groups was slight. In conclusion, the present results did not reveal an unambiguous superiority of any of the studied cage options for well-being of farmed blue foxes.

*Physiology & Behaviour, 2000: 69, 571 – 580, 2 figs., 5 tables, 59 refs.*

### **Extent of Digging and its Possible Underlying Causal Factors in Penned Blue Foxes**

*H. Korhonen, P. Niemelä, I. Wikman*

A recent European animal welfare recommendation stresses the importance of studying digging behaviour in farm-born blue foxes (*Alopex lagopus*). The current study was conducted (1) to clarify the extent of digging and (2) to evaluate factors that motivate digging. In experiment I, six juvenile male blue foxes were housed together from August to the following June in an earthen enclosure. Experiment 2 was conducted from July to December, using ten enclosures each containing two juvenile male blue foxes. Behaviour was monitored by 24-h video recordings and visual observations. Progress of digging was also followed by making scale drawings of all digging marks on paper. As early as the first study day, clear signs of digging were observed. Digging sites were concentrated below and close to nest-boxes and pen walls. Maximally about 20% of the total enclosure area was affected. The total surface area of digging sites did not increase from late summer onwards because foxes tended simultaneously to cover part of the old sites when digging new ones. Motivational tendency to dig varied with time. Digging activity decreased during autumn

and almost totally ceased during winter. In May, foxes resumed digging activity. Digging motivation was evaluated by two means: (1) by analysing digging purpose (experiments 1 and 2), and (2) by the damming-up test (experiment 1), that is, after 10 months foxes that had been exposed to the earthen floor were transferred for 12 days into wire-mesh cages with no possibility to dig in the ground. Thereafter, foxes were transferred back into the earthen enclosure to measure the rebound of digging following deprivation. Foxes were observed to dig for the following reasons: (1) to make a hole or a resting site, (2) to locate an escape route, (3) to cache food, faeces, or sticks, (4) in response to a novel object (new nestbox, replacement of nestbox), and (5) displacement without any clear goal. Daily time spent digging averaged 7 mm and 17 mm per fox in Exps. 1 and 2, respectively. A clear rebound effect for digging was not identified. It can be concluded that digging is a complex behavioural pattern caused by a variety of motivations that can vary over time. The present study was unable to show unambiguously that digging is an important need for farmed foxes.

*Acta Ethol, 2001: 3, 127 – 133, 5 figs., 1 table, 26 refs.*

### **Physiological and Behavioural Responses in Blue Foxes (*Alopex Lagopus*) Comparisons between Space Quantity and Floor Material**

*H. Korhonen, L. Jauhiainen, P. Niemelä, M. Harri, R. Sauna-aho*

Welfare-related physiological and behavioural responses were studied in farm bred blue foxes (*Alopex lagopus*). Comparisons in space quantity were made between two different-sized shed cages (50 cm long (W50) and 120 cm long (W120); each 105 cm wide x 70cm high) and for one out-of-shed pen (5 m long x 3 m wide x 18 m high; W500). Each option had a wire-mesh floor. Furthermore, we tested how floor material affects responses by comparing the W500 foxes in wire-mesh floor pens with foxes housed in earthen floor pens (E500: 5 m long X 3 in wide X 1.8 m high). Each test group comprised 20 juvenile males maintained in pairs. The experiments lasted from weaning in July to pelting in

December. Final body weights of the W500 foxes were significantly lower than those of the W50 or W120 foxes. Claw length of back foot was longer for E500 than for W500 foxes. Posture of front feet was the most folded for W50 and the least folded for E500 foxes. Breaking strength of tibia was highest for foxes housed on the earthen floor (F500). Gastrocnemius muscle succinate dehydrogenase activity tended to decrease and the number of leucocytes tended to increase with cage size. Alanine-aminotransferase and aspartate-amino transferase activities were significantly higher in foxes housed in shed cages (W50, W120) than in enclosures (W500, E500). Creatine-kinase activity tended to decline with increasing cage size. Highest and lowest open field activity was found for E500 and W50 foxes in both wire-mesh and earthen floor test arenas. Some differences were found in body weight-related organ sizes between groups. Heart weight was significantly higher in W500 than in W50 or W120 foxes. Brain weight was significantly lower in W50 than in W500 foxes. Liver weight increased with increasing cage size. Capture time was significantly lower for W50 and W120 foxes than for W500 or E500 foxes. Cortisol levels after capture were significantly higher in foxes from enclosures (W500, E500) than in those from shed cages (W50, W120), but after ACTH stimulation the levels were similar in each group. Rectal temperatures after restraint were highest in foxes from W500. Fur properties of W500 and E500 foxes were poorer than those of W50 or W120 foxes.

*Animal Science, 2001: 72, 375-387, 5 tables, 60 refs.*

### **Determination of the Aversion of Farmed Mink (*Mustela Vison*) to Carbon Dioxide**

*J. Cooper, G. Mason, M. Raj*

High concentrations of carbon dioxide are commonly used to kill mink before their pelts are removed. The aversiveness of this procedure was investigated by using a passive avoidance technique. Eight mink were trained to obtain a reward (a novel object) by entering a chamber which could be filled with carbon dioxide, as under commercial conditions (over 80 per cent by volume). In the absence of carbon dioxide, mink entered the chamber within a mean (sd) of 16 (2.1)

seconds and spent 45 (12) per cent of the next 10 minutes interacting with the novel object. When there was carbon dioxide in the test chamber, the mink would not enter it and coughed and recoiled from the chamber's entrance instead. It was concluded that the mink detected and avoided high concentrations of

carbon dioxide, and that if mink are to be killed humanely, less aversive techniques should be used.

*The Veterinary Record, 1998: 143, 359-361, 1 fig., 3 tables, 15 refs.*

### **Increasing Costs of Access to Resources Cause Rescheduling of Behaviour in American Mink (*Mustela Vison*): Implications for the Assessment of Behavioural Priorities**

*J. J. Cooper, G. J. Mason*

Consumer demand studies of animal preference commonly involve the imposition of costs on access to resource compartments rather than direct costs on resource consumption. The aim of this study was to analyse how such increasing access costs alter the scheduling of behaviour, in order to investigate some potential problems with using this technique to measure behavioural priorities. We investigated the effect on mink of placing a cost (a weighted door) on the access to resources. Six mink were individually housed in closed economy test arenas. Each consisted of a home cage (containing food, water and a nest box), an empty compartment and six resource compartments with access to a box of hay, a water bath, a raised platform, a wire cylinder, a novel object, and small toys. Door weights were increased from 0 to 1000 g and the minks' behaviour was recorded on video for 8 h per day. As expected, increasing door weight reduced the number of visits to each compartment but lengthened each visit. Furthermore, as costs on access increased, there were changes in how mink behaved during each visit to resource-compartments. They became increasingly likely to interact with each resource during a visit, and they showed shorter latencies to interact with the resources. The time spent in compartments not interacting with the resources also declined. Overall, these changes in within-visit behaviour meant that the greater the cost on access, the greater the proportion of time spent with a resource devoted to actually interacting with it. Thus, the time spent with a resource over-estimated the actual use of that resource, particularly at lower access costs. These results illustrate the dangers of simply using time spent with a resource as a measure of consumption in studies of behavioural priorities. As a consequence of longer visits and more interactions, the total time spent swimming, manipulating the novel objects and occupying the hay box did not decline with increasing door weight. However, unexpectedly, this compensatory re-scheduling did not occur for all activities, because the time spent occupying the platform, manipulating the toys and the cylinder and

the time in the empty compartment declined with higher access costs. This suggests that increasing access costs for unlimited periods of time with resources may, although not strictly valid for the production of demand curves, yield a ranking of behavioural priorities if high enough costs are used. Further research is necessary to see whether the minks' failure to defend time spent in the platform, manipulating toys and the wire cylinder and in the empty compartment does represent the low priority of these activities. Or whether some other factors, such as constraints on the ability to re-schedule the activities prevent mink from compensating for higher costs on access.

*Applied Animal Behaviour Science, 2000: 66, 135-151, 9 figs., 1 table, 35 refs.*

### **Feeding Growing Mink (*Mustela vison*) PCB Aroclor® 1254 Does Not Affect Baculum (Os-penis) Development**

*R. J. Aulerich, S. J. Bursian, A. C. Napolitano, T. Oleas*

Recent studies reported in the literature have shown a negative correlation between the concentrations of environmental contaminants and baculum (os-penis) mass and/or length in wild-trapped mustelids. Henny *et al.* (1996) found that organochlorinated contaminants, including polychlorinated biphenyls (PCBs), were significantly correlated with smaller testes and bacula in juvenile wild-trapped river otter from Oregon. Harding *et al.* (1999) reported a significant negative correlation between PCB concentrations (as Aroclor 1260) and baculum length in juvenile mink, but not in river otter trapped in British Columbia.

The objective of this study was to examine the effects of dietary exposure to a known concentration of the PCB mixture, Aroclor 1254, on baculum development in growing male mink under laboratory conditions.

*Bull. Environ. Contam. Toxicol., 2000: 64, 443 – 447, 1 fig., 12 refs.*

### **Proliferation of Periodontal Squamous Epithelium in Mink Fed 2,3,7,8-Tetrachlorodibenzo-p-Dioxin (TCDD)**

*J. A. Render, J. R. Hochstein, R. J. Aulerich, S. J. Bursian*

The maxilla and mandible from 2 adult female mink fed 5.0 ppb 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) for 6 mo were grossly unremarkable, but histologically had nests of squamous epithelium within the periodontal ligament. There was osteolysis of the adjacent alveolar bone.

