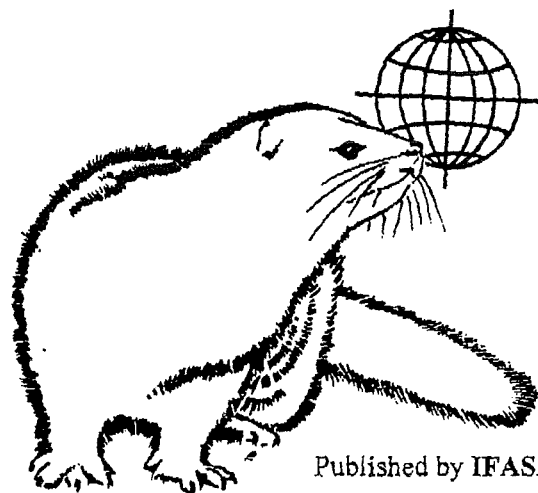


SCIENTIFUR  
ISSN 0105-2403  
Vol. 23, No. 2  
May, 1999



Published by IFASA

INTERNATIONAL FUR ANIMAL SCIENTIFIC ASSOCIATION

1.	Contents	85
2.	Notes	93
	<b>New book: Handbook of biological data for mink. Compiled by R.J. Aulerich, D.C. Powell, S.J. Bursian. Code 3-M.</b>	94
3.	<b>Nutrition &amp; nutritional physiology</b>	
	<b>Repeatability of mineral element content in the fur of female white nutrias. D. Mertin, K. Šivogová, P. Fl'ak, P. Sviatko, E. Podolanová, I. Tocka. Original Report. Code 2-3-O.</b>	95
	<b>The possibility for in vitro estimation of carbohydrate and starch digestibility in mink. Helle Nygaard Lærke, Christian Friis Børsting. Code 3-6-7-M.</b>	100
	<b>Annual variation in the content of dry matter, protein, amino acids, fat and fatty acids in herring offal. Søren Krogh Jensen, Christian Friis Børsting. Code 6-7-M-F.</b>	100
	<b>Different proportions between energy from protein, fat and carbohydrate in the feed for mink females during winter and suckling periods. Tove N. Clausen, Carsten Hejlesen. Code 6-5-M.</b>	101
	<b>Low content of protein and fish in mink feed during winter and suckling period. Carsten Hejlesen, Tove N. Clausen. Code 6-5-M.</b>	101

<b>Fatty fish products in mink feed during the growth period (1997 trials).</b> <i>Tove N. Clausen, Carsten Hejlesen. Code 7-6-M.</i>	101
<b>Reduced fish content in the feed for mink kits during growth period.</b> <i>Tove N. Clausen, Carsten Hejlesen. Code 7-6-M.</i>	102
<b>Poultry offal containing 20 percent feathers in mink feed during the growth period.</b> <i>Carsten Hejlesen, Tove N. Clausen. Code 7-6-M.</i>	102
<b>Phase feeding of mink kits in the growth period (protein reduction).</b> <i>Carsten Hejlesen, Tove N. Clausen. Code 6-M.</i>	102
<b>Vitamin E analyses in blood and liver for evaluation of the response of the mink to dietary fat quality.</b> <i>Åse Uttenthal, Christian Friis Børsting. Code 3-6-M.</i>	103
<b>Influence of the feed on the urine acidity in mink kits during the suckling period.</b> <i>Tove N. Clausen, Birthe Damgaard. Code 3-6-5-M.</i>	103
<b>The palatability of CO<sub>2</sub> stored barley in mink feed.</b> <i>Carsten Hejlesen. Code 6-7-M.</i>	103
<b>The palatability of CO<sub>2</sub> stored wheat in mink feed.</b> <i>Carsten Hejlesen. Code 6-7-M.</i>	104
<b>Palatability trials with 7.5% swine pulp in mink feed, 1998.</b> <i>Carsten Hejlesen. Code 6-7-M.</i>	104
<b>Palatability experiment with gelatine hydrolysate for mink.</b> <i>Carsten Hejlesen. Code 6-7-M.</i>	104
<b>Palatability experiment with potato juice in mink feed.</b> <i>Carsten Hejlesen. Code 6-7-M.</i>	104
<b>Determination of fatty acids in fat rich fish products.</b> <i>Søren Krogh Jensen, Christian Friis Børsting. Code 3-7-M-F-O.</i>	105
<b>Rapid qualitative analysis of oils of vegetable and animal origin using supercritical chromatography (SFC).</b> <i>Steen Buskov, Marianne Decker, Kirsten Mortensen, Hilmer Sørensen. Code 3-7-M-F-O.</i>	105
<b>Metabolism of the amino acids leucine and methionine in skin, liver and muscle tissues in mink.</b> <i>Bent Riis, Christian Friis Børsting. Code 3-6-M.</i>	105
<b>Influence of nutrition on fur quality.</b> <i>Christian Friis Børsting. Code 2-6-M.</i>	106
<b>Digestibility of bacterial protein grown on natural gas in mink, pigs, chicken and Atlantic salmon.</b> <i>A. Skrede, G.M. Berge, T. Storebakken, O. Herstad, K.G. Aarstad, F. Sundstøl. Code 3-6-7-M.</i>	106

- Single cell protein produced from natural gas (BioProtein). A new protein source for fur animals.** *Anders Skrede. Code 7-M-F.* 107
- Dietary Fumonisin disrupt sphingolipid metabolism in mink and increase the free sphinganine to sphingosine ratio in urine but not in hair.** *M.K. Morgan, J.J. Schroeder, G.E. Rottinghaus, D.C. Powell, S.J. Bursian, R.J. Aulerich. Code 8-3-9-M.* 107
- Mercury accumulation in mink fed fish collected from streams on the Oak Ridge Reservation.** *R.S. Halbrook, L.A. Lewis, R.I. Aulerich, S.J. Bursian. Code 8-3-14-M.* 108
- Nutritional quality of meat from some alternative species.** *J. Sales. Code 7-M-F-O.* 108
- Good feeding management during the winter produces better breeding males.** *J. Clausen, M. Sønderup. Code 5-6-12-M.* 108

#### Titles of other publications – not abstracted

- The adequate food balance for chinchillas.** *D. Lauria. Acaecer, Vol. 21 (243), pp. 40-41, 1996. In SPAN. Code 6-O.*
- News on cut off from herrings and mackarels.** *Christian F. Børsting, S.K. Jensen. Dansk Pelsdyravl, 61 (6), pp. 300-301, 1998. 2 tables, 1 fig., 1 ref. In DANH. Code 6-7-M-F.*
- Boiled potatoes in the diet: no success.** *H.-J. Risager. Dansk Pelsdyravl, 60 (4), pp. 199, 1997. In DANH. Code 7-6-M.*
4. **Ethology, incl. Animal welfare, management & production**
- Selection for kit growth -considering welfare of the dam. Results of the second year of selection.** *Bente Krogh Hansen, Peer Berg, Jens Malmkvist, Steffen Werner Hansen, Niels Therkildsen, Ulla Lund Rasmussen. Code 4-5-11-2-M.* 109
- Increased distance between mink females during the reproduction period.** *Lise Overgaard. Code 5-10-11-12-M.* 109
- Evaluation of a plus-maze adapted to test fear of mink in a novel environment.** *Jens Malmkvist. Code 10-11-M.* 110
- Behaviour influencing pelt quality – fur chewing in mink.** *Steffen Hansen, Jens Malmkvist. Code 11-2-M.* 110

	<b>Management in relation to size and quality of mink skins.</b> <i>Steen H. Møller. Code 2-12-M.</i>	111
	<b>Development and possible causes of fur damage in farm mink – significance of social environment.</b> <i>S.W. Hansen, B. Houbak, J. Malmkvist. Code 2-10-11-14-M.</i>	112
5.	<b>Reproduction</b>	
	<b>Age-dependent features in the reproductive performance of domesticated silver fox males.</b> <i>L.V. Osadchuk. Original Report. Code 3-5-F.</i>	113
	<b>Steroid hormone concentrations in relation to sexual activity in domesticated silver fox males.</b> <i>L.V. Osadchuk. Original Report. Code 3-5-F.</i>	119
6.	<b>Pathology &amp; diseases</b>	
	<b>Is mastitis in mink females a factor when the greasy kits syndrome occur?</b> <i>Tove Clausen, Hans Henrik Dietz. Code 5-9-M.</i>	125
	<b>Caries and odontoclastic resorptive lesions in a chinchilla (<i>Chinchilla lanigera</i>).</b> <i>D. A. Crossley, R. R. Dubielzig, K. G. Benson. Code 2-9-O.</i>	125
	<b>The prevalence of antibodies to calicivirus in foxes.</b> <i>J. Dedek, K. Frölich. Code 9-F.</i>	125
	<b>Vaccine-induced canine distemper in European mink, <i>Mustela lutreola</i>.</b> <i>Meg R. Sutherland-Smith, Bruce A. Rideout, Andrea B. Mikolon, Max J. G. Appel, Patrick J. Morris, Amy L. Shima, Donald J. Janssen. Code 9-M.</i>	125
	<b>The dependence of resistance of cage breeding mink to Aleutian disease from litter size.</b> <i>V.A. Ilukha, L.B. Uzenbayeva, H.I. Meldo. Code 9-5-M.</i>	126
	<b>Ultrasonography of adrenal glands in normal ferrets.</b> <i>Robety T. O'Brien, Joanne Paul-Murphy, Richard R. Dubielzig. Code 2-O.</i>	126
7.	<b>Fur properties</b>	
	<b>Methods for measuring pelt properties.</b> <i>P. V. Rasmussen. Code 2-M-F-O.</i>	127
	<b>Biochemistry and skin quality - tools and perspectives.</b> <i>Bent Riis. Code 2-3-M-F-O.</i>	127
	<b>Fur development can be investigated microscopically.</b> <i>P. V. Rasmussen. Code 2-M-F-O.</i>	128

8.	<b>Congresses, symposiums, etc.</b>	
	<b>Physiological bases for increasing the productivity of predatory fur animals</b>	129
	PLENARY SESSION	
	<b>The use of biologically active substances for raising efficiency in farmed mink.</b> <i>N.A. Balakirev, T.M. Demina, O.V. Rastimeshina. Code 3-5-6-M.</i>	130
	<b>Changes in digestive enzyme activity in nutrias and chinchillas dependent on diet composition.</b> <i>B. Barabasz, V.M. Oleinik. Code 3-6-O.</i>	130
	<b>Influence of somatotropins of gene engineering on physiological state of mink.</b> <i>L.K. Ernst, N.N. Tyutyunnik, L.N. Sirotkina, L.F. Adigamov. Code 3-4-M.</i>	131
	<b>Attempts to improve reproductive performance of farmed foxes.</b> <i>M. Harri, J. Mononen, T. Rekilä, L. Ahola, T. Pyykönen. Code 5-4-10-11-F.</i>	132
	<b>The results and development of research in the field of ecological physiology of fur-bearing animals.</b> <i>N.N. Tyutyunnik. Code 1-3-10-M-F-O.</i>	132
	SECTION 1: Physiological-biochemical control and regulation of the physiological status	
	<b>Parasitological data as a method of evaluation of the physiological state of fur animals.</b> <i>V.S. Anikova, L.V. Anikieva. Code 3-9-M-F-O.</i>	134
	<b>Hemolytic resistance of erythrocytes and functional properties of hemoglobins in some vertebrates.</b> <i>A.G. Borisova, A.S. Goryunov. Code 3-9-F-O.</i>	135
	<b>Interferon status of fur bearers in normal and pathological states.</b> <i>L.Ye. Boyarintsev, V.V. Klímenko, N.N. Tyutyunnik. Code 3-9-M-F-O.</i>	136
	<b>Isolation and identification of immuno-competent lymphocytes from the polar fox blood.</b> <i>I.A. Domskey, Z.N. Beltyukova. Code 3-9-F.</i>	136
	<b>Comparative characteristics of non-specific resistance indices in farmed mink and nutria.</b> <i>V.Z. Gazizov, N.A. Suntsova. Code 3-9-M-O.</i>	137
	<b>Distribution of superoxide dismutase and catalase in organs and tissues of fur animals.</b> <i>V. Ilukha. Code 3-9-M-F-O.</i>	137
	<b>The levels of vitamins A and E in blood serum of polar foxes at different age.</b> <i>T.N. Ilyjina, T.N. Ruokolaynen. Code 3-6-F.</i>	138
	<b>Histology of mink thymus in immunopathology.</b> <i>T.A. Ivanova, S.I. Lyutinsky, A.N. Aliev. Code 3-2—9-M.</i>	138
	<b>Testing antimicrobial effect of two antibiotics in fur animal feeds using disk-diffusin susceptibility test.</b> <i>T. Juokslahti, E. Smeds, K. Wallin. Code 6-7-8-M-F-O.</i>	138