*Veterinary and Human Toxicology, 2000: 42, 85 – 86, 10 refs.*

### **Proliferation of Maxillary and Mandibular Periodontal Squamous Cells in Mink Fed 3,3',4,4',5-pentachlorobiphenyl (PCB 126)**

*J. A. Render, R. J. Aulerich, S. J. Bursian, R. F. Nachreiner*

This report characterises squamous cell proliferation in young farm mink (*Mustela vison*) fed a diet supplemented with 0.024 ppm 3,3',4,4',5-pentachlorobiphenyl (polychlorinated biphenyl [PCB] congener 126). One to 2 months of dietary exposure to PCB 126 resulted in gross lesions of the upper and lower jaws consisting of mandibular and maxillary nodular proliferation of the gingiva and loose teeth. The maxilla and mandible of the PCB-treated mink were markedly porous because of loss of alveolar bone. Histologically, this osteoporosis was caused by proliferation of squamous cells that formed infiltrating cords. This report clearly documents the fact that the environmental contaminant PCB 126 can cause osteoinvasive squamous proliferation in young mink, although the dose used in the present study was 7 and 36 times higher than what is typically encountered in contaminated bird eggs and fish, respectively.

*J. Vet. Diagn. Invest., 2000: 12, 477 – 479, 5 figs., 19 refs.*

### **Studies on Influenza Viruses H10N4 and H10N7 of Avian Origin in Mink**

*L. Englund*

An influenza A virus, A/mink/Sweden/84 (H10N4), was isolated from farmed mink during an outbreak of respiratory disease, histopathologically characterised by severe interstitial pneumonia. The virus was shown to be of recent avian origin and closely related to concomitantly circulating avian influenza virus. Serological investigations were used to link the isolated virus to the herds involved in the disease outbreak. Experimental infection of adult mink with the virus isolate from the disease outbreak reproduced the disease signs and pathological lesions observed in the field cases. The mink influenza virus also induced an antibody response and spread between mink by contact. The same pathogenesis in mink was observed for two avian influenza viruses of the H10N4 subtype, circulating in the avian population. When mink were infected with the prototype avian H10 influenza virus, A/chicken/Germany/N/49, H10N7, the animals responded with antibody production and mild pulmonary lesions but neither disease signs nor contact infections were observed. Detailed studies, including demonstration of viral antigen in situ by immunohistochemistry, of the sequential development of pathological lesions in the mink airways after aerosol exposure to H 10N4 or H10N7 revealed that the infections progress very similarly during the first 24 h, but are distinctly different at later stages. The conclusion drawn is that A/mink/Sweden/84, but not A/chicken/Germany/N/49, produces a multiple-cycle replication in mink airways. Since the viral distribution and pathological lesions are very similar during the initial stages of infection we suggest that the two viruses differ in their abilities to replicate and spread within the mink tissues, but that their capacities for viral adherence and entry into mink epithelial cells are comparable.

*Veterinary Microbiology, 2000: 74, 101 – 107, 26  
refs.*

**ANIMAL  
PRODUCTION REVIEW  
POLISH SOCIETY OF ANIMAL PRODUCTION  
1999**

***APPLIED SCIENCE REPORTS***  
**42**

**FUR ANIMALS PRODUCTION  
AND BREEDING**

*Summaries*

**Preliminary Investigation on Heavy Metal Content  
in Kidneys, Liver and Spleen of Polar Foxes  
(*Alopex Lagopus*)**

*P. Niedbala, O. Szeleszczuk, D. Mertin, K. Suvegova,  
P. Sviatko*

The aim of the work was to determine a content of 7 heavy metals namely Co, Cu, Mn, Zn, Kd, Fe, and Pb in kidneys, liver and spleen of Polar foxes. The investigation was carried out in 1996, during autumn killing of animals, at 6 farms of Polar foxes localised in the southern part of Poland. Samples of internal organs taken from 3 carcasses were frozen and then dried. The concentration of particular elements was examined in the Institute for Physiology of Farm Animals SAS, Kosice, and Slovak Republic, using atomic spectrophotometer absorption.

The results obtained, due to the lack of reference studies, give only approximate information concerning heavy metal content in the internal organs of Polar foxes.

Mean levels of Co in kidneys ranged from 1,18 to 1,82 mg/kg dry matter, in the liver 0,98-1,82 mg/kg

and in spleen 1,01-1,58 mg/kg. A content of Cu in kidneys (means from particular farms) averaged within a range 12,16 - 36,37 mg/kg, in the liver 5,0 - 47,51 mg/kg and in the spleen 5,01 - 8,14 mg/kg. The concentration of Mn in kidneys was within a range of 2,3 - 3,7 mg/kg, in the liver 2,01 - 3,12 mg/kg and in spleen 5,19 - 7,63 mg/kg, respectively. The Cd content in kidneys ranged from 0,72 to 4,07 mg/kg, in the liver 0,72 - 1,83 mg/kg and in the spleen 0,061 - 0,138 mg/kg. Mean levels of Pb in kidneys were within a range of 0,32 - 1,79 mg/kg, in the liver 0,11 - 0,92 mg/kg and in the spleen 0,45 - 1,77 mg/kg. On the basis of data reported for other species of fur animals (Silver foxes and minks) it can be concluded that contents of Co, Cu, Mn, Cd, and Pb in particular organs are similar. Only Zn and Fe concentrations in kidneys and liver of Polar foxes are distinctly higher, exceeding several times the levels in Silver foxes and minks. The level of Fe on average ranged between 5,66 and 1773,36 mg/kg in kidneys, in the liver between 1610,5 and 3647,88 mg/kg and in the spleen from 1610,5 - 3647,9 mg/kg. Mean content of Zn in particular organs was as follow: 74,2 - 143,9 for kidneys, 85,5 - 141,1 mg/kg in the liver and 89,1 - 208,4 mg/kg in the spleen.

### **Effect of Slow Releasing Melatonin Implant In the Course of Spermatogenesis in Testes of Blue Foxes**

*O. Szeleszczuk*

The purpose of the present work was evaluation of the influence of exogenous slow-releasing melatonin on spermatogenic processes in testes of polar foxes.

The experiment was conducted on 48 young polar foxes divided into 3 homogenic groups. Animals from the group I received melatonin implants (12 mg) on July, 14, from the groups II on July, 28. Males of the group III served as a control.

Animals from the group I reached a maximal body weight (7,07 kg) at the beginning of October, while those from the II<sup>nd</sup> and III<sup>rd</sup> group 1-2 months later. Dynamic increase of testes weight and volume, in animals from group I and II. Started at the beginning of October. In animals from the control group a month later, and lasted up to the end of December.

Maximal volume of testes estimated by the end of January amounted to 80,84, 81,56 and 71,55 cm<sup>3</sup> in animals from group I, II and III, respectively.

Paralelly with the volume of testes, a diameter of seminiferous tubules was growing up, reaching in animals of group I the maximal value (173,9 µm) in November, in group II 3 weeks later, while in group III following 5-6 weeks.

At the end of October, primary and secondary spermatocytes as well as few spermatids were observed in within the lumen of seminiferous tubuls.

Maturing spermatozoa appeared in testes of animals from group I and II by the end of November, while in those from group III (control) in January.

### **Disorders of Fertility and Prolificacy in Polar Blue Foxes**

*O. Szeleszczuk, P. Niedbata*

Investigations were conducted on 7 fox farms situated in the south of Poland. Analysis of reproductive results of breeding stock included breeding and farm records over the years 1983-1994 and oral information from breeder or farm manager. Data contained number of vixens. Proportion of mated and whelped vixens, litter size, number of dead cubs from birth up to weaning and to the slaughter (sale). Besides, feeding system, including methods of acquiring feed, formulating diet, and use of vitamin-mineral mixtures was taken into account. Chemical composition of sampled feeds was also examined. Health status at the farm was estimated on the basis of records in the notebook of veterinary services, by clinical examinations. Besides, 10% of vixens culled from foundation stock were subjected to anatomicopathological examination with particular attention paid to reproductive system.

Over years 1983-1994 a clear decrease of the proportion of mated vixen (from 93,4 to 72,9%) whelped vixens (from 93,4 to 77,4%) was recorded on the farms included into analysis. Besides, regarding the numbers of born and weaned cubs a distinct decreasing tendency was observed (from 8,4 to 4,44). On some farms between years 1983-1987 a drastic to 1,1 and even 0,5 weaned cub/vixen was recorded.

Reduced prolificacy and fertility of blue foxes could be caused a negative correlation between reproductive performance and pelt quality traits. Systematic selection directed on the Norwegian fox pelt quality could result in accumulation of undesirable genes coding reproductive traits. Possible reason of decreased fertility and prolificacy of blue foxes on Polish farms were unfavorable environmental conditions- poor feeding and unsuitable care about cubs and the like. Breeders from examined farms used feeds of low quality (in respect of both nutritive and sanitary value) sometimes for reasons beyond their control.

### **Digestibility of Protein and Fat from Poultry Offals in Diets for Minks**

*B. Barabasz, D. Mertin, M. Lizak*

The aim of the present work was to investigate a degree of utilisation of protein and fat from hard poultry offals (heads) included into feeding ration in different, increasing amounts and simultaneous estimation of the optimal content of these offals in the diet. Investigations were performed in years 1997-1998 on the farm of the Research Institute of Animal Breeding in Nitra, Slovak Republic. The experiment, conducted on minks of standard variety, included 4 stages of appropriate investigations preceded by preliminary periods. In succeeding stages of the experiment a content of poultry offals in diets was gradually increased to 20.8%; 33.0%; 43.6%; 55.3% respectively. The highest coefficient of digestibility was found for the mixture containing 43.6% of examined poultry offals. The coefficient amounted to 81.25%, which indicates that hard poultry offals (heads) are used effectively by minks and that it is possible to include into the diet up to 43% of poultry offals. The best digestibility of fat (coefficient of digestibility up to 94%) was found in case of mixtures containing large amounts of poultry offals (stage III and IV).

### **Blanced Feed Mixtures for Chinchilla Used Actually in Poland**

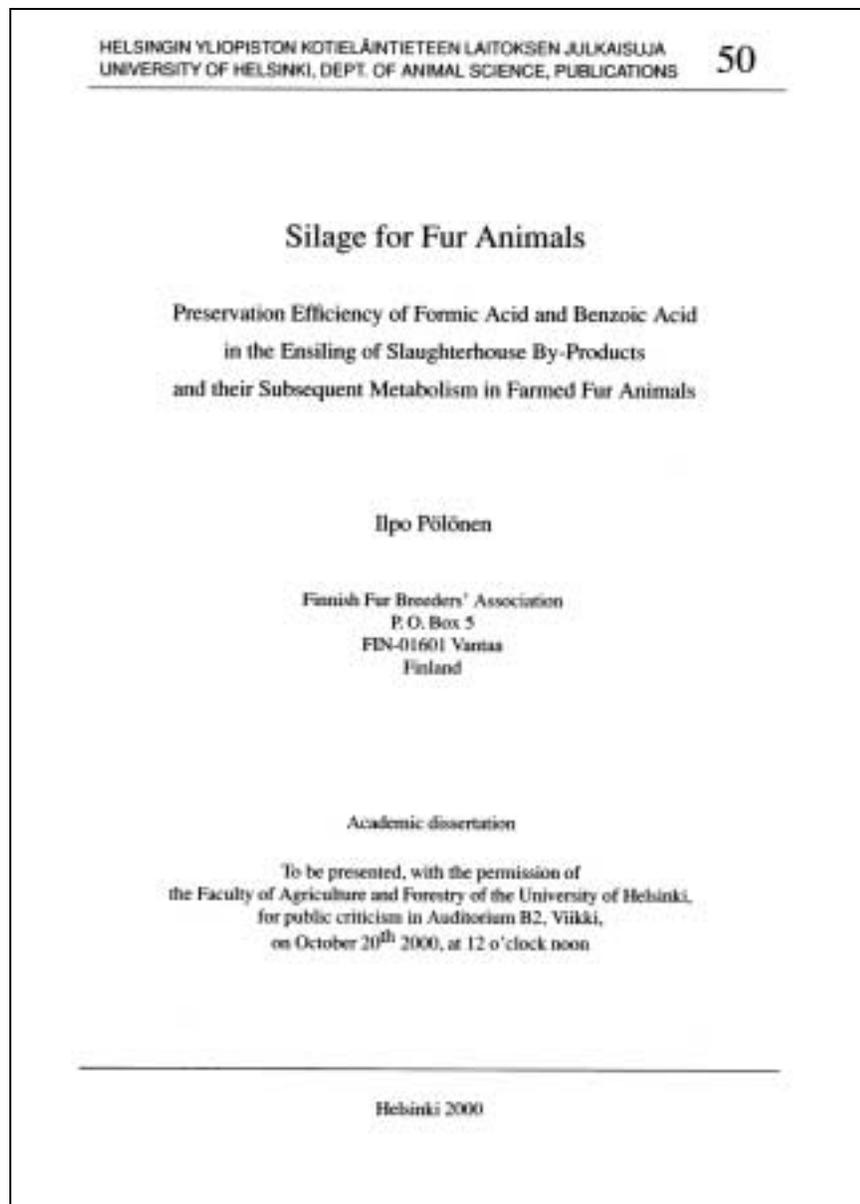
*B. Barabasz, R. Heliasz*

Investigations involved an evaluation of pelleted mixtures for chinchillas available in the country. The examinations included composition of mixtures and nutritive value of particular ingredients. Besides, an attempt was conducted of estimation nutritive value of mixtures, using as a criterion reproductive results on the chinchilla farms utilising these mixtures in the practical feeding. It was found that all mixtures contained a large number (11-14) of components providing required variability of flavour. Protein content in examined mixtures ranged from 12-20%. Fibre content averaged 12% (in extreme cases 9-11%), which should be accepted under the condition of supplementing the diet with hay. On the basis of the obtained results authors offered new formulas of balanced mixtures, with composition optimal for chinchillas.

## New doctor in fur animal nutrition

**Iipo Pölönen**, has presented his dissertation at the Faculty of Agriculture and Forestry of the University of Helsinki On October 20 in 2000.

ISBN 951-45-9560-2  
ISBN 951-45-9561-0 (PDF)  
ISBN 951-45-9562-9 (HTML)  
ISSN 1236-9837  
Helsinki 2000  
University Print



**Abstract**

The efficiency and feasibility of organic acids, especially formic and benzoic acids in the feeding of fur animals was investigated in five experiments, where the main emphasis was focused on the metabolism and rate of elimination of these preservatives, in order to assess practical dietary recommendations. Experiments were carried out with mink (*Mustela vison*), blue foxes (*Alopex lagopus*) and raccoon dogs (*Nyctereutes procyonoides*).

Formic acid (85% w w<sup>-1</sup>) alone (6 g kg<sup>-1</sup>, pH 4.0) stabilized slaughterhouse by-products, but only in the short term. The effect against yeasts was marginal and a regrowth of aerobic bacteria attributable to yeast growth and subsequent increase in pH resulted in organoleptic spoilage of the silages within 35 d irrespective of storage temperatures (4 and 20 °C). Additional propionic acid (2 g kg<sup>-1</sup>) enhanced preservation efficiency, but benzoic acid (2 g kg<sup>-1</sup>) was more effective against yeasts. In practical applications a combination of 10 g kg<sup>-1</sup> formic acid and 3 g kg<sup>-1</sup> sodium benzoate stabilized boneless by-products for several months. Ensiling improved apparent digestibility of fat of the boneless by-products in mink, but for high-ash by-products it resulted in the hydrolysis of fat, indicative of the formation of insoluble calcium salts.

Oxidation tests in mink showed that the mink oxidizes formate at a rather low rate. Based on the average oxidation rate of 30-35 mg kg<sup>-1</sup> BW h<sup>-1</sup>, the maximum daily formic acid (85% w w<sup>-1</sup>) intake was approximated to be 1 g kg<sup>-1</sup> BW. In blue foxes, based on the half-life measurements in blood, a maximum intake was estimated at 2.2 g kg<sup>-1</sup> BW. Regardless of the different methods of investigation, the results suggest that blue foxes metabolize formic acid more efficiently than mink. However, both in mink and blue foxes metabolism of formate appeared to be less efficient than in previously studied nonprimates which warrants a close monitoring of dietary concentrations in practice, particularly during periods of high feed intake. For optimal metabolism of formate, both mink and blue foxes should receive supplemental folic acid, more than is conventionally recommended for the prevention of folic acid deficiency.

The results concerning the practical production trial are consistent with observed formate oxidation rates and earlier research. Dietary formic acid concentration of 5 g kg<sup>-1</sup> appeared to be a threshold level for preweaned and weaned mink kits. At the threshold concentration during the intensive growth period performance is temporarily deteriorated by formate irrespective to defects in production parameters at pelting. Based on the number of born and weaned kits per female and the histologically evaluated developmental stage of spermatogenesis, the level of formic acid ensiled silage did not have negative effect on reproductive performance of mink. Furthermore, reproductive performance was not affected by dietary folic acid level (1.5 and 10 mg kg<sup>-1</sup> DM). Weaning weights of male kits were negatively affected by the highest silage level that contributed approximately 4.5 g kg<sup>-1</sup> formic acid.

With respect to the elimination of benzoate, none of the studied mink, blue foxes or raccoon dogs showed signs of sensitivity, but there were inter-species differences in benzoate elimination. Blue foxes eliminated large amounts of benzoate as hippuric acid (benzoylglycine) across all dietary levels whereas its proportion decreased in mink and raccoon dogs. In raccoon dogs, the proportion of hippuric acid was also initially low. In blue foxes 10% of dietary benzoate appeared unbound in urine, a value double that observed in mink and raccoon dogs. Furthermore, in this species, faecal percentage of free benzoic acid increased with dietary level and accounted for 15% with the highest dietary level of 4.15 mmol kg<sup>-1</sup>. Dietary glycine contents encountered in practice did not limit urinary hippuric acid excretion.