- Concentration of chosen minerals in the fur of coypu females of various genotypes in relation to physiological condition.** *D.Mertin, K. Süvegová, P. Fl'ak, P. Sviatko, I. Tocka. Code 2-3-4-O.* 139
- Comparative characteristics of digestive hydrolase activities in predatory fur animals.** *V.M. Oleinik. Code 3-6-M-F-O.* 140
- Comparable characteristics of the lymphoid tissue of the small intestine in farm mink and polecat.** *A.B. Panfilow. Code 2-3-4-M-O.* 141
- Analysis of the origin of depigmentation in animals under domestication.** *L.A. Prasolova, I.N. Oskina, L.N. Trut. Code 2-3-4-11-M-F-O.* 141
- Lipoproteins in the blood serum in mink and polar fox, the main representatives of farmed fur-bearing animals.** *T.L. Regerand, E.I. Lizenko, V.S. Sidorov. Code 3-6-M-F-O.* 142
- Gut associated lymphoid tissue in farmed nutria.** *N.A. Suntsova. Code 2-O.* 142
- Reproduction disturbances in female blue foxes.** *O. Szeleszczuk, P. Niedbala, G. Maloszyc, V. Ilukha. Code 5-8-9-F.* 143
- Genetical polymorphism in Marmota bobac.** *E.A. Tirnaeva, L.G. Markovich, T.L. Kazakova, G.A. Fedoseeva, V.N. Pomytko. Code 3-4-O.* 143
- Vitamin B<sub>1</sub> metabolism in mink kits in different biological periods and growth Phases.** *R.V. Trebukhina, I.P. Chernikevich, L.K. Lashak, V.G. Petushok. Code 3-6-M.* 144
- Lactate dehydrogenase isoenzymes in tissues of fur animals with various ecogeneses.** *A.R. Unzhakov, L.K. Kozhevnikova. Code 3-10-M-F-O.* 144
- Role of cytochemical tests in evaluation of morphological-functional properties of leucocytes.** *L.B. Uzenbayeva, E.E. Alexandrova. Code 2-3-M-F.* 145
- SECTION 2: The effect of environmental factors on the organism and optimization of breeding**
- Non-traditional feeds in mink rations.** *N.A. Balakirev, M.V. Wolkova. Code 6-7-M.* 146
- Immune status of mink-hypotrophics and its immunocorrection.** *L.Ye. Boyarintsev, V.V. Klimenko, N.N. Tyutyunnik. Code 3-9-M.* 146
- Control of canine distemper in fur animals using vaccination.** *A.L. Elakov, V.I. Ulasov, V.M. Kolyshkin, A.V. Vasiliev. Code 9-M-F-O.* 147
- Seasonal changes in glucocorticosteroids in fur-bearing animals** *V.Z. Gazizov, O.Yu. Bespyatykh. Code 30-10-M-O.* 147

<b>The effect of environmental conditions on reproduction in two genotypes of mink.</b> <i>A.V. Kharlamova. Code 4-5-10-M.</i>	148
<b>Digestibility of nitrogen and fats from feed rations for mink with various proportions of poultry by-products.</b> <i>D. Mertin, K. Süvegová, I.Točka, P. Fl'ak. Code 3-6-7-M.</i>	148
<b>Level of digestive hydrolases in the blood of predatory fur-bearing animals during the annual life cycle.</b> <i>V.M. Oleinik, E.B. Svetckina. Code 3-6-10-M-F.</i>	149
<b>Computer optimisation of fur-bearing animals feeding.</b> <i>D.N. Pereldik, O.H. Duletsky. Code 6-7-12-M-F-O.</i>	149
<b>Food and oxythiamin deficiency of vitamin B<sub>1</sub> in mink.</b> <i>G.G. Petrova, T.N. Ilyina, N.N. Tyutyunnik, I.P. Chernikevich, S.P. Izotova. Code 3-6-9-M.</i>	150
<b>Effect of temperature and humidity on fur-bearing animals.</b> <i>I.A. Plotnikov, V.Z. Gazizov, S.N. Yarygin. Code 3-10-M-O.</i>	151
<b>Periparturient behaviour of reproducing farmed blue fox vixens.</b> <i>T. Pyykönen, J. Mononen, T. Rekilä. Code 5-11-F.</i>	151
<b>Genetic determination of motion activity in ferrets.</b> <i>J. Rafay. Code 3-4-O.</i>	152
<b>Effect of fatness on the reproductive indices in foxes of different behavioural types.</b> <i>N.N. Shumilina, T.M. Chekalova. Code 2-5-11-F.</i>	152
<b>Physiological effects of different dietary fat:carbohydrate ratios during the life cycle of blue foxes (<i>Alopex lagopus</i>).</b> <i>A. Skrede, Ø. Ahlstrøm. Code 3-6-F.</i>	153
<b>The effect of tameness and aggressiveness on fights and hormonal status in farm rearing mink.</b> <i>O.V. Trapezov, O.V. Antonenko, I.N. Oskina, R.G. Gulevich. Code 4-3-11-M.</i>	153
<b>Influence of salts of mercury on the HS-protein contents in the organs of laboratory animals.</b> <i>N. Volokhova, N. Galibina, V. Ostashkova, I. Bolotnikov. Code 3-6-8-O.</i>	154
<b>Long-term starvation in fur animals.</b> <i>Yu. S. Zabolotskikh. Code 3-5-6-M-F-O.</i>	154
<b>Fur animal weight decrease after full long-term starvation.</b> <i>Yu.S. Zabolotskikh, Ye.V. Baibikov. Code 3-5-6-M-F-O.</i>	155
<b>SECTION 3: Ways of stimulation of reproduction and development</b>	
<b>Efficiency of the biopreparation "BIOZH" in fur-bearing animals.</b> <i>V.V. Durova. Code 6-7-F.</i>	155

- Influence of vitamin E on the physiological state, productivity and milk composition in blue fox.** *V. Ilukha, L. Kozhevnikova, M. Valtonen, S. Kasanen, H. Meldo, N. Tyutyunluk. Code 3-5-6-F.* 156
- A new *in vitro* test of the pluripotency of the mink ESC and ESC-likelines.** *H.A. Kizilova, S.Yu. Vatolin, E.D. Lopuhova, M.A. Sukoyan. Code 3-4-M.* 156
- Embryonic mortality in mink.: Morphological analysis of preimplantation embryonic loss.** *H.A. Kizilova, A.I. Zhelezova, A.N. Golubitsa, S.L. Baiborodin. Code 2-3-5-M.* 157
- Experimental study of the preparation ligavirin at Aleutian disease of mink.** *V.V. Klimenko, L.Ye. Boyarintsev, I.A. Domsy. Code 9-M.* 157
- Mival in the diet for young mink.** *P.P. Orlov. Code 6-7-M.* 158
- The role of embryonic variability in hormonal mechanisms under domestication of silver foxes.** *L.V. Osadchuk. Code 4-3-5-11.* 158
- Paste of domestic fly maggots in diets for fur-bearing animals.** *I.A. Plotnikov. Code 3-6-7-M-F.* 159
- Implantation of biologically active substances to fur-bearing animals.** *O.L. Rapoport. Code 3-6-7-M-F-O.* 159
- Effect of enlarged breeding nest box on reproductive success of blue foxes (*Alopex lagopus*).** *T. Rekilä, M. Harri, L.Jalkanen. Code 5-10-11-12-F.* 160
- Growth stimulation in young mink.** *N.A. Shulyatyeva, P.P. Orlov. Code 3-6-7-M.* 160
- Complex research into endocrine thyroid gland, adrenal cortex and gonadal functions in fur animals.** *L.N. Sirotkina, N.N. Tyutyunnik. Code 3-5-6-M-F-O.* 161
- The effect of biostimulant mival on mink reproductive function.** *Y.J. Sivkova, P.P. Orlov. Code 3-5-6-M.* 162
9. **List of addresses** 163





## Notes

Scientifur, Vol. 23, No. 2

May 1999

When you read these pages it is spring both regarding the prices of mink skins, which have increased at the latest auctions, and regarding normal springtime in the Northern hemisphere. We are glad to be here, and glad to send out SCIENTIFUR vol. 23. No. 2 containing more titles of scientific reports on fur animal research than ever before.

We thank the Research and Advisory Unit (PFR) of the Danish Fur Breeders Association for sending us the Technical Year Report 1998 (February 1999) with a total of 202 pages and ISSN No. 1395-198X, including English summaries of almost all reports. This enables us to present the important information to the readers of SCIENTIFUR very quickly. Copies of the individual reports can be obtained if you contact the author(s) in question and copies of the entire report can be obtained from: **PFR, Herningvej 112 C, DK-7500 Holstebro, Denmark.**  
Fax No. +45-97435277.  
E-mail: [pfr@pfr.dk](mailto:pfr@pfr.dk)

We also thank the Organizing Committee of the 2nd International Symposium: Physiological basis for increasing the productivity of predatory fur animals, held in Petrozavodsk, Karelia, Russia, Sept 15-17, 1998 for sending us the abstracts of the reports presented at the symposium. We are fortunate enough to be able to bring all these abstracts in the present issue of SCIENTIFUR. The fact that we have not received the full reports brings us to ask interested readers to take direct contact with the authors. This may, however, be difficult due to insufficient addresses in the collection of abstracts, but we are sure that you can get the necessary assistance at the address given on page 129.

(E-mail:

[ILYUHA@MAZE.CENTRE.KARELIA.RU](mailto:ILYUHA@MAZE.CENTRE.KARELIA.RU))

Late May the IFASA board of Directors will meet with the Greek Organizing Committee. Together they will confirm the 1st Announcement of the VII International Scientific Congress in Fur Animal Production, Greece, 1st half of September 2000, and a more detailed plan for the work of the different subcommittees up to the congress and the programme for the congress will be discussed. We look forward to bringing the 1st Announcement in SCIENTIFUR No. 3 of August 1999, but we are convinced that most of you will by then already have received the announcement direct from the Organizing Committee.

One of the important arrangements during the congress will be the meeting of the membership at which occasion election of the board of directors will take place, but also the future of IFASA and SCIENTIFUR in relation to the *ELECTRONIC AGE* will surely be clarified during this meeting.

We thank for prompt payment of the invoice for subscription. The lowest number until now will this year receive a kind reminder from us instead of SCIENTIFUR No. 2.

**For easier contact to the board of IFASA with the President or Vice-president the E-mail addresses are given here:**

President, Einar J. Einarsson:

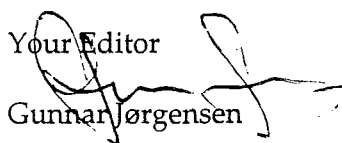
[ainar.einarsson@bokhandlerfor.no](mailto:ainar.einarsson@bokhandlerfor.no)

Vice president, Bruce D. Murphy:

[murphy@MEDVET.Umontreal.CA](mailto:murphy@MEDVET.Umontreal.CA)

Your Editor

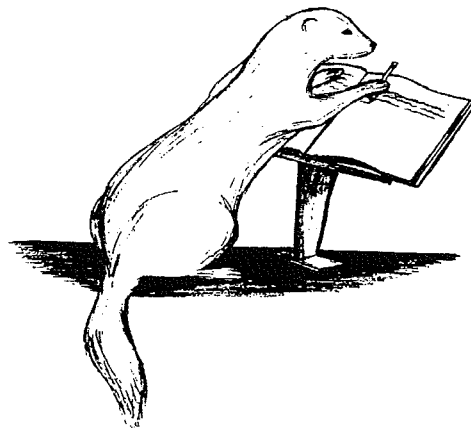
Gunnar Jørgensen



## HANDBOOK OF BIOLOGICAL DATA FOR MINK

*Total 138 pages. 325 references and 125 tables*

This handbook was compiled to serve as a convenient source of biological data and reference values for mink (*Mustela vison*). The data presented were obtained from the scientific literature. The entries are indexed for quick access and referenced so that more details can be obtained, if desired. References are referred to by numbers in [ ] in the text with full citations given in the Literature Cited section. Some of the information was derived from data for control mink from studies where it was presumed that the animals were normal, raised under standard conditions, and fed diets that met the nutrient requirements of the species. Much of the material is presented in tabular form to facilitate comparison. Although there are some discrepancies in the data listed for certain parameters, no attempts were made to explain the differences. The information contained in the handbook should be of interest to fur farmers, as well as allied fur industry personnel, veterinarians, pathologists, toxicologists, nutritionists, zoologists, biologists, teachers, and others interested in this furbearer.



Copies of this handbook are available (free) as long as supplies last. Contact:

Dr. Richard J. Aulerich  
Dept. Animal Science  
2209 Anthony Hall  
Michigan State University  
E. Lansing, MI 48824-1225  
USA

## Original Report

## Repeatability of mineral element content in the fur of female white nutrias

D. Mertin<sup>1</sup>, K. Süvegová<sup>1</sup>, P. Fl'ak<sup>1</sup>, P. Sviatko<sup>2</sup>, E. Podolanová<sup>1</sup>, I. Tocka<sup>3</sup>

<sup>1</sup>Research Institute of Animal Production, Hlohovska 2, 949 01 Nitra, Slovakia

<sup>2</sup>Institute for Physiology of Farm Animals SAS, Kosice, Slovakia

<sup>3</sup>Slovak Agricultural University, Nitra, Slovakia

### Summary

The aim of the experiment was to find out the concentration of Ca, K, Na, Mg, Fe, Zn, Cu, Mn and Co in the fur of female white nutrias on the back and abdomen in dependence on their physiological state: at the age of 8 months, at parturition and at weaning. There were 12 females in the experiment. The fur samples were cut. The mineral element content was determined by the method of atomic absorption spectral photometry. The results were evaluated mathematically and statistically. The highest total concentrations were found with Ca (back:  $1068.26 \pm 110.91$  mg.kg<sup>-1</sup> dry matter, abdomen:  $1248.43 \pm 115.18$  mg.kg<sup>-1</sup> dry matter) and Mg ( $651.56 \pm 59.98$  mg.kg<sup>-1</sup> dry matter and  $675.12 \pm 54.55$ , resp.), and the lowest ones with Co ( $0.690 \pm 0.0394$  and  $0.5825 \pm 0.0353$  mg.kg<sup>-1</sup> dry matter, resp.). The analysis of coefficients of repeatability enabled us to draw the conclusion that there is a high repeatability of mineral element content in the fur of white nutrias dependent either on the studied regions of the body, season or both.

### Introduction

We conducted a study of the repeatability of the mineral composition of fur in female white nutrias in dependence on their physiological state. Some of the main factors influencing the chemical composition of an organism are species and breed differences, effect of seasons, physiological state, age, lactation and pregnancy (Georgievskij *et al.*, 1982). Mertin *et al.* (1997) studied the repeatability of mineral element content in the fur of female standard nutrias. They found a high repeatability of the mineral element content within genotype, studied body parts, age and physiological stage.

### Material and methods

The experiment was performed on the Experimental Fur Animal Farm of the Research Institute of Animal Production in Nitra. There were 12 female white nutrias studied in the experiment. The animals were kept in one-storey cages with pools in a hall. They were fed a pelleted feed mixture (KK). Alfalfa (in spring and

summer) and fodder beet (in autumn and winter) were given as supplementary feed. They drank water from pools. The animals in the experiment were clinically healthy. The aim of the experiment was to determine the concentration of Ca, Na, K, Mg, Fe, Zn, Cu, Mn and Co in the fur of female white nutrias in chosen body regions, namely in the middle of the back and abdomen in dependence on the physiological stage (period): 1. Primiparous females – sexual maturity, age 8 months – fur maturity; 2. Females on the day of parturition; 3. Females on the day of weaning. Fur samples were cut. Each sample contained approximately 2 g fur. The concentration of the studied

mineral elements was determined by atomic absorption spectral photometry. Three measurements were performed with each sample. The obtained results were mathematically and statistically evaluated (Winer, 1971; Grofik and Fl'ak, 1980).

### Results and discussion

Basic variation and statistical characteristics of mineral element content in the fur of white nutrias according to periods and body regions are given in Table 1. Ca and Mn content was lowest in females at the age of 8 months on the abdomen and K, Na, Fe content on the back.

**Table 1.** Basic variation and statistical characteristics of content of mineral elements (mg.kg<sup>-1</sup> d.m.) in fur of white nutrias

P	b <sub>i</sub>	n	Calcium - Ca				Potassium - K				Sodium - Na			
			back		abdomen		back		abdomen		back		abdomen	
			$\bar{x}$	S $\bar{x}$	$\bar{x}$	S $\bar{x}$	$\bar{x}$	S $\bar{x}$	$\bar{x}$	S $\bar{x}$	$\bar{x}$	S $\bar{x}$	$\bar{x}$	S $\bar{x}$
8m	3	9	333.00	9.02	768.46	99.59	110.55	22.23	49.56	10.57	113.52	15.50	54.71	2.21
Pa	5	15	1172.28	167.08	1286.98	222.74	557.83	47.17	144.13	30.25	314.35	54.72	105.12	21.53
W	4	12	1489.67	136.89	1920.18	191.44	604.61	32.66	287.56	16.46	296.29	19.55	146.82	38.35
S	12	36	1068.26	110.91	1248.43	115.18	469.94	41.77	168.30	20.75	258.12	27.45	114.75	16.42
P	b <sub>i</sub>	n	Magnesium - Mg				Iron - Fe				Zinc - Zn			
8m	3	9	709.77	22.25	994.26	36.68	63.48	5.15	93.80	2.17	149.32	2.87	174.11	1.57
Pa	5	15	851.46	112.87	740.62	77.83	124.83	19.81	104.38	11.77	174.04	1.66	152.17	4.95
W	4	12	358.04	34.60	353.89	34.99	186.46	21.35	144.72	9.21	174.09	5.84	168.36	1.70
S	12	36	651.56	59.98	675.12	54.55	130.04	13.30	115.18	6.72	167.88	2.79	163.05	2.66
P	b <sub>i</sub>	n	Copper - Cu				Manganese - Mn				Cobalt - Co			
8m	3	9	5.2600	0.3475	6.6100	0.1887	0.7533	0.0502	1.4933	0.2019	0.6000	0.0597	0.4666	0.0416
Pa	5	15	5.7680	0.0767	5.7680	0.1572	2.3740	0.3747	3.9780	0.5280	0.5860	0.0477	0.4480	0.0240
W	4	12	7.3250	0.3681	8.2625	0.5193	3.6325	0.4598	5.2950	0.5281	0.8875	0.0626	0.8375	0.0340
S	12	36	6.1600	0.2064	6.8100	0.2602	2.3883	0.2820	3.7958	0.3710	0.6900	0.0394	0.5825	0.0353

P – period, 8m – age 8 months, Pa – parturition, W – weaning, S – total, b<sub>i</sub> – number of females in the period, n – number of analyses during the period (3. b.)

We did not find marked differences with Zn concentration. Cu concentration increased in dependence on age mainly on the back. Co content was approximately on the same level on the back and on the abdomen at the age of 8 months and at parturition. The highest content of Co was determined in the fur of females at parturition. The highest Co content was deter-

mined in the fur of females at weaning. The Mg concentration decreased in dependence of age and physiological stage, especially on the abdomen. In Table 2 are given the results of 2-way variance analyses of the hierarchic classification with firm effect of periods, random effect of animals within the periods and with error of experiment with content of mineral ele-

ments. Also shown are F-tests of 1-way analyses of variance of comparison of animals within the studied periods. When we compare the F-tests of periods of mineral element content in the fur of white nutrias we find statistically significant differences in K and Co concentra-

tions. It is a matter of course that the 2-way analyses of variance pointed out the significant differences between the animals as these F-tests are in fact functions of 1-way analysis of variance.

**Table 2.** 2-way variance analysis of content of selected macroelements in fur of white nutrias

			Calcium - Ca		Potassium - K		Sodium - Na		Magnesium - Mg	
			MS	F	MS	F	MS	F	MS	F
<i>Back</i>										
P	2		3579386.74	3.87	777336.74	10.93++	12654.86	1.64	83126.76	2.62
A	9		925418.51	1762.86++	71155.01	512.01++	770795.70	664.64++	31802.61	1099.39++
e	24		524.95		138.97		115.97		289.27	
P	$f_{bi}$	$f_e$								
8m	2	6		57.56++		1107.21++		763.54++		67.35++
Pa	4	10		3376.82++		937.99++		1229.72++		1734.98++
W	3	8		824.72++		185.40++		90.72++		265.12++
<i>Abdomen</i>										
P	2		4791974.95	3.45	153174.04	5.90++	231972.42	1.08	1109.63	6.61+
A	9		1389669.54	5139.13++	25959.03	270.64++	215563.31	5.20++	6793.53	209.02
e	24		270.41		95.92		4144.38		803.43	
P	$f_{bi}$	$f_e$								
8m	2	6		2738.51++		171.59++		63.23++		16.34++
Pa	4	10		9156.03++		1279.82++		738.07++		973.51++
W	3	8		3478.72++		50.63++		2.56++		430.19++

P - period, 8m - age 8 months, Pa - parturition, W - weaning, A - animals, e - error

F - tests for 1-way variance analyses:

$$F_{0.05}(2, 6) = 5.143 \quad F_{0.05}(4, 10) = 3.478 \quad F_{0.05}(3, 8) = 4.066$$

$$F_{0.01}(2, 6) = 10.925 \quad F_{0.01}(4, 10) = 5.944 \quad F_{0.01}(3, 8) = 7.591$$

F-tests for 2-way hierarchic variance analyses:

$$F_{0.05}(2, 9) = 4.256 \quad F_{0.05}(9, 24) = 2.300$$

$$F_{0.01}(2, 9) = 8.021 \quad F_{0.01}(9, 24) = 3.256$$

Statistically highly significant differences between seasons were found in K and Cu concentrations. However, the variability was highly statistically influenced by individual and was confirmed not only by F-tests of 2-way analysis of variance but also by F-tests of 1-way analyses of variance within the periods. We use these F-tests to characterize the statistical significance of repeatability coefficients of mineral elements content within periods. The estimation of repeatability coefficients are given in Table 3 with their standard errors. The repeatability of individual elements in the fur of ac-

cording to the individual regions of body was very high and in almost all elements higher than 0.95 and/or 0.99 with the exception of Na, K, Co (abdomen). K at parturition showed negative repeatability coefficients. According to the repeatability coefficients we can state, in spite of the fact that there were only three repeated measurements in the animals, that there is high repeatability of the content of mineral elements in the fur of white nutrias either from the viewpoint of the studied regions of the body, periods or together.

**Table 3.** 2-way variance analysis of content of selected microelements in fur of white nutrias

			Iron - Fe		Zinc - Zn		Copper - Cu		Manganese - Mn		Cobalt - Co	
			MS	F	MS	F	MS	F	MS	F	MS	F
Back												
P	2		392387.79	2.49	2067.22	3.35	12.9408	4.480	21.3187	3.483	0.3516	2.825
A	9		157533.97	137.19++	616.59	122.72++	2.8883	38.092++	6.1214	59.044++	0.1245	22.838++
e	24		114.83		5.02		0.0758		0.1037		0.0054	
P	$f_{hi}$	$F_2$										
8m	2	6		2240.01++		35.13++		80.333++		11.741++		28.785++
Pa	4	10		362.19++		25.39++		0.162		80.637++		15.259++
W	3	8		70.67++		538.53++		135.170++		44.907++		32.340++
Abdomen												
P	2		8167.12	1.85	1606.46	2.57	20.9818	4.801	37.5907	3.545	0.5862	17.272++
A	9		4416.94	118.15++	624.15	194.95++	4.3610	26.089++	10.6031	89.165++	0.0339	8.778++
e	24		37.39		3.20		0.1675		0.1189		0.0039	
P	$f_{hi}$	$F_2$										
8m	2	6		28.98++		19.59++		23.377++		121.67++		13.368++
Pa	4	10		193.24++		351.89++		19.955++		811.48++		6.741++
W	3	8		57.82++		57.01++		27.462++		35.03++		8.274++

P - period, 8m - age 8 months, Pa - parturition, W - weaning of young, A - animals, e - error

**Table 4.** Repeatability coefficients of mineral elements content in fur of white nutria

		Calcium - Ca		Potassium - K		Sodium - Na		Magnesium - Mg			
P	$\rho$	$s_p$	$\rho$	$s_p$	$\rho$	$s_p$	$\rho$	$s_p$			
Back											
8m	0.9496	0.0421	0.9972	0.0023	0.9960	0.0033	0.9567	0.0363			
Pa	0.9991	0.0006	0.9968	0.0022	0.9978	0.0017	0.9982	0.0012			
W	0.9963	0.0028	0.9839	0.0122	0.9676	0.0245	0.9887	0.0086			
T	0.9983	0.0008	0.9941	0.0029	0.9955	0.0022	0.9972	0.0013			
Abdomen											
8m	0.9989	0.0009	0.9827	0.0147	0.9540	0.0386	0.8364	0.1261			
Pa	0.9996	0.0002	0.9976	0.0016	0.9959	0.0028	0.9969	0.0021			
W	0.9991	0.0006	0.9429	0.0424	0.3421	0.2860	0.9930	0.0053			
T	0.9994	0.0002	0.9889	0.0055	0.5834	0.1530	0.9857	0.0071			
		Iron - Fe		Zinc - Zn		Copper - Cu		Manganese - Mn		Cobalt - Co	
P	$\rho$	$s_p$	$\rho$	$s_p$	$\rho$	$s_p$	$\rho$	$s_p$	$\rho$	$s_p$	
Back											
8m	0.9986	0.0011	0.9191	0.0662	0.9635	0.0307	0.7816	0.1615	0.9025	0.0789	
Pa	0.9917	0.0057	0.8904	0.0718	0.3875	0.0735	0.9636	0.0250	0.8261	0.1086	
W	0.9587	0.0310	0.9944	0.0042	0.9781	0.0166	0.9360	0.0474	0.9126	0.0637	
T	0.9784	0.0108	0.9759	0.0120	0.9251	0.0361	0.9508	0.0241	0.8792	0.0564	
Abdomen											
8m	0.9031	0.0784	0.8610	0.1091	0.8817	0.0943	0.9757	0.0206	0.8047	0.1470	
Pa	0.9846	0.0107	0.9915	0.0059	0.8633	0.0878	0.9963	0.0026	0.6567	0.1871	
W	0.9498	0.0375	0.9491	0.0380	0.8981	0.0735	0.9189	0.0593	0.7080	0.1821	
T	0.9750	0.0124	0.9847	0.0076	0.8931	0.0504	0.9670	0.0163	0.7216	0.1153	

P - period, 8m - age 8 months, Pa - parturition, W - weaning of young, T - total

Therefore it is possible to deduce from the above mentioned that the content of mineral elements is more or less stable also with regard to sporadic differences between the above mentioned periods. Our results document the mineral composition of fur changes in dependence on age, genotype, physiological state in adult females, and it corresponds to studies of various animal species done by other authors (*Georgievskij et al.*, 1983) and in nutrias (*Mertin et al.*, 1997). Compared to standard nutrias there is lower content of mineral elements, mainly Ca, K, Na and Fe, in white nutrias. However, the changes in the content of mineral elements in dependence on age and physiological stages are similar with individual elements in standard and white nutrias, and their repeatability is high in both colour mutations. The results show that it is suitable to use fur in the study of mineral metabolism, and physiological and pathological changes in nutrias.

## References

- Georgievskij, V.I., Annenkov, B.N., Samochi, V.T. 1982. Minerálna vyziva zcierat. Bratislava, Príroda, 431 pp.
- Grofik, R., Fl'ak, P. 1990. Statistické metódy v poľnohospodárstve. Bratislava, Príroda, 344 pp.
- Mertin, D., Süvegova, K., Fl'ak, P., Sviatko, P. 1997. Repeatability of mineral elements content in the fur of female standard coypus. *Zivocisna vyroba* 42, 19, pp. 453-458.
- Winer, B.J. 1971. Statistical principles in experimental design. McGraw-Hill Kogakusha, Ltd., Tokyo, Düsseldorf, Johannesburg, London, Mexico, New Delhi, Panama, Rio de Janeiro, Singapore, Sydney, 2nd edit., 907 pp.