## **Faglig Årsberetning**

**2000**

**Pelsdyrerhvervets Forsøgs- og Rådgivningsvirksomhed**



## **Annual Report**

**2000**

**Danish Fur Breeders Research Center**

**Editor:** *Peter Sandbøl*  
**Lay out:** *Peter Sandbøl*  
**Cover photo:** *Bente Krogh Hansen*©  
**Printed by:** *DP/DPA*

ISSN 1395-198X

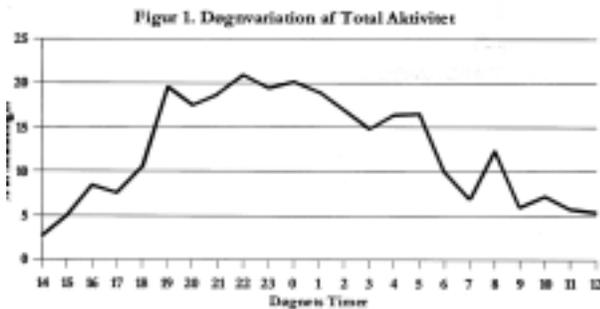
**Danish Fur Breeders Research Center**  
Herningvej 112 C  
DK-7500 Holstebro  
Phone: +45 96 13 57 00  
Fax: +45 97 43 52 77  
e-mail: pfr@pfr.dk

**Reports on: Ethology and Animal Welfare**

**The swimming behaviour of farm mink at different ambient temperatures**

*C.P.B. Hansen, L.L. Jeppesen*

Previous research with farm mink (*Mustela vison*) has shown a significant positive correlation between ambient temperature and swimming activity. Because a link with the general increase in activity during the warmer summer month could not be ruled out, we set up an experiment to investigate specifically whether ambient temperature influences the swimming activity. In separate cages with access to bath water, three times four female mink were placed in a temperature controlled room. After a week of familiarisation the animals were subjected to two periods of four days for each of four temperatures (8, 16, 24 and 32 degrees). The animals were recorded on video during day three after which water losses from the baths and water drunk were measured. From the video tapes the animals position and behaviour were both scanned every ten minutes and recorded in the intervals through one-zero sampling. The level of activity was independent of the temperature and the time of feeding and peaked at night between 19:00 and 07:00 (Fig. 1).



**Fig. 1.** Circadian variation in total activity of mink x-axis: Hours. y-axis: % of observations

Although ten of the mink used the bath for swimming, more than 70% of swims were conducted by one individual alone. Four of the animals did express stereotyped behaviour but neither this nor swimming was correlated with the ambient temperature. The most significant influence of the temperature was the position of the animals. At higher temperatures the animal were lying significantly more on the shelf above the water and less in the nest box than at lower

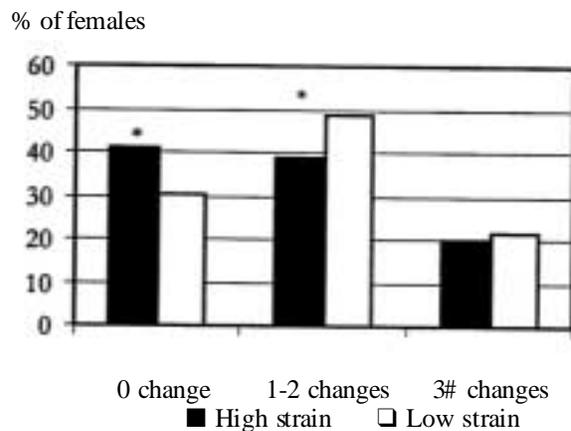
temperatures. This was probably due to the occurrence at this temperature of a temperature gradient of 1.7 degrees with the higher end in the nest box. The water consumption of the animals doubled between eight and thirty-two degrees. When allowed, 85% of the animals' water intake was from the bath instead of from the standard water tube. A significant correlation between swimming activity and water losses from the baths was also found.

The results presented here do not support the theory that the mink's swimming activity is correlated with ambient temperature. Instead, it seems more appropriate to assume that the previously encountered correlation has been due to seasonal variation in the level of general activity.

*Annual Report 2000, 7-11. 3 tables, 1 fig., 9 refs. Danish Fur Breeders Research Center, Holstebro, Denmark*

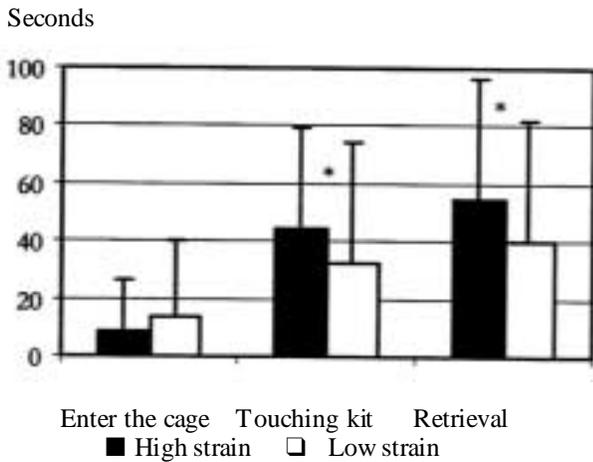
**Effect of external strain on lactating mink**  
*L. Overgaard*

Research may demand conditions that are less suitable for the animals. 58 lactating mink were subject to high external strain caused by passing of the feeding machine 5 or 10 times per day and only being fed once or twice (unpredicted feeding). 54 lactating females (control group) were subject to low external strain and were fed all at one time once or twice daily (predicted feeding). Until one week before expected parturition all the mink had equal conditions.



**Fig. 1.** % of females changing 0, 1-2 and 3 or more times between the cage and nest box. Mean of 10 min. observations 2 times weekly in 6 weeks. \* = p<0.05

The two groups gave birth to an equal number of kits, but the females subjected to high external strain weaned fewer kits due to larger kit mortality; partly because of more greasy kits. The females' activity was evaluated according to how often they changed between being in the nest box or in the cage during 10 minute observation periods over six weeks (Fig. 1). To assess the females nesting ability a 'kit-retrieval-test' was carried out. The two behavioural observation methods showed that females subjected to high external strain were less active and used more time to catch the kit back into the nest box than females subjected to low external strain (Fig. 2). It was concluded, that high external strain affected lactating mink, so that they took less care of their kits, resulting in high kit mortality.



**Fig. 2.** The time passed before the female enters the cage, touches the kit or gets the kit back to the nest. \* = p<0.05

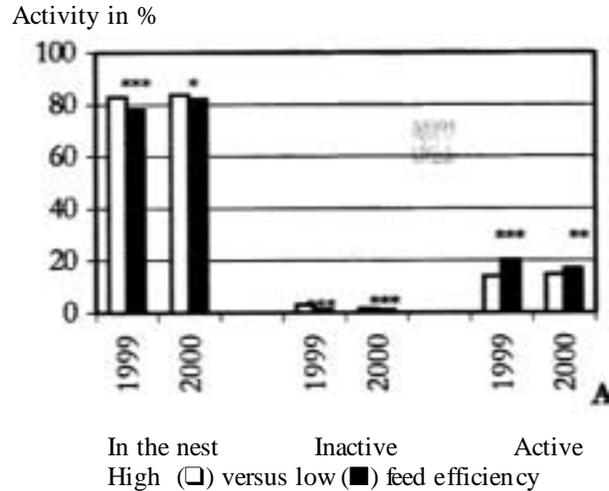
*Annual Report 2000, 13-16. 2 tables, 2 figs., 4 refs. Danish Fur Breeders Research Center, Holstebro, Denmark.*

**Activity of mink selected for high or low feed efficiency II.**

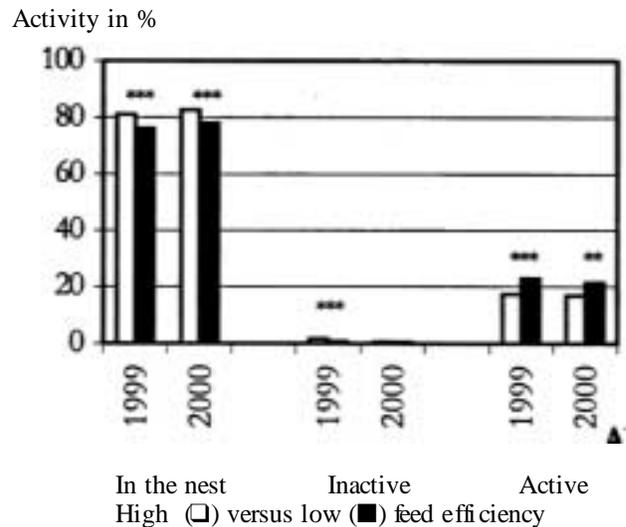
*L. Overgaard, K. Sørensen*

The aim of this study was to investigate whether feed efficiency was a heritable property in mink. Included in this study it was tested if the selection would affect the activity level of the mink. The study was made with two lines of mink selected for high or low feed efficiency. The activity level of the mink was

examined in 1999 at 145 males in July and 127 pairs in October, and again in 2000 at 171 males in July and 141 pairs in October (Fig. 2 and 3).



**Fig. 2.** Activity of male kits selected for high and low feed efficiency. Observation week 42 in October 1999 and 2000. \* = p<0.05; \*\* = p<0.01; \*\*\* = p<0.001.



**Fig. 3.** Activity of female kits selected for high and low feed efficiency. Observation week 42, October 1999 and 2000. \*\* = p<0.01; \*\*\* = p<0.001.

In July 2000 and October both years mink selected for high feed efficiency were less active than mink selected for low feed efficiency. In July 1999 there were no differences in activity between the selection lines. It was concluded that selection on feed efficiency in mink influences their activity level.