"Forget gold. Strategic metals are where it's at."

### The possibility for *in vitro* estimation of carbohydrate and starch digestibility in mink

Helle Nygaard Lærke, Christian Friis Børsting

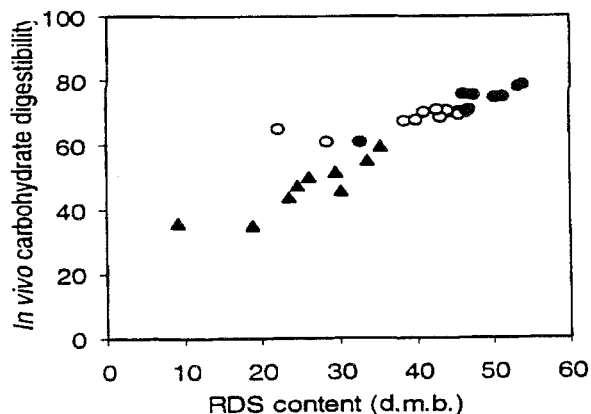


Fig. 1. *In vivo* crude carbohydrate digestibility versus the content (dry matter basis, d.m.b.) of rapidly digestible starch+glucose (RDS) in raw materials of barley (O), wheat (●) and peas (▲) determined after incubation for 20 min.

An *in vitro* method, originally developed to simulate the digestion of starch in the human small intestine, was modified and tested to study the correlation to the digestibility of crude carbohydrates and starch in mink. The principle of the method is an incubation of the sample with pancreatin and amyloglucosidase for 20 and 120 min., respectively. Glucose released from the media at these times are termed rapidly (RDS) and slowly digestible starch (SDS), respectively. Subsequently, the sample is boiled and treated with KOH, and finally fully degraded with amyloglucosidase for determination of the total glucose content. Preliminary results showed a good correlation between RDS and the *in vivo* carbohydrate digestibility in mink. Subsequently the method was modified, so that the samples were only incubated with pancreatin and amyloglucosidase for 20 min. This modification did not influence the results significantly. The RDS fraction as a proportion of the dry matter or of the total starch content of the raw materials correlated well with the *in vivo* carbohydrate digestibility when regression analyses were per-

formed for each category of raw materials separately ( $R^2=0.74$  for barley, 0.84 for wheat and 0.63 for peas). Across raw materials (barley, wheat, pea), the content of RDS as a proportion of dry matter correlated well with the *in vivo* digestibility of carbohydrates ( $R^2=0.85$ ). Diets for mink contain high levels of protein and fat, which may interfere in the *in vitro* analysis. However, for the cereals, there was a better correlation between the content of RDS in the diets and the *in vivo* results than between the content of RDS in the raw materials and the *in vivo* data. Only diets containing peas, which turned out to be difficult to analyse, showed a very poor correlation between the *in vitro* and *in vivo* results.

In principle, this method can be used as a control method to determine whether cereals and other starch containing raw materials have been satisfactory heat-treated before use in mink feeds. However, in order to establish satisfactory relations between *in vitro* and *in vivo* results, further experiments with a larger span in carbohydrate and starch digestibility are needed.

Technical Year Report 1998, pp. 15-24 (PFR, February 1999). In DANH, Su.ENGL. 3 tables, 4 figs., 2 refs.

### Annual variation in the content of dry matter, protein, amino acids, fat and fatty acids in herring offal

Søren Krogh Jensen, Christian Friis Børsting

Seasonal variation in the content of dry matter, protein, amino acids, fat and fatty acids in herring scrap. Samples of herring scrap were collected during 1995, 1996 and 1997 from two factories and analysed for protein, amino acids, fat, fatty acids, vitamin E, peroxide value, FFA and TVN. The analysed values of protein, fat and dry matter varied greatly during the year. Thus, the content of dry matter varied from 20-35%. The protein content in the wet scrap varied between 9 and 16% and the fat content varied from 5-28%. However, the relative com-



position of both amino acids and the fatty acids was fairly constant. The analysed quality indicators all indicated very good quality of the product, and the content of vitamin E varied from 7-36 mg/kg wet scrap. In conclusion, the huge variation observed during the year makes it important to analyse scrap for at least dry matter, crude protein and fat content before inclusion in feed mixtures.

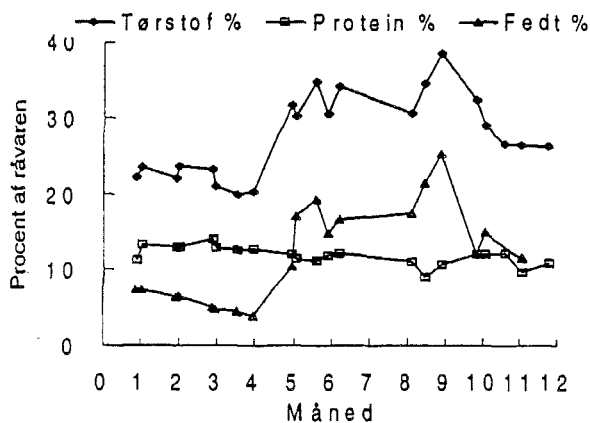


Fig. 1. Annual variation in protein, fat and dry matter content of herring scrap. The values express the average of the two factories.

*Technical Year Report 1998, pp. 25–31 (PFR, February 1999). In DANH, Su.ENGL. 3 tables, 2 figs., 5 refs.*

#### Different proportions between energy from protein, fat and carbohydrate in the feed for mink females during winter and suckling periods

*Tove N. Clausen, Carsten Hejlesen*

For the investigation 6 groups, each consisting of 140 wild type female mink, were used. The protein content in the feed in the winter and reproduction periods was lowered from 55% of the metabolisable energy from protein to 45%, and the carbohydrate content was varied from 5 to 20% of the metabolisable energy from carbohydrate.

The results showed that we can lower the protein content in the feed in the winter and re-

production periods to 45% of the metabolisable energy from protein and use 15% of the metabolisable energy from carbohydrates in the feed without negative consequences for litter size, and kit and female weights at weaning.

*Technical Year Report 1998, pp. 33–38 (PFR, February 1999). In DANH, Su.ENGL. 4 tables.*

#### Low content of protein and fish in mink feed during winter and suckling periods

*Carsten Hejlesen, Tove N. Clausen*

A reduction in fish as a protein source is possible. As an alternative to the traditional diet composition in the winter and lactation periods three compositions with decreasing contents of fish were evaluated. They were compared to a traditional diet with 73% fish and 55% of ME from protein. Protein made up 45% of ME, the fish content was reduced from 46% to 12% and swine pulp was increased from 3% to 9% in the experimental diets. The experiment was conducted with 4 groups of 115 female mink (colour type standard), which were fed the experimental diet from late January to weaning in June.

The results showed that neither the number of kits per female nor female weight loss nor kit weight gain were affected by the chosen combination of low protein supply, low fish content and high content of swine pulp compared to the traditional diet.

*Technical Year Report 1998, pp. 39–43 (PFR, February 1999). In DANH, Su.ENGL. 3 tables.*

#### Fatty fish products in mink feed during the growth period (1997 trials)

*Tove N. Clausen, Carsten Hejlesen*

Investigations were conducted on the use of large amounts of fat from fish in the growing-furring period in standard mink kits. We used seven groups each consisting of 78 male kits.

The variation in fish fat ranged from 20-70% of the total amount of fat in the feed and was achieved by increasing the amounts of herring scrap and herring oil. The results showed that it is possible to use high amounts of fat from fish in the feed without any negative effects on skin size, pelt quality or animal health, if the quality of the fish is good. There was a tendency towards reduced pelt quality with a high amount of fish fat in the feed, and it was concluded that the amount of fat from fish in the feed should not exceed 50-55% in the growing-furring period.

*Technical Year Report 1998, pp. 45-55 (PFR, February 1999). In DANH, Su.ENGL. 8 table, 2 refs.*

#### **Reduced fish content in the feed for mink kits during growth period**

*Tove N. Clausen, Carsten Hejlesen*

In the growing-furring period of 1997 we investigated the consequences of reducing the amount of fish offal and industrial fish in the feed for mink kits from 32.5 - 27.5 - 22.5 - 17.5 to 12.5 % and increasing the amount of a dry protein-mix, on health, growth and pelt quality. (Protein-mix: 26 % fishmeal, 13,5 % heat-treated soybeans, 13,5 % corn gluten, 13,5 % wheat gluten, 13,5 % meatbone-meal, 13,5 % hemoglobin meal and 6,5 % potato protein)

In the investigation we used 5 experimental groups consisting of 81 male mink kits each. The use of high amounts of dry protein raw materials instead of fish offal and industrial fish had no negative consequences on the skin length and pelt quality at pelting, however there was a tendency towards reduced pelt quality with reduced amounts of fish in the feed.

*Technical Year Report 1998, pp. 57-65 (PFR, February 1999). In DANH, Su.ENGL. 7 tables.*

#### **Poultry offal containing 20 percent feathers in mink feed during the growth period**

*Carsten Hejlesen, Tove N. Clausen*

The feather content in poultry offal produced by Danpo, Løgstør has been increased from 12 to 20%. Effects on weight gain, skin length and fur quality were investigated as the poultry offal content in the diet increased from 5 % to 20 %. The experiment was conducted with 3 groups of 81 and 1 group of 162 male mink (colour type scanglow).

It was concluded that up to 20 % poultry offal in the diet did not have any effect on weight gain, skin length or fur quality.

*Technical Year Report 1998, pp. 67-72 (PFR, February 1999). In DANH, Su.ENGL. 4 tables, 2 refs.*

#### **Phase feeding of mink kits in the growth period (protein reduction)**

*Carsten Hejlesen, Tove N. Clausen*

Protein level and reduction in protein supply on different dates in the growing-furring period were evaluated as effects on weight gain, skin length and fur quality in 1997.

The experimental animals consisted of 8 groups of 81 and 1 group of 162 (control) male mink (colour type scanglow). Three groups were supplied with either 24%, 29% or 34% of ME from protein during the entire growing-furring period. 6 groups had the protein supply reduced from 29% to 24% of ME on different dates. To 4 of these 6 groups extra methionine was added to fulfill the norm for this amino acid.

In conclusion the highest skin length was achieved with 24-29% of ME from protein in the entire growing-furring period, while the

best fur quality was obtained on 29-34% of ME from protein. Furthermore, skin length and fur quality were not reduced when protein supply was reduced from 29% to 24% of ME, without methionine addition, on October 1st compared to 29% during the entire growing-furring period.

*Technical Year Report 1998, pp. 73-81 (PFR, February 1999). In DANH, Su.ENGL. 6 tables, 3 refs.*

### Vitamin E analyses in blood and liver for evaluation of the response of the mink to dietary fat quality

*Åse Uttenthal, Christian Friis Børsting*

A challenge study with mink enteritis virus (MEV) was performed with young male kits fed either oxidised herring oil or fresh soya oil + fresh lard. Both experimental diets were used from weaning until the beginning of September, when the challenge study was performed. Within each group half of the animals were vaccinated against MEV in late June. The following results were obtained:

Diet	Number of male mink kits	Vaccinated?	Protection against disease?	Vitamin E-conc. in liver and serum
Oxidized herring oil (70 of % fat)	6	Yes	Yes	Normal
Oxidized herring oil (70 of % fat)	6	No	No	Normal
Fresh soya oil and lard (70 % of fat)	6	Yes	Yes	Normal
Fresh soya oil and lard (70 % of fat)	6	No	No	Normal

On the basis of previous results (*Børsting and Clausen, 1997*) it was concluded that the lack of differences in the vitamin E concentrations between dietary groups could only be explained by the fact that the herring oil was less oxidised than planned. Therefore, it remains uncertain how dietary fat quality influences the response of the mink to vaccination and infection with MEV.

*Technical Year Report 1998, pp. 83-86 (PFR, February 1999). In DANH, Su.ENGL. 1 table, 2 refs.*

### Influence of the feed on the urine acidity in mink kits during the suckling period

*Tove N. Clausen, Birthe Damgaard*

An evaluation of the effect of different feed compositions on the urine pH in mink kits at the end of July was performed. 60 litters in 10 different feeding groups were used. Feed with an energy distribution of 45:50:5 gave lower urine pH than feed with an energy distribution of 45:40:15. Addition of magnesium oxide to the feed gave a rise in urine pH, whereas an increasing addition of ammonium chloride gave decreasing pH values in the urine. 0.35 % ammonium chloride added to a standard Danish mink feed gave a reduction in urine pH in all the samples to below 6.6.

*Technical Year Report 1998, pp. 87-94 (PFR, February 1999). In DANH, Su.ENGL. 6 tables, 9 refs.*

### The palatability of CO<sub>2</sub> stored barley in mink feed

*Carsten Hejlesen*

To ensure stability when storing barley in atmospheric air a minimum of 85% dry matter is required. For storage in CO<sub>2</sub>-atmosphere the required dry matter content is lower, approximately 80%. CO<sub>2</sub>-storing is economically attractive as drying often is unnecessary. A preference test was conducted to evaluate a possible palatability effect of storage method. There were 2 groups of 9 male mink (colour type Standard) per group. The experiment lasted 4 weeks; two weeks where each animal had unrestricted access to both the control and test diet and 2 weeks with unrestricted access to either the control or test diet. The control diet comprised 12.7% barley stored in atmospheric air, while the test diet comprised 12.7% barley stored in CO<sub>2</sub>-atmosphere. It was concluded that CO<sub>2</sub>-stored barley had a positive effect on feed palatability compared to barley stored in atmospheric air.