*Annual Report 2000, 17-20. 1 table, 3 figs., 6 refs. Danish Fur Breeders Research Center, Holstebro, Denmark.*

### **Alternative management routines and housing systems of farmed foxes: How do they affect reproduction?**

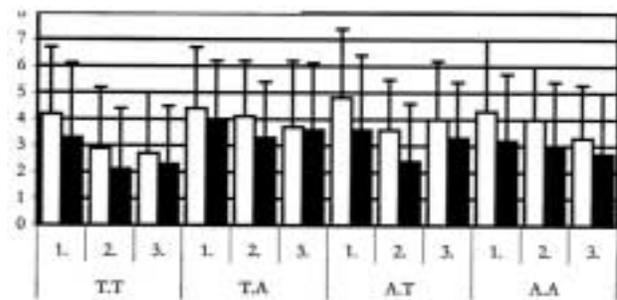
V. Pedersen

In order to examine consequences of different housing systems on the behaviour, welfare and performance of farmed foxes, a Danish study on alternative housing was conducted in the years 1993-1996 (Jeppesen, 1994, Pedersen, 1994, 1997; Pedersen and Skovgaard, 1995, 1996, Pedersen et al., 1996). Among other results, this study left the impression that one of the alternative systems caused an impaired reproductive success reflected in a higher proportion of vixens losing their cubs around birth in some years. Since the alternative system in question in previous studies (Jeppesen and Pedersen, 1992, Pedersen and Jeppesen, 1993) had shown to reduce fearfulness and increase welfare of adult silver fox vixens it seemed important to examine the causes of a higher cub mortality in this system. Eventually, it was revealed that this system differed from the traditional system in some uncontrolled ways. Firstly, the vixens were kept permanently in the same cage (and nest box) year-round and the time span of birth dates between neighbours could be up to 6 weeks. In the traditional system, when mating was completed, vixens were moved to other but similar cages according to date of parturition, starting from the bottom of the shed. This accomplished that neighbouring vixens gave birth at largely the same dates in this system. Secondly, the individual vixen was kept in closer contact with neighbouring vixens during the breeding season in the alternative system due to the location of the nest boxes on the roof of the cages. In the traditional system, the nest box was placed in one of the two rooms of the fox cage in such a way that it blocked for the vixens' access to that room and thus blocked for the access to close contact with neighbouring vixens.

The objective of the present study, conducted for a 3-year period, was to examine how the above-mentioned different housing and management routines affected reproductive success in farmed silver fox vixens. One hundred primiparous vixens were randomly assigned to a 2x2 factorial design, where the housing system was either the traditional (1.2m<sup>2</sup>, standard nest box in the cage, T) or an alternative cage environment (2.2m<sup>2</sup>, top

mounted nest box and two platforms, A) and the management routine was either the traditional (alternate neighbours, successive birth dates, T) or an alternative (permanent neighbours, random birth dates between neighbours, A). Numerous parameters linked to reproduction were registered during the course of the study. The main findings were that a stable environment seemed to benefit reproductive success in the silver foxes, most strongly expressed in the traditional housing system (Fig. 3). The alternative housing system showed a potential for an improved reproductive success, but differed significantly only from the traditional cage environment with the traditional management routine on a few occasions.

y-axis = number of cubs



**Fig. 3.** Mean number of cubs (+ SD) born (□) and weaned (■) in the 3 years and in the 4 experimental groups: T.T = traditional housing and management with new neighbours according to whelping date. T.A = traditional housing, constantly same neighbours. A.T = alternative housing, traditional management with new neighbours according to whelping date. A.A = alternative housing, constantly same neighbours.

Cub-mortality was relatively high in the alternative cage environment though no significant differences were found between this and the traditional environment. However, reasons for cub mortality in the alternative environment should be examined thoroughly, especially since it has been proven to increase welfare of the vixens in previous studies. Through modifications of the nest box design and the access to the nest box the welfare of cubs might be improved as well, thus reducing cub mortality.

*Annual Report 2000, 21-28. 3 tables, 4 figs., 12 refs. Danish Fur Breeders Research Center, Holstebro, Denmark.*

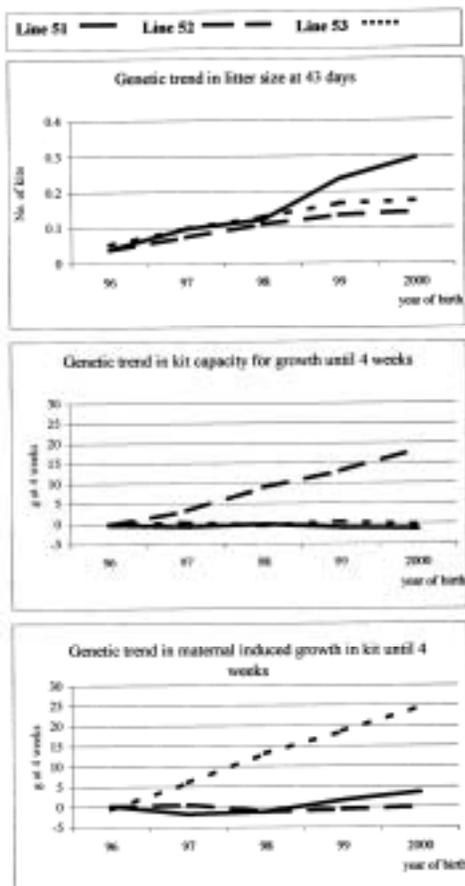
## Reports on: Genetics and Breeding

### Selection for kit growth - considering welfare of the dam. Results of the fourth year of selection

*B.K. Hansen, P. Berg, J. Malmkvist, S.W. Hansen, U.L. Rasmussen*

The present report is the fourth provisional report of a selection project started in 1996. The aim of the project is to evaluate the genetic variation in early kit growth and its relation to body weight later in the growth period and the demands on the dam. The three selection lines were established in 1996. In line 51 the selection criteria is litter size. The selection for growth of kits is in line 52 based on kit's own capacity and in line 53 on the maternal ability to induce growth in kits, in both lines kit growth is adjusted for litter size. In all lines the breeding values are estimated by an Animal Model. The material includes registrations from 7865 kits. There is a positive response in the selected trait in all lines (Fig. 1).

**Fig. 1.** Genetic trend using all animals and information



available from all years.

The response in litter size is 0.3 kit at 43 days in line 51. The response in male kit growth is about 18 grams at 4 weeks in line 52 and about 24 grams of body weight at 4 weeks in line 53. Preliminary results from the present selection experiment confirm that there are two ways to affect the early growth of kits by selection: to select for the kits own growth capacity or to select for maternal ability to induce growth on kits. In line 53 the phenotypic effect on kit body weight at 4 weeks is highest. Registrations from the behaviour tests are collected, but not analysed.

*Annual Report 2000, 29-32. 1 table, 1 fig. 7 refs. Danish Fur Breeders Research Center, Holstebro, Denmark.*

### Is feed efficiency a hereditary trait?

*K. Sørensen, P. Berg, U.L. Rasmussen, B.K. Hansen*

Feed is the largest expense in the production of mink; this was the main reason for a selection experiment on feed efficiency using mink of brown colour type. Feed efficiency was measured on male kits in July over a 4-week period as weight gain divided by dry matter feed intake. The selection started in 1989 with lines selected for high (HFE) and low (LFE) feed efficiency, in 1992 the LFE line was stopped. In 1993 the HFE line became basis for new selection lines which has currently been selected for seven generations for either high (HFE-HW) or low (LFE-HW) feed efficiency combined with high body weight in November. The data contained records from eleven generations (years) with 4508 animals of which 1868 were males with records for feed efficiency. Genetic parameters and genetic trends for feed efficiency, weight gain, feed intake and weight in November have been estimated using bivariate Animal Models by an Average Information REML algorithm. Heritability for feed efficiency was 0,29 and 0,61 for weight in November. Comparisons of selection lines show that statistically significant differences for mean breeding values of feed efficiency were found in all years. Differences in feed efficiency in recent years were mainly due to differences in weight gain because there were only small differences in feed intake.

*Annual Report 2000, 33-38. 4 figs., 6 refs. Danish Fur Breeders Research Center, Holstebro, Denmark.*

## Reports on: Nutrition and Nutritional Physiology

### Astaxanthin (Novasta™) for mink females in the reproduction period 2000

T.N. Clausen, C. Hejlesen, P. Sandbøl

We investigated the possible effect on reproduction in mink of adding algae meal (Novasta™) with a high content of astaxanthin to the feed in the winter and reproduction period. Two groups of wild type mink females with approximately 350 females per group were used. To the feed in the study group 0,25 g of Novasta per animal per day was added from February 14 to weaning of the kits at 6 weeks. There were no differences in number of kits and kit weight at weaning between control and investigation group. Analyses of astaxanthin in the feed and plasma showed much lower values than expected. No clear explanation as to the cause of this discrepancy has been found.

*Annual Report 2000, 39-42. 4 tables, 5 refs. Danish Fur Breeders Research Center, Holstebro, Denmark.*

### Energy Distribution in Mink Feed in the Winter and Reproduction Periods

C. Hejlesen, T.N. Clausen

It has been shown, that feed protein content in the winter and reproduction periods can be lowered from 55% of the metabolizable energy (ME) to 45% with a carbohydrate content of 10 to 15% of the ME without negative effects. A protein content of 45 % of the ME and a carbohydrate content of 20% has indicated reduced number of live born kits. Further-more 30% of the ME from protein (a typical growth period diet) in the period from December to late February has elevated the frequency of greasy kits.