*Technical Year Report 1998, pp. 95-100 (PFR, February 1999). In DANH, Su.ENGL. 5 tables.*

### **The palatability of CO<sub>2</sub> stored wheat in mink feed**

*Carsten Hejlesen*

To ensure stability when storing wheat in atmospheric air a minimum of 85 % dry matter is required. With storage in CO<sub>2</sub>-atmosphere the required dry matter content is lower, approximately 80%. CO<sub>2</sub>-storing is economically attractive as drying often is unnecessary. A preference test was conducted to evaluate a possible palatability effect of storing method. There were 2 groups of 9 male mink (colour type Standard) per group. The experiment lasted 4 weeks, two weeks where each animal had unrestricted access to both the control and test diet and 2 weeks with unrestricted access to either the control or test diet. The control diet comprised 12.7% wheat stored in atmospheric air, while the test diet comprised 12.7% wheat stored in CO<sub>2</sub>-atmosphere. In conclusion CO<sub>2</sub>-storage did not affect the palatability of the wheat.

*Technical Year Report 1998, pp. 101–106 (PFR, February 1999). In DANH, Su.ENGL. 5 tables.*

### **Palatability trials with 7.5% swine pulp in mink feed, 1998**

*Carsten Hejlesen*

Swine pulp comprising swine spines, toes and heads is a new protein and fat source for mink feed. To investigate the palatability of swine pulp, a preference test with 2 groups of 9 male mink (colour type scanglow) per group was initiated. The duration of the test was 4 weeks: 2 weeks where each animal had unrestricted access to both the control diet without swine pulp and the test diet with 7.5 % swine pulp and 2 weeks with unrestricted access to either the control or test feed. In conclusion, 7.5 % swine pulp had a neutral tending to positive effect on the palatability of the feed.

*Technical Year Report 1998, pp. 107–113 (PFR, February 1999). In DANH, Su.ENGL. 5 tables.*

### **Palatability experiment with gelatine hydrolysate for mink**

*Carsten Hejlesen*

A potential new protein source is Gelatine hydrolysate, which is based on bones. An investigation to evaluate the palatability effect of Gelatine hydrolysate was conducted with 2 groups of 9 male mink (colour type standard) per group. The preference test lasted 4 weeks. During the 2 weeks each animal had unrestricted access to both a control diet without Gelatine hydrolysate and a test diet with 4% Gelatine hydrolysate. Furthermore, during the 2 weeks the animals had free access to either a control diet or a test diet.

It was concluded that 4% Gelatine hydrolysate did not effect the palatability of the diet. But there was a suggestion that 4% Gelatine hydrolysate may be close to the limit where palatability could be affected negatively.

*Technical Year Report 1998, pp. 115–120 (PFR, February 1999). In DANH, Su.ENGL. 5 tables.*

### **Palatability experiment with potato juice in mink feed**

*Carsten Hejlesen*

In 1997 the palatability of potato juice was investigated. Potato juice, a by-product from potato flour production, can be an interesting protein and carbohydrate source in mink feed. The experiment was conducted as a preference test with 2 groups of 9 male mink (colour type scanglow) per group. The experiment took 3 weeks - 2 weeks where each animal had unrestricted access to both the control diet without and the test diet with 8.0% potato juice and 1 week with unrestricted access to either the control or the test diet. It was concluded that 8.0% potato juice had a significant negative palatability effect on the feed.

*Technical Year Report 1998, pp. 121–126 (PFR, February 1999). In DANH, Su.ENGL. 5 tables.*

### Determination of fatty acids in fat rich fish products

Søren Krogh Jensen, Christian Friis Børsting

In EU the determination of fatty acids in feed is performed by a gas chromatographic determination of the individual methylated fatty acids after isolation according to the Stoldt fat method. However, the necessary drying steps in this method increase the risk of unwanted oxidation of especially the long chain polyunsaturated fatty acids. Therefore, we made a comparison of fatty acid composition in fatty herring and mackerel scrap after isolation of the fat by either the Stoldt fat method or the Bligh & Dyer method. The results showed that the Bligh & Dyer method is superior to the Stoldt fat method for application in fatty fish products and the difference between the two methods became more pronounced with increasing degree of unsaturation of the fatty acids.

*Technical Year Report 1998, pp. 127–129 (PFR, February 1999). In DANH, Su.ENGL. 1 table, 3 refs.*

### Rapid qualitative analysis of oils of vegetable and animal origin using supercritical chromatography (SFC)

Steen Buskov, Marianne Decker, Kirsten Mortensen, Hilmer Sørensen

Supercritical fluid chromatography with packed columns has been used as a rapid method for characterisation of triacylglycerols in different vegetable oils and animal milk (mink milk) which has been extracted from grounded seeds and freeze dried milk using supercritical fluid extraction (SFE). The results show that the SFC-method is a good alternative to existing analytical methods like GC-FAME.

Furthermore the SFC-method gives information about the distribution of triacylglycerols and other oil-related compounds occurring in the oils, which would not

be available with the existing GC-FAME-method. The SFC-method has also been used for characterisation of supercritical fluid extracted mink milk and, in spite of an uncomplete separation of animal milk triacylglycerols, the method is still a good and promising technique.

*Technical Year Report 1998, pp. 131–141 (PFR, February 1999). In DANH, Su.ENGL. 2 tables, 5 figs., 8 refs.*

### Metabolism of the amino acids leucine and methionine in skin, liver and muscle tissues in mink

Bent Riis, Christian Friis Børsting

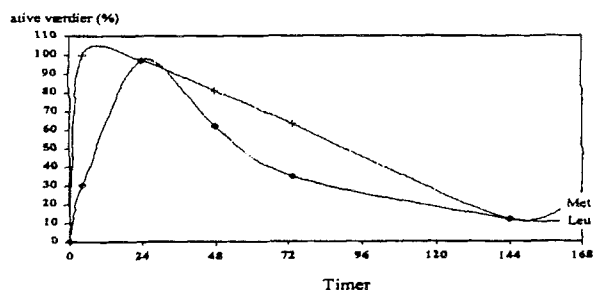


Fig 2. Incorporation and clearance of methionine and leucine in mink skin in relation to time of injection.

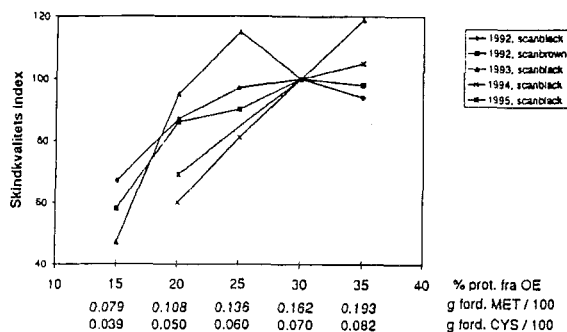
Mink perform protein synthesis and create chemical energy from amino acids. The results from injecting  $^{14}\text{C}$ -labeled methionine and leucine into the body cavity of scanblack showed that maximum absorption in the liver took 36 hrs for methionine and 12 hrs for leucine. The similar results in the skin were 12 and 36 hrs, respectively. In the muscle the maximum absorbance for both labeled amino acids was less than 5 hrs. The clearance from the liver took approx. 96 hrs for methionine and approx. 48 hrs for leucine. In the skin it took approximately 6 days before both amino acids had disappeared, and in muscle tissue the time for clearance could not be determined. In the liver tissue 7.9% of the injected methionine was

bound when the binding was at the maximum. The analogue result for leucine was 4.9%. In the muscle this figure could not be estimated. These results clearly show that this method is well suited for investigating amino acid turnover in mink organs and skin.

*Technical Year Report 1998, pp. 143–150 (PFR, February 1999). In DANH, Su.ENGL. 3 figs., 6 refs.*

### Influence of nutrition on fur quality

*Christian Friis Børsting*



**Fig. 1.** Fur quality in male mink in relation to % of ME from protein. Quality index calculated on the basis that fur quality at 30% protein equals 100.

Research in fur animal nutrition has traditionally been focused on the effects of nutrition on fur quality and size. In optimisation of nutrition a major goal is to fulfil the requirements of all nutrients in order to utilise the genetic potential for producing good fur quality and size. This presentation was mainly addressing questions regarding the effects of protein, amino acids and fat on fur properties.

The most recent research has shown that maximum fur **quality** will always be obtained with Danish mink feed of normal amino acid composition if at least 30% of Metabolisable Energy (ME) is from protein throughout the growing-furring period. However, in most cases, 25% of ME is sufficient to obtain maximum quality. Similarly, maximum pelt size is

obtained with at least 25 % of ME from protein. Requirements have been established for all essential amino acids. With regard to fur quality methionine is by far the most limiting amino acid in Danish mink feed of the present composition, whereas cysteine only in a few cases turned out to influence fur quality. Hair growth during the entire growing-furring period in relation to dietary protein supply has been studied histologically. It was shown that reduction in dietary protein level at different points from conception until the end of September influences hair growth during priming in October.

Recent research concerning the effects of marine lipids in mink diets has revealed that maximal fur quality can be obtained when as much as 50 % of dietary fat is of marine origin, whereas 70 % marine lipid reduced fur quality.

*DIAS Internal Report No. 111, pp. 55-62. In DANH, Su. ENGL. 1 table, 3 figs., 12 refs. Author's summary.*

### Digestibility of bacterial protein grown on natural gas in mink, pigs, chicken and Atlantic salmon

*A. Skrede, G.M. Berge, T. Storebakken, O. Herstad, K.G. Aarstad, F. Sundstøl*

The composition and amino acid digestibility of bacterial protein meal (BPM) produced by *Methylococcus capsulatus* (Bath), *Alcaligenes acidovorans*, *Bacillus brevis*, and *Bacillus firmus* grown on natural gas were studied. The BPM contained 959 g kg<sup>-1</sup> dry matter, 702 g kg<sup>-1</sup> crude protein, 103 g kg<sup>-1</sup> fat, and 95 g kg<sup>-1</sup> nucleic acids. The amino acid composition of BPM was similar to that of fish meal, except for less lysine (6.1 vs. 8.6 g/16 g N) and more tryptophan (2.1 vs. 0.9 g/16 g N). Total tract apparent digestibility (TTAD) in mink, chickens and pigs, and apparent ileal digestibility (AID) in pigs, were obtained by feeding BPM as the sole source of protein. In salmon, TTAD was measured by regression, using diets where BPM substituted fish meal. The average TTAD of

total N from BPM was 79.0%, 85.4%, 80.5%, and 81.9% in mink, pigs, chickens and salmon, respectively. Ileal N digestibility in pigs was 78.1%. There were substantial differences among digestibilities of individual amino acids. Arginine and lysine revealed the highest digestibilities and cystine the lowest. The average TTAD coefficients for lysine were 88.7%, 89.2%, 82.6% and 97.7% in mink, pigs, chickens and salmon, respectively, whereas lysine AID in pigs was 84.5%. Average TTAD for cystine was 47.2% in mink, 77.0% in pigs, 44.7% in chickens and 51.9% in salmon. Cystine AID in pigs was 54.9%. Methionine showed TTAD values ranging from 80.9% in chickens to 84.5% in mink, and a pig AID of 83.8%. There were highly significant correlations among the TTAD coefficients of BPM in mink, chicken and salmon, and among the latter figures and AID in pigs ( $p < 0.001$ ). Although highly significant, the TTAD coefficients in pigs were less correlated to TTAD in mink, chickens and salmon than pig AID ( $p < 0.001$ ). It appears that small intestine digestion and overall uptake of amino acids from BPM were similar among the investigated species.

*Animal Feed Science and Technology* 76, pp. 103-116, 1998. 6 tables, 49 refs. Authors' abstract.

#### Single cell protein produced from natural gas (BioProtein). A new protein source for fur animals

Anders Skrede

BioProtein is a new single cell protein produced by bacterial fermentation with natural gas as the source of carbon and energy. The bacteria culture consists of the naturally occurring methanotrophic bacteria *Methylococcus capsulatus* (Bath) and a set of heterotrophic bacteria. BioProtein is produced by Norferm DA in a new manufacturing plant at Tjeldberget, Norway. The trade name "Pronin" will be used for BioProtein intended for use in animal feed. BioProtein is a reddish/brownish meal, containing approximately 95% dry matter and 70% crude protein. The amino acid

composition is favorable considering commonly limiting amino acids in feed for fur animals. The content of methionine + cystine is on the same level as in fish meal, whereas the lysine level is lower and the threonine and tryptophan contents are higher than in fish meal. BioProtein contains about 10% fat, mainly palmitic acid (C16:0) and palmitoleic acid (C16:1), and 7% nucleic acids.

Digestibility studies with BioProtein using mink and other monogastric animals have shown an apparent protein digestibility of about 80%, corresponding to about 83% true digestibility. Lysine and arginine were the most digestible amino acids (approximately 90% apparent digestibility), whereas cystine was the least digestible amino acid. There was high correlation between amino acid digestibilities determined directly with BioProtein as the sole source of protein, and values obtained by the difference method using 50% protein from BioProtein and 50% from coalfish fillet. This indicates that there were no associative effects between the protein sources, and a linear relationship between the level of BioProtein in the diet and amino acid digestibility. Preliminary studies indicate that the fat digestibility of BioProtein is approximately 80%. Long-term production type studies with mink have so far not been carried out, but studies with other species have shown that BioProtein is a suitable protein source in feed for monogastric species.