The aim of this investigation was to elucidate possible effects on reproductive performance of lowering the protein content in the winter and reproduction periods from 55% of the ME to 45%, and varying the carbohydrate content between 10 and 25% of the ME. In addition to this, feeding a typical growth period diet from December to late February was investigated

It is concluded that without negative effects on reproductive performance the protein content in the winter and reproduction periods can be reduced from

55 to 45% of the ME with 40% and 15% of the ME from fat and carbohydrate respectively. Feeding 30% of the ME from protein from December to late February elevated the number of live born kits, but it also elevated the kit loss from birth to weaning. It did not have any significant effect on the frequency of greasy kits.

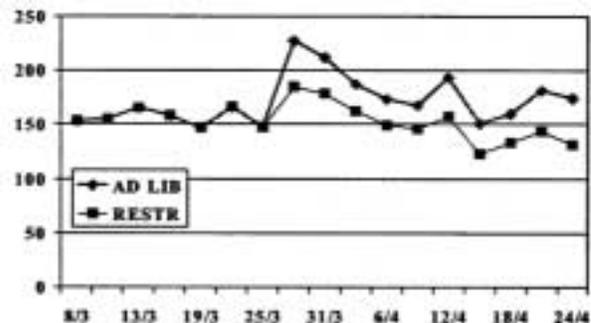
*Annual Report 2000, 43-50. 16 tables, 7 refs. Danish Fur Breeders Research Center, Holstebro, Denmark.*

### Ad libitum or restrictive feeding of scanblack mink females in the gestation period

T.N. Clausen, C. Hejlesen

We investigated the importance of feed intensity in April for mink females milk production, based on kit weights at day 28 and at weaning. Two groups of standard mink females were fed *ad libitum* (AD LIB) versus 20 % less than *ad libitum* (RESTR) in the gestation period (March 25 to April 24; Fig. 1).

g feed / female / day



**Fig. 1.** The amount feed per female in AD LIB and RESTR groups during gestation period.

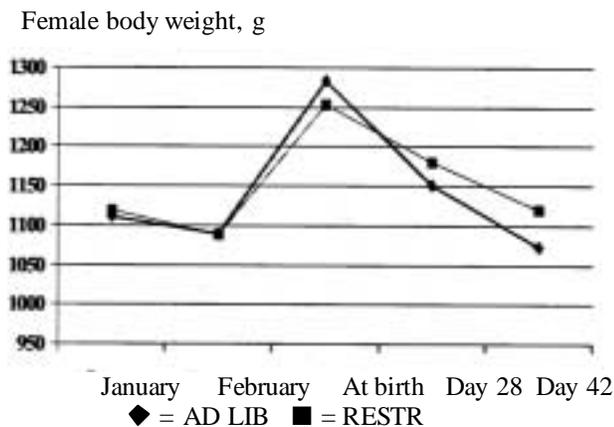
There were no significant differences in the number of kits at birth and at weaning, but significantly more kits died from birth to day 28 in the RESTR group.

The kit weight in the AD LIB group was higher at day 28 (significant) and at weaning (not significant) than in the RESTR group (Table 3).

The females in AD LIB had higher weight at birth, but lower weight at day 28 and weaning than the RESTR group, due to more kits and heavier kits (Fig. 3).

**Table 3.** Average kit weights at the age of 28 and 42 days. (SD in parenthesis). Different letters indicate significant difference between groups. NS=non significant.

Feed group	Mean body weight, g			
	Age 28 days		Age 42 days	
	Males	Females	Males	Females
AD LIB	166 (37) a	150 (35) a	269 (75)	253 (64)
RESTR	154 (35) b	138 (35) b	259 (69)	239 (65)
P value	0.0009	0.004	NS	NS (p=0.1)



**Fig. 3.** Females fed *ad libitum* or restrictive: average body weights in the winter and during lactation 2000.

It was concluded that the feed intensity of the females in the gestation period was important for the milk production in the lactation period.

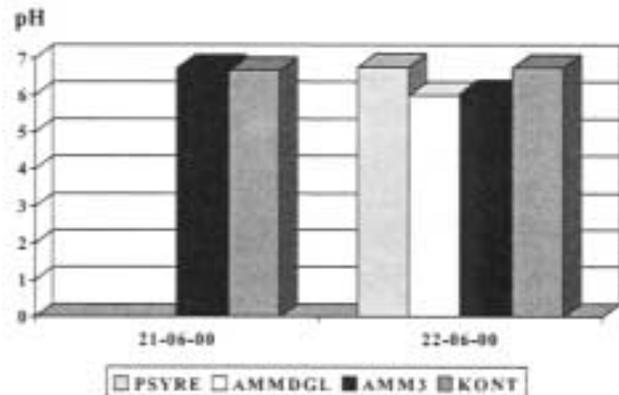
*Annual Report 2000, 51-54. 4 tables, 2 figs., 4 refs. Danish Fur Breeders Research Center, Holstebro, Denmark.*

### Addition of phosphoric acid or ammonium chloride to mink feed in June. Influence on urine pH and body growth.

*T.N. Clausen*

Urine pH and body growth were investigated in mink kits in a 17 days period from weaning June 13 to June 30. Four groups of each 10 litters of wild type mink kits borne May 1 were used. 0,2 % phosphoric acid (75%) was added daily to the feed in group PSYRE, 0,35 % ammonium chloride was added daily to the feed in group AMMDGL, 0,35 % ammonium chloride was added three days a weak to the feed in group AMM3 and one group served as control (KONT).

A daily addition of 0,35 % ammonium chloride in the period June 13 to June 30 gave a non- significant reduction in the kit body growth. 0,35 % ammonium chloride in the feed reduced the urinary pH to around 6.0. On the days where there was no ammonium chloride in the feed of group AMM3, the urine pH was on the same level as in the KONT group. 0,2 % phosphoric acid did not lower the urinary pH compared to the control group.



**Fig. 1.** Urine pH of mink kits fed plane control feed (KONT), or control feed with 0.2% phosphoric acid (PSYRE), or 0.35% ammonium chloride each day (AMMDGL) or 0.35% ammonium chloride 3 days a week (AMM3). At day 21/06 only groups KONT and AMM3 were sampled. Ammonium chloride was not added to the feed of group AMM3 on June 21.

*Annual Report 2000, 55-57. 3 tables, 1 fig., 8 refs. Danish Fur Breeders Research Center, Holstebro, Denmark.*

### Shelf life of sulphuric acid- and Ensilox- preserved fish silage.

*T.N. Clausen, C. Hejlesen*

The shelf life of sulphuric acid and Ensilox-preserved fish silage were investigated. The silage were produced in May from the same fish lot, and the products were analysed regularly until mid-October. The shelf life of Ensilox-preserved fish silage seemed to be lower than that of sulphuric acid-preserved fish silage. It is suggested that Ensilox-preserved fish silage should be used within 3 months after production.

*Annual Report 2000, 59-60. 5 tables, 1 ref. Danish Fur Breeders Research Center, Holstebro, Denmark.*

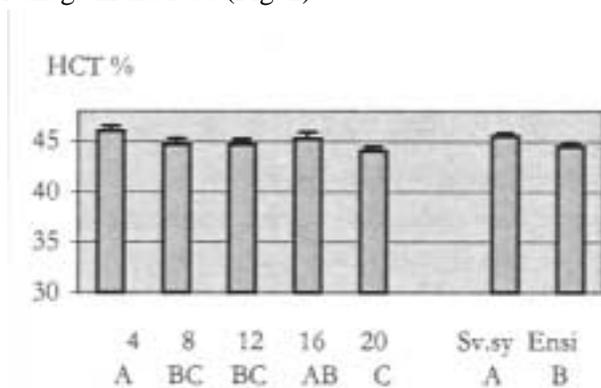
### Sulphuric acid- and Ensilox-preserved fish silage for mink in the growing-furring period

T.N. Clausen, C. Hejlesen

A study was done on sulphuric acid- and Ensilox-preserved fish silage for mink in the growing-furring period 1999.

Nine groups, each consisting of 81 wild type male mink kits and 81 wild type female mink kits, were used. In the growing-furring period the kits were fed 4, 8, 12, 16 or 20 % fish silage preserved with sulphuric acid or 4, 8, 12 or 16 % fish silage preserved with Ensilox (based on formic acid).

The results showed that mink kits fed up to 16 % Ensilox-preserved fish silage in the growing-furring period attain the same skin size and quality as mink kits fed up to 20 % sulphuric acid-preserved fish silage. However, there was a tendency towards reduced skin quality when we used 16 % Ensilox-preserved silage in the feed. The blood percent was lower in the groups fed Ensilox-silage compared to the groups fed sulphuric acid silage, and there was a reduction in the blood percent with increasing amount of silage in the feed (Fig. 2).



**Fig. 2.** The mean blood percent of mink (and SE) in relation to the amount of silage (4-20 % of silage in feed), or the type of silage (Sv.sy = sulphuric acid silage, Ensi = Ensilox silage) in feed. Different letters indicate significant differences between groups.

*Annual Report 2000, 61-65. 6 tables, 2 figs., 4 refs. Danish Fur Breeders Research Center, Holstebro, Denmark.*

### Rape lecithin+ for mink in the growing-furring period.

T.N. Clausen, C. Hejlesen

Rape lecithin+ (R+) is a new commercial product based on phospholipids and fatty acids extracted from rape- and sunflower oil. The product has a high content of gamma-tocopherol and choline, and should be able to replace the addition of these in the vitamin premix. Six groups, each of 81 male and 81 female mink kits were fed in the growing-furring period with the addition of around 8,5 % fat. Fat was added as R+, soybean oil (SOY), lard (SV), 2/3 SOY & 1/3 SV, 1/2 R+ & 1/2 SV, or 1/2 R+ & 1/2 SOY. Rape lecithin+ alone or in combination with soybean oil or lard, reduced body weight and skin size, and can not be recommended for mink kits in the amounts used in this investigation.

*Annual Report 2000, 67-71. 7 tables, 5 refs. Danish Fur Breeders Research Center, Holstebro, Denmark.*

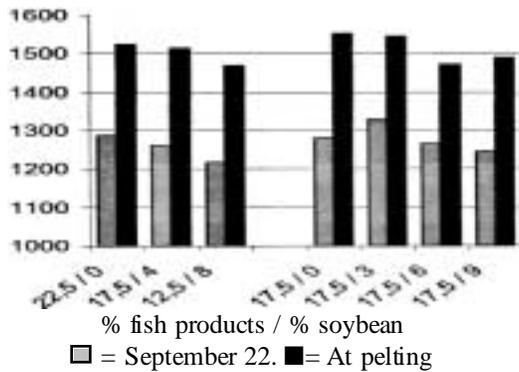
### Toasted soya beans for mink in the growing - furring period.

C. Hejlesen, T.N. Clausen

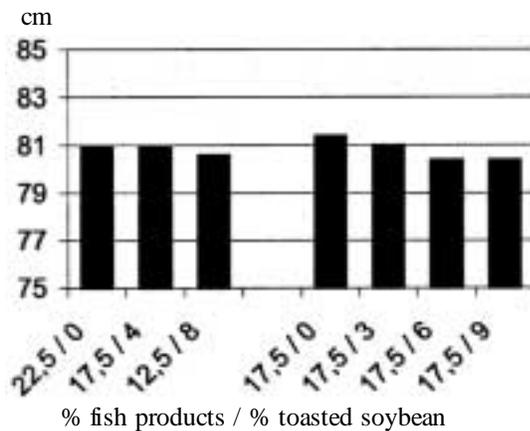
Toasted soybean is an attractive source of protein as price is not influenced by demand for mink feed. Trypsin inhibitors (anti nutritional factors, ANF) in soy beans is markedly eliminated by heat treatment (toasting), but moreover soy beans contain oligo-saccharides and other ANF, which limits the use of it in mink feed. Experiments, where the fish content was varied strongly, indicated that toasted soybeans ought not to comprise more than 4-8% of the feed in the growth period. In this experiment 7 groups of 81 male- and 81 female scanbrown mink were allotted up to 9% toasted soybeans in feed containing three levels of fish-offal and industrial fish (12.5, 17.5 and 22.5% fish) and constant level of these (17.5%).

It is concluded, that more than 3% toasted soybean had a depressive effect on weight gain until late September, on weight at pelting in November and on skin length. Fur quality was not affected significantly, but the wool density was significantly reduced when 9% toasted soybeans was fed.

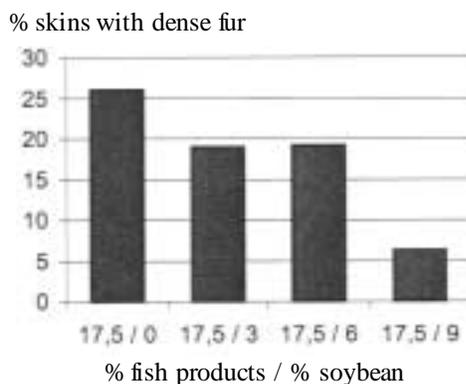
Weight gain, g



**Fig. 1.** Body growth in grams from weaning to September 22 and to pelting. Reduced growth with increasing amount of toasted soybean. No significant differences.



**Fig. 2.** Skin size in cm. Indication of reduced skin length with increasing % of toasted soybean in the feed.



**Fig. 3.** Significantly fewer skins with dense fur when 9% soybean was used in the feed. ( $p < 0.004$ ).

*Annual Report 2000, 73-76. 2 tables, 3 figs., 3 refs. Danish Fur Breeders Research Center, Holstebro, Denmark.*

### Phase feeding of mink in the growing - furring period

*C. Hejlesen, T.N. Clausen*

A reduced protein content from 29 to 24% of the ME in the growth period feed from mid September has in several investigations not influenced skin length or fur quality. In these investigations fat energy has substituted energy from protein. In this experiment energy from protein was substituted by energy from either fat or carbohydrate starting at three different dates in the growing-furring period.

In conclusion, substituting energy from protein either with energy from fat or carbohydrate had no effect on weight gain, skin length or fur quality.

*Annual Report 2000, 77-80. 5 tables, 7 refs. Danish Fur Breeders Research Center, Holstebro, Denmark.*

### Analytical and calculated EFLC separation of intact oils / lipids (triacylglycerols) as methods for evaluation of oil / fat quality

*S. Buskov, K. Mortensen, H. Sørensen*

Enhanced Fluid Liquid Chromatography (EFLC) based on acetonitrile:2-propanol:CO<sub>2</sub> as eluent is described for direct analysis of intact triacylglycerols in different vegetable and animal oils. The EFLC method, like HPLC and SFC, is suitable for qualitative analyses for these oils and gives an overall good separation of the individual triacylglycerols with additional sub-separation in groups defined by carbon number (CN), number of double bonds (DB) and equivalent carbon number (ECN). A linear correlation between  $\log k'$  and CN, and also between  $\log k'$  and ECN is found which enables prediction of the retention times of individual triacylglycerols with good accuracy. Predicted and determined capacity factors for combinations of triacylglycerols from palmitic acid (P), stearic acid (S), oleic acid (O), linoleic acid (L), linolenic acid (Ln) and erucic acid (E) are reported using a correction constant,  $g_i$ , which depends on the type of unsaturated fatty acid.

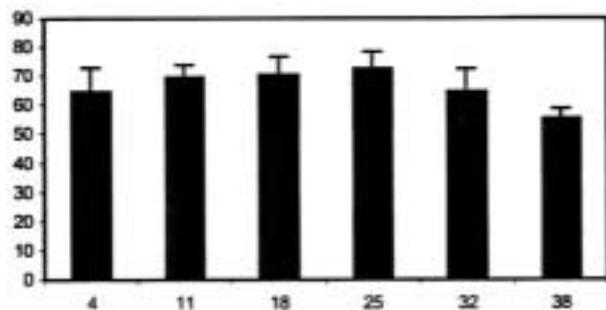
*Annual Report 2000, 81-94. 3 tables, 11 figs., 18 refs. Danish Fur Breeders Research Center, Holstebro, Denmark.*

#### **Investigation of dry matter content in mink milk**

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

Determination of individual constituents in mink milk is generally expressed in % of dry matter (DM) in the milk. The interval of DM content reported for mink milk has, however, varied considerable in different investigations, leading to a need for further evaluation of these differences. In the present study, the DM content in mink milk obtained from 4 different lactating years (1997, 1998, 1999, 2000) has been determined by lyophilisation. Moreover, selected samples were reanalysed by a standardised AOAC method (Air oven method). The results obtained revealed only minor differences in DM level determined by the two methods tested. Mink milk has been shown to have a considerably higher content of DM compared to the DM content in milk from other animals. The variation in DM content was marked both between different animals, and during the lactating period for individual animals. The now obtained results have been compared and discussed in relation to data from earlier studies on DM in mink milk.

% DM



**Fig. 1.** Variation of dry matter content in mink milk from day 4 to day 38 in lactation. Each bar is a mean of 10 females. Standard deviation marked on the top.

*Annual Report 2000, 95-98. 2 figs., 9 refs. Danish Fur Breeders Research Center, Holstebro, Denmark.*

#### **New methods of analysis for characterization of lipids in mink feed and studies of lipid metabolism.**

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

Lipids, vegetable oils and animal fat are quantitatively dominated by triacylglycerols, but this group of lipids comprises also appreciable amounts of amphiphilic compounds, especially phospholipids, as well as nutritional important groups of compounds as fat-soluble vitamins, phyosterols, and antioxidants. Considering the quantitatively dominating part that lipids form of most of the traditionally used mink feed, it is obvious that efficient methods of analyses for determination of individual intact lipids are of utmost importance. Such methods are wanted for correct information on the lipid quality, potential risk of rancidity, content of native intact lipids, triacylglycerols and phospholipids. Methods based on Supercritical Fluid Techniques (SFT) give opportunities for quantitative and selective extraction of triacylglycerols by Supercritical Fluid Extraction (SFE) followed by extraction of amphiphilic lipids (phospholipids) by use of SFE with modifier. With Supercritical Fluid Chromatography (SFC) individual intact triacylglycerols are well separated and give a supplement to traditionally used gas chromatographic (GC) analyses of fatty acid methyl esters (FAME), which are transformation products of triacylglycerols. The new and recently obtained improved techniques for lipid analyses are Enhanced Fluid Liquid Chromatography (EFLC) supplied with Evaporative Light Scattering Detection (ELSD). This new method of analysis allows determination of individual intact lipids (triacylglycerols) with prediction of the type of fatty acids in the compounds, and the technique is relatively simple to perform. The potential value of this technique is shown by the results included and discussed in this work, and it gives the basis for studies of lipid metabolism, which is a poorly investigated area of the mink research.