*Proceedings NJF-seminar No. 295, 1998. In NORG. 8 pp, 3 tables, 8 refs. Author's summary.*

#### Dietary Fumonisin disrupt spingolipid metabolism in mink and increase the free sphinganine to sphingosine ratio in urine but not in hair

M.K. Morgan, J.J. Schroeder, G.E. Rottinghaus, D.C. Powell, S.J. Bursian, R.J. Aulerich

This study was conducted to investigate the effects of dietary *Fusarium moniliforme* culture material (M-1325) containing known concentrations of fumonisins B<sub>1</sub>, B<sub>2</sub> and B<sub>3</sub> on sphingo-

lipids in urine and hair of mink (*Mustela vison*) for use as potential, non-invasive biomarkers of exposure to fumonisins in this species. Feeding mink diets containing 86, 22, and 7 ppm or 200, 42, and 12 ppm of fumonisins B<sub>1</sub>, B<sub>2</sub> and B<sub>3</sub>, respectively, yielded marked increases in urinary free sphinganine (Sa) and free sphingosine (So) concentrations, and free Sa/free So ratios in hair samples from mink fed the control or high dose fumonisin diets for 100 days were similar and were not apparently altered by exposure to these mycotoxins. These results suggest that Sa/So ratios in urine, but not in hair of mink can serve as an early indicator of exposure to fumonisins in this species.

*Vet Human Toxicol* 39 (6), pp. 334-336, 1997. 1 table, 21 refs. Authors' abstract.

#### **Mercury accumulation in mink fed fish collected from streams on the Oak Ridge Reservation**

R.S. Halbrook, L.A. Lewis, R.I. Aulerich, S.J. Bursian

This study evaluates effects of feeding mercury (Hg) contaminated fish collected from streams on the Oak Ridge Reservation (ORR) on mink. Diets composed of 25, 50, or 75% fish collected from streams on the ORR were fed to mink beginning 3 months prior to breeding and ending 6 weeks following whelping. Mercury concentrations in diets, tissues of adult mink and their offspring, and physiological and reproductive effects observed in mink fed diets composed of 75% fish collected from the Clinch River above the ORR or from the ocean. Mercury concentrations in prepared diets and in tissues of adult mink and their offspring increased progressively with increased percentage of ORR fish in the diets. Female mink fed diets containing 75% ORR fish had reduced body weight and a decreased number of kits compared to those fed diets containing 75% fish collected above the ORR or from the ocean. However,

based on previously reported Hg concentrations associated with adverse effects in mink, the observed adverse effects are not thought to result from exposure to Hg.

*Arch. Environ. Contam. Toxicol.* 33, pp. 312-316, 1997. 4 tables, 1 fig., 18 refs. Authors' abstract.

#### **Nutritional quality of meat from some alternative species**

J. Sales

The proximate composition, fatty acid composition, cholesterol content, amino acid, vitamin and mineral compositions of camel, buffalo, harp seal, kangaroo and ostrich were compared with beef and chicken meat. It is concluded that the nutritional composition of the analysed meats do not differ from that of conventional meat and the low intramuscular fat content and fatty acid composition are attractive to developed countries.

*World Review of Animal Production*, Vol. 30, 1-2, pp. 47-56, 1995. 7 tables, 43 refs. CAB-abstract.

#### **Good feeding management during the winter produces better breeding males**

J. Clausen, M. Sønderup

Data on 559 mink males at 5 farms in Denmark were grouped according to a weight loss averaging 29, 21, 16, 11 or 2% from November to February, and mated at an average body weight of 2085, 2265, 2371, 2488 and 2650 g. In the 5 body weight groups, the average number of females mated per male was 5.8, 5.9, 5.5, 6.0 and 6.8 respectively, and of females mated with these males, 5.4, 7.2, 5.8, 8.6 and 8.0% failed to produce a litter.

*Dansk Pelsdyravl* 60, 12, pp. 522-523. In DANH. 4 tables. CAB-abstract.



### Selection for kit growth and dam welfare. Results of the second year of selection

*Bente Krogh Hansen, Peer Berg, Jens Malmkvist, Steffen Werner Hansen, Niels Therkildsen, Ulla Lund Rasmussen*

In mink production both large litters and high kit weaning weights are desired. Focusing strongly on these two aspects in selection can, however, lead to increasing demands on lactating dams. It is therefore important to know the relationship between maternal traits to produce milk and take care of the kits and weight changes of the dam during the lactation period. Knowledge about dam behaviour and its relation to maternal traits is useful in efforts to simultaneous improvement of kit growth and dam condition during lactation.

These relations are studied in a selection experiment started in 1996 and planned to continue until 2001, with final registration in 2002. The aim is to describe the genetic variation in early kit growth and its relation to later body weight and furthermore, to study the relation of kit growth and maternal behaviour to the effects of lactation period on the dam. Three selection lines were established. The breeding goals in the lines are: litter size (line 51), the kit's own capacity for growth (line 52) and the maternal ability to induce growth in the kits (line 53). Breeding values are estimated by an Animal Model. Methods to describe maternal behaviour were developed in 1997 and tested in 1998. A positive response has been found in all selected traits. In the second year the response in kit body weight at 4 weeks was 14 grams in line 52 and 8 grams in line 53.

Preliminary results thus confirm that there are two ways to affect the early growth of kits by selection: to select for the kit's own growth capacity or to select for maternal ability to induce growth in kits. Preliminary results from behaviour studies suggest that the frequency that the dam moves from the nest box to the

cage can be related to the number of lost kits. Thus, scanning observations of this will be used as a simple behavioural indicator of problems. Furthermore, a standardised test to evaluate maternal behaviour directed towards a 'kit in distress' has been developed, and used on females from the selection lines.

*Technical Year Report 1998, pp. 7–14 (PFR, February 1999). In DANH, Su.ENGL. 1 table, 2 figs., 4 refs.*

### Increased distance between mink females during the reproduction period

*Lise Overgaard*

The aim of this study was to investigate whether a reduced number of female mink in a mink shed would affect the reproduction results. One week before expected parturition (16 April) 75 female mink were placed with an empty cage between each other. In another shed 75 female mink were placed beside each other, and the additional cages were filled with other mink. In that way one of the mink sheds held twice as many mink as the other. The behaviour of the females was observed by scan sampling before they were moved (16 April) and again from birth to weaning at 6 weeks of age. The females were weighed at birth and 28 and 42 days after birth. The number of kits born and weaned was registered and the kits were weighed at 28 and 42 days. The females placed in every second cage weaned more and larger kits, and the females themselves had a lower weight loss. Before the move the females placed in each cage seemed to be more active, but after birth the two groups didn't show any behavioural differences. It was concluded that fewer mink in a shed had a positive effect on the females' condition and their reproduction results.

*Technical Year Report 1998, pp. 151–156 (PFR, February 1999). In DANH, Su.ENGL. 2 tables, 2 figs., 9 refs.*

## Evaluation of a plus-maze adapted to test fear of mink in a novel environment

Jens Malmkvist

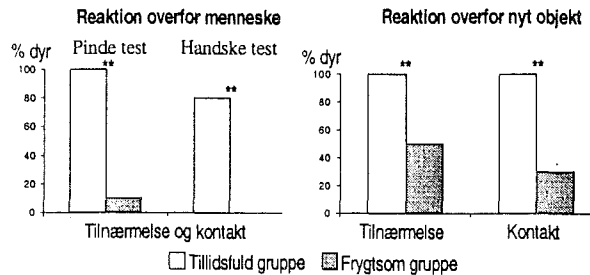


Fig. 2. Reaction in mink from 2 selection groups to humans and a novel object in the home cage.

The elevated plus-maze test is widely used in ethopharmacological research of fear/anxiety. In contrast to the system used in rodents, elevation was not an important part of the plus-maze adapted to mink. The test apparatus consists of two uncovered ('open') and two covered cage arms of equal size (1: 148 cm), extending perpendicularly from a common central platform. Twenty adult male mink belonging to groups selected over 8 generations for fearful ( $n = 10$ ) or confident ( $n = 10$ ) reaction towards humans were tested for 5 minutes July and December 1997. Behaviour and vocalisation were recorded on video. Prior to the experiment the animals were tested by additional tests involving humans and a novel object test. These tests had earlier been shown to reflect differences between the two groups. Mink from the fearful group did not differ in amount of time spent in open or covered arms compared to mink from the non-fearful group, and only in trial 2 did both groups spend more time in covered than in open arms. Neither time used, frequencies of visits, speed nor the ratio between time used in open:covered arms could reveal any difference between the two groupings of mink. However, in both trials only fearful mink showed approach-withdrawal behaviour (in all parts) and freezing postures (in open parts of maze). This plus-maze test adapted to mink showed limited ability to separate the two groups. This could be because no real difference exists between these mink

when tested without an observer present, indicating a non-generalised fear response. However, the results can probably be explained by a failure of principle in the designed maze, due to unintended confounding between novelty and shelter. As a consequence of this, implications for further tests of fear reactions in novel environment are suggested.

Technical Year Report 1998, pp. 163–167 (PFR, February 1999). In DANH, Su.ENGL. 3 figs., 7 refs.

## Behaviour influencing pelt quality – fur chewing in mink

Steffen Hansen, Jens Malmkvist

Fur chewing is defined as systematic chewing of guard hairs and underwool without penetration of the skin as in definite bites. Fur chewing is seen in several species when kept in captivity, such as mink, foxes, sable and marten. The most frequent type of fur chewing in farmed mink is chewing on the tail. This type of chewing is not observed in mink living in nature.

A specific common cause for fur chewing cannot be pointed out but detailed studies of the behaviour of mink has increased the knowledge of this phenomenon, for instance development over the year, diurnal rhythm, environmental conditions as well as inherited correlations. Development over the year is connected with the annual cycle of mink and with farm management. An increase in the frequency of chewing on neck and tail in the month of September coincides with an increase in the level of aggression. The increase in aggression is due to the establishment of a social hierarchy between mink kept in pairs or in a group. After pelt moulting the frequency of neck chewing increases in females, whereas tail chewing increases in males as well as females. The difference in neck chewing is probably an expression of sexual play in connection with sexual maturity. When breeders are placed individually in December, the frequency of tail

chewing increases whereas the frequency of neck chewing stagnates. In March, the frequency of neck chewing in the females increases due to the male's neck hold during mating. In the nursing period the frequency of body chewing is strongly reduced in females whereas males in the same period still show a high frequency of body chewing. After the kits have been weaned, the frequency of body chewing again increases in females.

Diurnal recordings of mink performing fur chewing have shown that chewing own fur takes place out in the cage in the activity period of the mink and that long sequences of chewing on the cage mate occur when the mink are lying still together in the nest box. Weaning age affects the later frequency of tail chewing. Mink weaned at the age of 6 weeks show a higher frequency of tail chewing in September-December than mink weaned at the age of 10 weeks. The frequency of tail chewing is further intensified if the kits are housed individually after weaning.

Fur chewing can thus be related partly to the aggressive or sexual behaviour of the mink and partly to a more diffuse condition where understimulation seems to be involved. Repeated acute stress does not affect the frequency of fur chewing and we have not been able to prove a correlation between irritation/allergy to old straw and the frequency of fur chewing. No correlation to the nature of the feed has been proved either. Sensitivity to develop a behaviour leading to fur chewing either on the animal itself or on cage mates is partly genetic. By selectively removing mink who chew the cage mate on the neck it is possible to reduce the frequency of fur chewing considerably but not to remove the problem. Selection for or against neck chewing at the same time increases or reduces all sorts of chewing not relatable to aggression or sexual behaviour. This seems to indicate that a common mechanism may be the reason for the systematic chewing of the animal itself or of the cage mate. It is recommended to selectively remove mink that chew the cage mate on the neck in order to avoid an increase of the fur chewing problem in the population.

At the same time the frequency of fur chewing should lead to an evaluation of the production environment and management in relation to the requirements of farm mink.

*DIAS, Internal Report no. 111, 1998, pp. 35-42. In DANH, Su. ENGL. 4 figs., 9 refs. Authors' summary.*

### Management in relation to size and quality of mink skins

Steen H. Møller

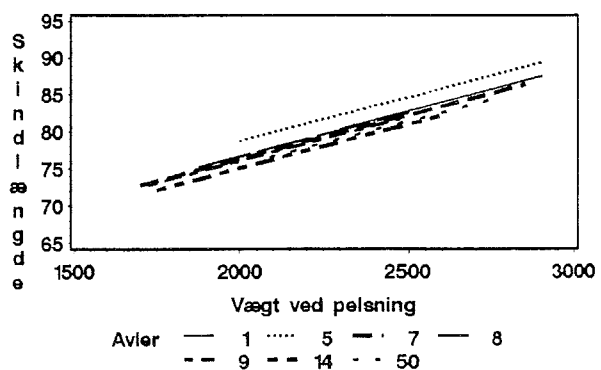


Fig. 1. Skin length as a function of weight. Black male kits from 1996.

The topic of this presentation is the effect of management during growth and pelting on skin size and quality in mink. Mink kits housed in pairs of one male and one female generally grow a little heavier and produce a slightly longer skins than kits housed singly. A slight increase in the amount of fur chewing induced by the cage mate is counterbalanced by a marginal increase in general pelt quality. In order to utilise the growth potential in young mink it is costume to feed almost ad libitum until pelting. More restricted feeding from August or September has in most cases led to an unacceptable reduction in skin length. One reason may be that the body weight during moulting is more important to skin length than a weight change between moulting and pelting. A recent investigation has shown that the effect of 100 g of body weight in late October is 1.3 cm of skin

while the effect of 100 g of weight loss from October to pelting is only 0.6 cm. The same investigation showed that the elasticity of the skin did not change during the pelting season from mid November to mid December. Contrary to expectations, the regression of skin length on body weight at pelting was unaffected by the date of pelting.

The skin length increases with the force used at straining, but at dressing the skins regain the same size as before straining. The increase in straining force of up to 50 kg in male skins facilitated by the introduction of straining machines is therefore only a short term benefit, as the price will adapt to the dressed skin length. The skin elasticity varies between colour types and farms, indicating a difference between farms, far greater than differences in straining load could account for. It is thus possible to increase skin length by management or genetic factors without increasing the body size. The negative correlation between skin length and quality is mainly caused by the body condition, while skin quality is largely unaffected by skin length due to body length. Skin quality is difficult to measure and knowledge of the effects of management is therefore limited. As information on the quality grading of each skin at Copenhagen Fur Centre is available for the farmers today, it is possible to include this information in on-farm investigations. This information is a unique potential source of information on the effects of pelting management and skin properties. If the individual mink can be identified through the pelting process, the effect of factors during lactation and breeding may also be investigated.

*DIAS, Internal Report no. 111, 1998, pp. 43-48. In DANH, Su. ENGL. 3 tables, 1 fig., 16 refs. Author's summary.*

### **Development and possible causes of fur damage in farm mink – significance of social environment**

*S.W. Hansen, B. Houbak, J. Malmkvist*

The aim of the present experiment was to investigate the temporal development of fur damage in mink as well as the significance of social conditions (alone, in pairs or in family groups) on frequency and development of fur damage in mink kits. The adult generation was selected and distributed into two groups, partly on the basis of the frequency and character of fur damage. The kits examined were offspring from these adult mink plus those from a randomly selected control group. Fur damage occurred when the kits were 2 months old irrespective of weaning time and social condition. Fur damage in the neck, however, only appeared when the animals were placed two or more together, so it can be deduced that the appearance of neck damage is not self-inflicted. It may appear as a result of normal behaviour of mink in connection with mating and aggressive interactions and also as an abnormal behaviour probably caused by understimulation. Fur damage on the tail increased when mink were separated or when females lost their kits at weaning. Tail damage is caused by an abnormal behaviour (fur chewing) that is self-inflicted, where frustration and understimulation can be involved. It seems possible that the threshold value for the occurrence of fur chewing could be changed through selection.

*Acta Agric. Scand., Sect. A, Animal Sci. 48, pp. 58-64, 1998. 6 figs., 17 refs. Authors' abstract.*

*Original Report*

## Age-dependent features in the reproductive performance of domesticated silver fox males

L.V. Osadchuk

*Institute of Cytology and Genetics, Siberian Branch of the Russian Academy of Sciences,  
Novosibirsk 630090, Russia*

### Summary

Reproductive performance and morphometric traits were analysed in yearling and adult silver fox males subjected to long-term selection for domestic behaviour. It was shown that yearlings started to mate a week later than the older males. Sexual activity was lower during the first than the second and third breeding seasons. Some young (23.2%) males showed no sexual activity during the first breeding season. Fertility was not decreased in young males displaying reduced mating activity. In consecutive years, after removal of the sexually inactive yearlings from the breeding population, sexually inactive animals were infrequent among adults although 32.5% of them mated with less than five vixens per season. It is suggested that developmental disturbances may underlie the reduced sexual activity that we observed in some animals.

### Introduction

Reproductive physiology of fur bearing animals has become an essential component of interdisciplinary research. Geneticists, ethologists, endocrinologists and animal breeders have been concerned with environmental and genetic influences on reproduction. However, little is known about the effects of captive

breeding on the reproductive physiology of fur animals.

Captive breeding is the first step in the domestication of animals (Belyaev, 1978; Price, 1998). It involves adaptation to a captive environment and the ability to reproduce under man's control. Since early captive breeding, man has unconsciously carried out selection for tameness because it was easier to handle tame than aggressive or fearful animals. Thus, artificial selection for absence of aggressive response to human and docility (domestic behaviour) plays a key role in the domestication process (Belyaev, 1978). Domestication implies change and it may be reasonably expected that domesticated animals would differ phenotypically from their wild counterparts (Price, 1998). Reproduction and fertility are promising lines in research of the consequences that a captive environment has on fur bearing animals.

The silver fox (*Vulpes vulpes*) has been bred in captivity from the beginning of this century. They have been raised at first in conditions that were quite alien and to which they were not genotypically adapted. Limitation of living space, crowding in farms, food of new quality and contact with humans were novel and stressful for most farmed silver foxes. It remains debatable whether the fox as a species

has become adapted to captive conditions and whether it has become domestic in the strict sense of the word (Moe *et al.*, 1995). Because domestication implies adaptation to man and to the environment he provides (Price, 1998), the silver fox is still a species closer to its wild counterparts or a semidomestic species. Moreover, recent studies have shown that contacts with human beings, a source of stress for foxes, can affect the reproductive and endocrine systems (Pedersen, 1994; Bakken, 1998; Braastad *et al.*, 1998; Moe, Bakken, 1998).

In long-term selection experiments at the Institute of Cytology and Genetics (Novosibirsk, Russia) a population of tame silver foxes has been developed. The method of fox selection and the behavioural changes during silver fox domestication have been described with particular references to their amicability and adaptation to farm conditions because of a better tolerance to stress produced by captivity (Belyaev, 1979; Trut, 1995). For this reason, the domesticated silver fox is a good model for research not only in behaviour, but also in reproductive physiology.

Silver fox males are sexually mature at the age of 9-10 months and are able to mate during their first breeding season. However, some of them ignore mating during the first breeding season, and others are less sexually active than adults (Osadchuk, 1992, 1998a; Lanszki *et al.*, 1996). There are data indicating that mating starts later in yearlings compared to adult fox males (Jalkanen, 1992; Lanszki *et al.*, 1996). It is not clear whether domesticated silver fox males retain the same age-dependent features of reproductive performance as foxes not subjected to domestication.

The aim of this study was to analyse the reproductive performance of silver fox males of different ages after long-term domestication based on dates of the first successful mating, duration of sexual activity, litter size and number of vixens mated. Body and testes weights in yearling and adult males at different stages of the reproductive cycle were also compared.

## Material and Methods

Domesticated silver fox males maintained at the experimental fur farm of the Institute of Cytology and Genetics (Novosibirsk, Russia) were used. The behavioural changes brought about by domestication have been described in earlier studies (Belyaev, 1979; Trut, 1995). Inbreeding was not used when forming fox pairs.

In general, yearling fox males were selected for breeding stock in October-November by tests for fur quality and interest in the domesticator (Trut, 1995). Additional selection criteria were testicular size, parental fertility and birth date. It is a common practice to eliminate non-breeders from the farm population after the first breeding season or during the next pelting period. The vixens at Russian farms are bred naturally and artificial insemination is not used. Silver fox females have only one estrus lasting two or three days during the reproductive season. The time of estrus varies markedly from one individual to another but occurs within the reproductive season. Silver fox males are sexually active during the whole reproductive season, although there is a difference in the starting time and length of mating activity for individual males. During the breeding period, an estrus female is placed into the male cage each morning. Evidence of estrous is determined by vulval swelling and vaginal smear composition. Vixens are mated on the second or third day after the peak in vulval swelling. Mating is documented by direct observation. If mating took place, the same female is reintroduced the next day. As a rule, repeated matings occur with the same male. No male used in the present work showed clinical signs of cryptorchism, and palpation showed that testicle sizes were normal for the day of the annual reproductive cycle.

Reproductive performance was estimated in males of the experimental population born in three consecutive years. Foxes were assigned to one, two and three year-old groups. Breeding activity in the males of different ages was assessed by several criteria, namely, number of vixens mated over the breeding season, aver-

age litter size per mated vixen and the duration of the breeding season calculated as the time between the first and last matings. The yearling and adult silver foxes were also compared by the date of the first successful mating, and on the distributions of males according to the number of mated vixens and to the mating dates. In Russia, a fur breeder expects that a normal male would mate with not less than five vixens. Based on this number, we conventionally classified the males into the sexually active (that have mated vixens) and the sexually inactive (that have not mated). The population included yearling breeders and non-breeders, while adults were preselected by the number of mated females after the first breeding season. The correlation coefficient between the birth date of the male and its sexual activity during the first reproductive season was also calculated.

To estimate the differences in body and testes weights between yearling and adult males at different stages of the reproductive cycle, males were sacrificed in November (the pelting period) and in March at the end of the breeding season. The sacrificed foxes were weighed and the weights of the removed testes were determined.

All the values are means  $\pm$ SEM. The significance of the differences was evaluated using

Student's t-test and correlation analysis (Statistics for Windows, 1992).

### Results and Discussion

A high proportion of yearling males (23.2%) did not mate during the first breeding season (Table 1). It is a common practice of fur breeders to remove juvenile nonmaters from the herd. For this reason, the number of sexually active males increased amongst the two-three year old foxes, and sexually inactive adults rarely appeared (Table 1). This suggests disturbances in the sexual maturation of some males during their postnatal, even prenatal life. It is possible that certain recurring environmental events or management practices have negatively affected the formation of their sexual behaviour.

The present estimates of male sexual activity were based on the number of vixens mated with a male per breeding season. The estimation may appear subjectively biased because mating conforms to a time schedule according to which a particular male should mate with a definite number of vixens. However, sexual activity can be low in some males so that others have to perform better, to mate with more vixens out of schedule. As a result, the final estimates reflect actual sexual activity of males and contain objective characteristics.

**Table 1.** Age-dependent reproductive performance in domesticated silver fox males

Breeding season	Total number of foxes	Number of sexually active males	Number of mated vixens per sexually active male	Litter size	Duration of the breeding season (days)
First	95	73	3.9 $\pm$ 0.3*	4.9 $\pm$ 0.2	19.1 $\pm$ 1.5*
Second	31	31	6.1 $\pm$ 0.6	5.3 $\pm$ 0.2	24.7 $\pm$ 2.5
Third	15	15	6.1 $\pm$ 0.8	5.0 $\pm$ 0.4	24.0 $\pm$ 3.3

\*- The differences between yearling and adult males are significant ( $P < 0.05$ )

To estimate the age differences in the peak period of matings in silver fox males, we examined the distribution of males according to their mating dates during the first and consecutive breeding seasons (Figure 1). Yearling males did not differ in mating dates during the breeding season from adults; their mating numbers peaked at the same time.

The distribution of yearling and adult males according to the number of mated is shown in Figure 2. The proportion of nonmated and males with lower sexual activity (mated with less than five females per season) was highest for yearling males ( $P < 0.05$ ). The simple calculations showed that 70.5% of yearlings and 32.5% of adults did not fulfill the criterion of mating. These data are in agreement with those for unselected foxes (Lanszki et al., 1996; Osadchuk, 1998a). It is of interest that nonmated males tended to appear each year despite the selection against them. This evidences that additive genetic variation in male sexual activity was small and for this reason selection against the nonmated was ineffective.

The duration of the first breeding season based on the time between the first and the last matings was shorter than of the second or third ( $P < 0.05$ , Table 1). It has been reported that the length of the sexually active period was, on the average, 18.4 days for yearlings and 22.5 to 25.8 days for adults of different ages (Lanszki et al., 1996). This is in a good agreement with our estimates. The age of males did not affect female fertility because litter size for yearlings was the same as for adults (Table 1). This should be expected because litter size appears to be more dependent on the number of ovulated eggs than spermatozoa concentration in sperm.

There is a significant difference between yearlings and adults in the date of their first mating. The yearlings began to mate on 14 February and adults on 8 February ( $14.57 \pm 1.0$  vs.  $.08 \pm 1.0$ ,  $t = 3.69$ ,  $P < 0.01$ ). Yearlings started to mate somewhat later than the older males. We cannot compare the starting dates of mating in the present and others studies because of differences in latitude and climate that affect the

beginning of the breeding season (Forsberg, 1992). However Lanszki et al. (1996) have also concluded that yearling males start mating later. The shift to later mating dates can be explained by the sexual immature of yearling males or sexual inexperience that may be overcome throughout the first breeding season. Nevertheless, the coefficient correlation between the birth date and the number of mated females during the first breeding season was insignificant ( $r = 0.0097$ ,  $n = 95$ ) suggesting that the sexual activity in yearlings is not related to their date of birth.