*Annual Report 2000, 99-105. 1 table, 9 figs., 9 refs. Danish Fur Breeders Research Center, Holstebro, Denmark.*

## Reports on: Hair and skin

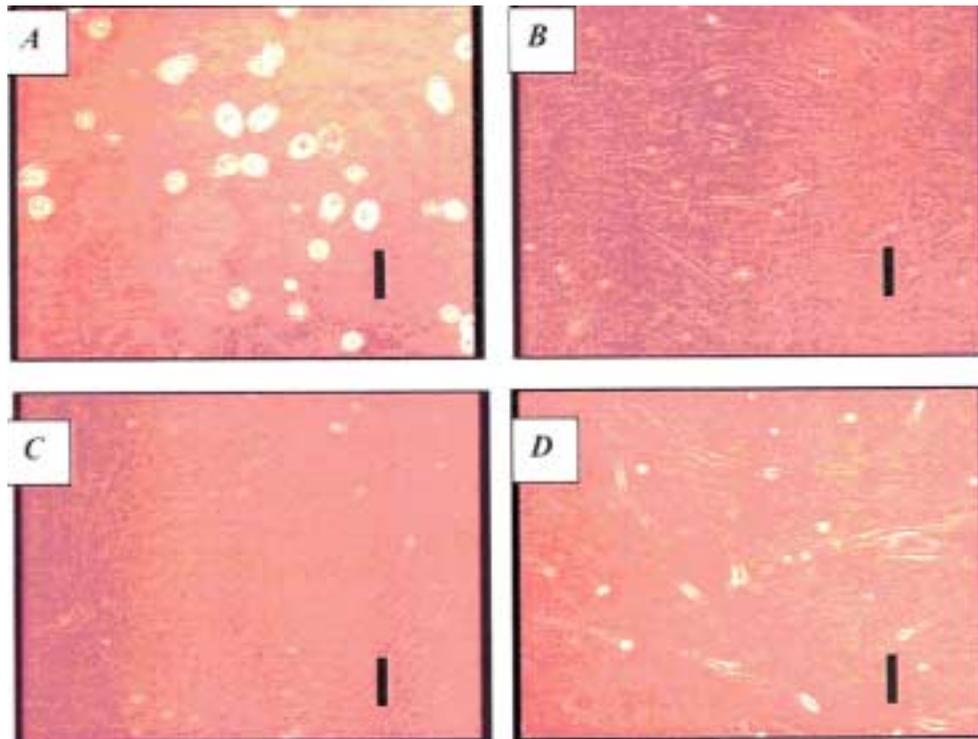
### Fibroblast stem cells from mink grown *in vitro* cell cultures – a smart and cheap tool for skin research and testing of feed additives.

*B. Riis*

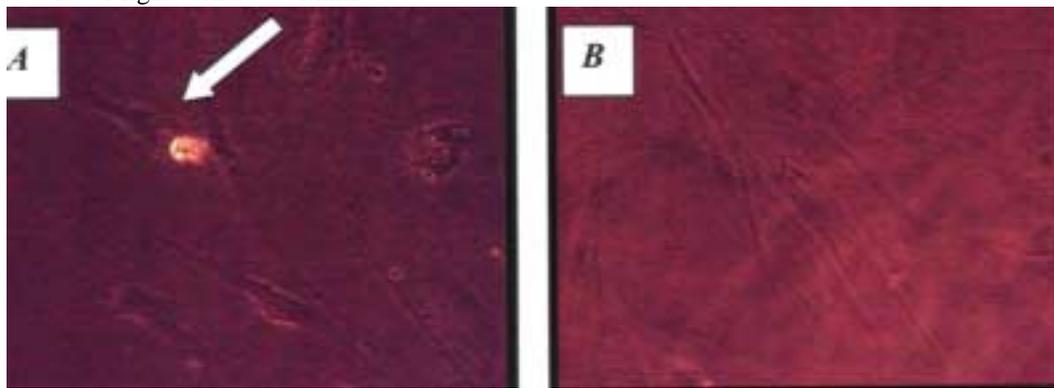
This study shows that it is possible to grow mink skin fibroblasts in primary culture. It was also found that the primary culture could be serially passaged thus establishing a stable subculture population designated MiS-1. It was shown that MiS-1 could be stored at –

196<sup>0</sup>C, thawed and further propagated. Capillary zone electrophoresis (CZE) analysis showed that samples from skin of very young mink kits and the MiS-1 essentially contained the same proteins. This shows that the skin fibroblast cells are valid models for mink skin research. Furthermore, testing of various substances (i.e. hormones, feed additives etc.) can be performed on such a skin model thus saving time and money.

*Annual Report 2000, 107-111. 3 figs., 3 refs. Danish Fur Breeders Research Center, Holstebro, Denmark.*



**Fig. 1.** Mink skin fibroblasts, MiS-1, in culture, (100 x). A new culture, B after 24 hours, C after 48 hours, D after 6 weeks. The dark scale at lower right corner = 0.1 mm.



**Fig. 2.** Mink skin fibroblasts, MiS-1, (300 x). A: A dividing cell (arrow), B: Slim characteristic of fibroblasts.

### Relationship between pelt colour in brown mink characterised with traditional methods and with colour measurements

*P.V. Rasmussen, P. Berg*

In mink production the shade of a certain coat colour can be controlled or modified by selection. In praxis, this is based on traditional, visual methods, meaning that differences between grades are relative. The question is whether absolute colour measurements applied to live animals and their pelts can complete the visual grading and the genetic knowledge based on it. We used visual and colorimetric methods separately to describe the fur colour of brown mink from a selection experiment (live animals and stretched, dried pelts). This paper presents correlations between visual colour intensity, clarity, and colorimetric lightness, red, yellow, and chroma (saturation). The results show that it is possible to characterise the colour of both sexes of live brown mink and the pelts with objective and nondestructive methods. Further, visual and colorimetric variables are correlated with each other to different degrees.

**Table 3.** Correlation of colorimetric L\*, a\*, b\* and C\* between live animals (A) and skins (S). Males (N = 206) over, and females (N = 184) under the diagonal.

	L* (A)	a* (A)	b* (A)	C* (A)	L* (S)	a* (S)	b* (S)	C* (S)
L* (A)		0.34	0.48	0.45	0.32	0.20	0.23	0.23
a* (A)	0.31		0.92	0.96	0.51	0.63	0.59	0.60
b* (A)	0.50	0.89		1.00	0.51	0.50	0.51	0.52
C* (A)	0.46	0.94	0.99		0.52	0.54	0.54	0.55
C* (A)	0.36	0.58	0.54	0.56		0.60	0.72	0.70
a* (S)	0.19	0.65	0.54	0.58	0.57		0.94	0.97
a* (S)	0.25	0.62	0.57	0.59	0.71	0.92		1.00
C* (S)	0.24	0.64	0.57	0.60	0.69	0.95	1.00	

**Table 4.** Correlation between visual grading of colour and clarity and colorimetric variables L\*, a\*, b\* and C\* on live animals. Males (N = 237) over, and females (N = 256) under the diagonal. ns = non significant, p ≥ 0.05.

	Colour	Clarity	L*	a*	b*	C*
Colour		-0.15	-0.17	-0.37	-0.36	-0.37
Clarity	-0.19		-0.07ns	0.60	0.41	0.46
L*	-0.21	0.03 ns		0.27	0.43	0.40
a*	-0.40	0.63	0.26		0.92	0.96
b*	-0.42	0.45	0.44	0.90		0.99
C*	-0.42	0.51	0.40	0.94	0.99	

*Annual Report 2000, 113-116. 5 tables, 6 refs. Danish Fur Breeders Research Center, Holstebro, Denmark.*

### Reports on: Pathology & Diseases

#### Pre-weaning diarrhoea and exanthema in mink kits in Sweden and Denmark - A case control study of possible causative agents and contributing factors.

*L. Englund, H.-H. Dietz., M. Chriél, K.-O. Hedlund*

Pre-weaning diarrhoea and exanthema ("greasy kits") is frequently observed in farmed mink kits. Previous studies have often suggested that this is a multifactorial disease complex but histopathological studies have also suggested an underlying viral infection. In this study intestines and intestinal contents from 180 mink kits, in affected and non affected farms, were examined by electron microscopy and histopathology. Epidemiological data were also collected. Preliminary results indicate that there may be a correlation between the presence of, as yet unidentified, virus and the occurrence of "greasy kits" in the 18 Swedish and Danish mink farms included in the study. More detailed studies of the observed virus-like particles are currently made in co-operation with experts on the identification of small enteric viruses in humans. Efforts are also made to try and isolate the observed viruses in different cell cultures, bearing in mind that *in vitro* growth of such viruses is often difficult before suitable media and cell lines are identified. Some of the human enteric viruses cannot be cultured at all, others will multiply only in particular cell lines. Nevertheless, virus culture is the preferred way to identify virus and to develop test methods which allow epidemiological studies on a larger scale. Should propagation in culture prove impossible, direct sequencing of the viral genomes will be applied.

*Annual Report 2000, 117. Danish Fur Breeders Research Center, Holstebro, Denmark.*