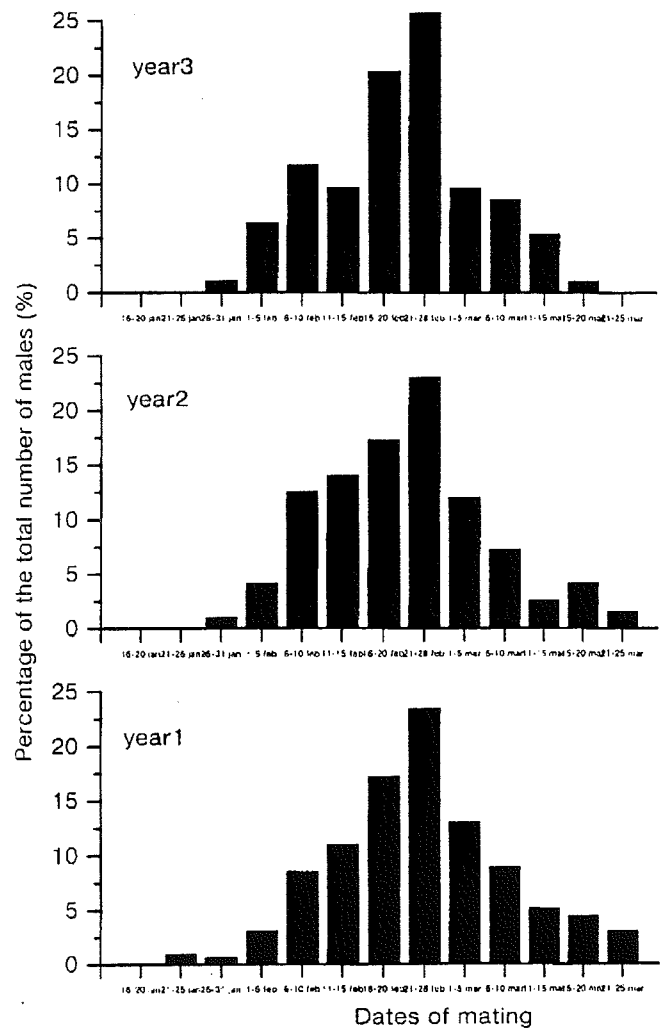
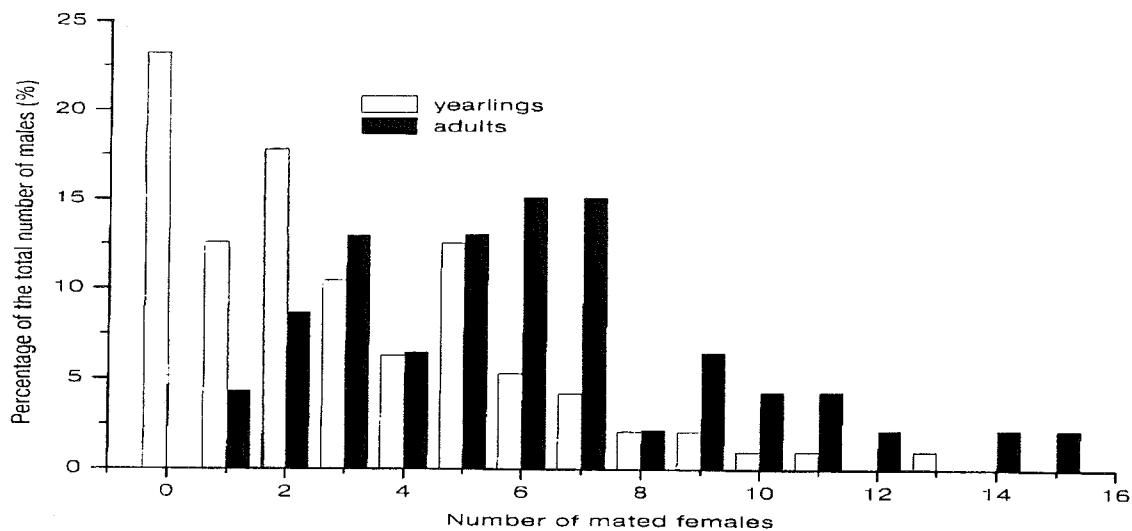


Figure 1. Distribution of silver fox males of different ages according to the mating dates during the breeding season. The calendar days are grouped in 5 for which the mating numbers are summed up.





**Figure 2.** Distribution of yearling and adult silver fox males according to the number of mated females during the breeding season.

No significant differences were found in body and testes weights between juvenile and adult males at different stages of the reproductive cycle (Table 2). This was evidence that juvenile foxes were constitutionally mature just before the first breeding season. These results are in contrast to those obtained for farm-bred males (Osadchuk, 1998a). Yearlings from commercial

populations have lighter bodies and testes than adults before the breeding season. There is reason to suggest that selection for domestic behaviour may produce inherited changes in the development of morphometric traits in males. The observation suggests that the development is accelerated in domesticated males compared to their farm-bred counterparts.

**Table 2.** Weights of body and testes in yearling and adult silver foxes at different periods of the reproductive cycle

Group	Body weight		Testes weight	
	November	March	November	March
Yearlings	7.25±0.16 (n=18)	5.90±0.13 (n=19)	6.84±0.46 (n=18)	8.80±0.70 (n=10)
Adults	7.39±0.14 (n=14)	5.94±0.24 (n=14)	6.85±0.37 (n=22)	8.97±0.39 (n=9)

Analysis of breeding data for the domesticated silver fox males presented here allowed us to determine two main features of their reproduction. First, some young males display no sexual activity; second, the mating activity of males, expressed as the number of mated vixens, is lower during the first than the next breeding seasons. The applied selection against young nonmaters is ineffective. The decrease in mating activity of males is not associated with fertility. It is suggested that developmental disturbances may underlie the observed reduced sexual activity in some male foxes. The

importance of sexual steroid hormones, particularly testosterone and estradiol, in the regulation of male sexual behaviour has long been recognised (for reviews see Allen, Adler, 1985; Zbranca *et al.*, 1989). Hormones do not directly release reproductive behaviour. They act, at least in adults, in a permissive way to allow the full expression of sexual events leading to copulation (Allen, Adler, 1985). The reproductive behaviour of partners should be co-ordinated, and it is under control of both external physiological (hormonal) factors and social environments. These behaviour-endocrine rela-

tionships have formed as a biological adaptive mechanism and they are species-specific. Sexual behaviour in the more primitive animals is completely controlled by sexual hormones with activating effects and species acquire independence from the activating hormonal effects with advancement on the phylogenetic scale (Zbranca *et al.*, 1989). Much has been learnt about the hormonal aspects of fur animal reproduction in recent years. The hormonal mechanisms that regulate male sexual activity are, so far, unclear. Studies have been performed to elucidate relationships between steroid hormone concentrations and sexual activity and to highlight the role of sexual steroids in the regulation of reproductive behaviour in the silver fox. The results have been partly reported (Osadchuk, 1997; Osadchuk, 1998a; Osadchuk *et al.*, 1998b) while articles presenting the data obtained using domesticated males silver fox as a model will appear in next issues of Scientifur.

### Acknowledgements

This work was supported by grants from the Russian Foundation for Fundamental Research N 97-04-49941 and the Russian State Program "Frontiers in Genetics".

### References

- Allen T.O., Adler N.T. 1985. Neuroendocrine consequences of sexual behavior. *Handbook Behav. Neurobiol.* Vol. 7: 725-766.
- Bakken M., 1998. The effect of an improved man-animal relationship on sex ratio in litters and on growth and behaviour in cubs among farmed silver fox (*Vulpes vulpes*). *Appl. Anim. Behav. Sci.* Vol. 56:309-317.
- Belyaev D.K. 1979. Destabilizing selection as a factor in domestication // *J. Heredity.* Vol. 70: 301-308.
- Braastad B.O., Osadchuk L., Lund G. and Bakken M. 1998. Effects of prenatal handling stress on adrenal weight and function and behaviour in novel situations in blue fox cubs (*Alopex lagopus*). *Appl. Anim. Behav. Sci.* Vol. 57: 157-169.
- Forsberg M. 1992. Seasonal breeding and the significance of light. In: *Reproduction in Carnivorous fur bearing animals* (Eds A.H. Tauson, M. Valtonen), pp. 17-38. Nordiska Jordbruksforskarens Forening. Copenhagen.
- Jalkanen L. 1992. Sperm quality in silver fox, variation and relation to the breeding results. In: *Reproduction in Carnivorous fur bearing animals* (Eds. A.H. Tauson, M. Valtonen), pp. 139-143. Nordiska Jordbruksforskarens Forening. Copenhagen.
- Lanszki J., Udvardy J., Lengyel K. 1996. The effect of age on sexual activity of arctic fox and of silver fox males. *Applied Science Reports, Polish Society of Animal Production.* Vol. 27: 223-240.
- Moe R.O., Bakken M. 1998. Anxiolytic drugs inhibit hyperthermia induced by handling in farmed silver foxes (*Vulpes vulpes*). *Animal Welfare.* Vol. 7: 97-100.
- Moe R.O., Bakken M., Haga O., Smith A. 1995. Techniques for surgical implantation of radio transmitters in the silver fox (*Vulpes vulpes*) J. *Zoo and Wild Med.* Vol. 26(3): 422-429.
- Osadchuk L.V. 1992. Age peculiarities of reproductive function in males of silver-black foxes. *Selskochozaystvennaya Biologia.* N 4: 26-31 (in Russian).
- Osadchuk L.V. 1997. Steroid hormones and reproductive behavior in silver fox males. *Inter. J. Mam. Biol. Suppl.* 2: 164-169.
- Osadchuk L.V. 1998a. A comparative study of sperm, sexual hormone concentrations and sexual activity in yearling and adult males of the silver fox (*Vulpes vulpes*). *Anim. Sci.* (accepted).
- Osadchuk L.V., Jalkanen L., Philimonenko A.A., Gultjaeva V.V. 1988b. Changes of testosterone level and sperm production and morphology in male silver foxes *Vulpes vulpes* throughout the breeding season. *Scientifur.* Vol. 22: 121-126.
- Pedersen V. 1994. Long-term effects of different handling procedures on behavioural, physiological, and production-related parameters in silver foxes. *Appl. Anim. Behav. Sci.* Vol. 40: 285-296.
- Price E.O. 1998. Behavioral genetics and the process of animal domestication. In: *Genetics and Behavior of Domestic Animals.* Academic Press. P. 31-65.
- Trut L.N. 1995. Domestication of the fox: roots and effects. *Scientifur.* Vol. 19: 11-18.
- Zbranca E., Mogos V., Postelnicu C. 1989. Hormones and sexual behaviour. *Physiologie.* Vol. 26(3): 169-181.

*Original Report***Steroid hormone concentrations in relation to sexual activity in domesticated silver fox males***L.V. Osadchuk**Institute of Cytology and Genetics, Siberian Branch of the Russian Academy of Sciences,  
Novosibirsk 630090, Russia***Summary**

Silver fox males start to breed at the age of 9-10 months, and they show well-defined seasonal changes in reproduction. It follows from breeding practice that some young males ignore mating during their first breeding season. The reasons why some males are sexually inactive are not yet clear, and currently there is no way to predict their low sexual activity. Testosterone, estradiol and cortisol concentrations in plasma were studied in a group of silver fox yearling males (n=13) during the transition from the non-breeding to the breeding season and during the mating period. After the first reproductive period, yearlings were retrospectively distributed into two groups, consisting of either sexually active (mated with females) or sexually inactive (were unable to mate). Two groups were then compared for the pattern of seasonal variation in steroid hormones. The results showed that there were no differences among yearling males in the pattern of seasonal variation of steroid secretion in relation to sexual activity. It is suggested that the baseline concentrations of sexual steroids cannot be used as criteria to predict future sexual activity in silver fox males.

**Introduction**

Breeding in the silver fox is seasonal, from the middle of January to the middle of March. Foxes start to breed at the age of 9-10 months. However, it is concluded from practice that some fox males do not start mating during the first year of life and this causes great economic losses. The reasons why yearling males occasionally fail to mate have not been studied and there currently are no ways and means by which their failures can be corrected. It is common practice of fur breeders to remove juvenile non-maters and males mated less than five vixens from the herd at the end of their first breeding season.

There are data indicating that sexual activity is lower and mating starts later in yearlings compared with adult fox males (Jalkanen, 1992; Lانسzki *et al.*, 1996; Osadchuk 1998a, 1999). In a previous study, we showed that a high percentage of yearling males of silver fox (27%) did not mate during the first breeding season or their sexual activity was reduced (26%) (Osadchuk, 1998a). In addition, sexual activity was not related to spermatogenesis, and, as a rule, non-maters had very good sperm performance.

Analysis of body and testes weights and sperm morphology in young fox males has shown that the reproductive capacity of yearling male foxes may be immature in the first breeding season (*Osadchuk, 1998a*). It is unclear whether lower sexual activity is related to seasonal changes in plasma steroid profiles and the endocrine mechanisms controlling reproduction.

It is known that sex steroid hormones are of importance in the regulation of sexual maturation and normal functioning of the reproductive system. It has been shown that developmental disturbances of the gonadal endocrine function delay the onset of sexual maturity, alter sexual behaviour and reduce male fertility (*Sandow, 1986; Auclair et al., 1995; Chandolia et al., 1997*). Moreover, hormonal tests were developed for the estimation and prediction of reproduction disturbances in some mammals (*Magistrini et al., 1996*).

The purpose of this study was to investigate the variation in testicular endocrine function in yearling silver fox males during the transitional period from the non-breeding to the breeding season including the pubertal period and the expected peak of mating activity. The hormonal concentrations were then retrospectively compared between groups of sexually active and sexually inactive males to identify possible endocrine dysfunction in sexually inactive males.

In this study we used silver foxes subjected to long-term selection for domestic behaviour. Domesticated foxes are unique because they show no aggressiveness to man. They are well adapted to captivity, providing an opportunity for studies of reproductive physiology. All farm populations of silver foxes are undergoing unconscious selection for domestication (*Belyaev, 1979; Trut, 1995*) and a better understanding of the reproductive biology of fur bearing animals under advanced domestication is needed for the development of management strategies. The age-dependent features in sexual activity are similar in domesticated and farm-bred undomesticated males (*Osadchuk, 1999*).

## Material and Methods

Domesticated silver fox males maintained at the experimental fur farm of the Institute of Cytology and Genetics (Novosibirsk, Russia) were studied. The behavioural changes during silver fox domestication have been described in detail elsewhere (*Belyaev, 1979; Trut, 1995*). The domesticates are friendly and well adapted to farm conditions because more tolerant to stress. Inbreeding was not used when forming fox pairs.

Estimates of testicular and adrenal endocrine function were based on plasma levels of testosterone, estradiol and cortisol. Thirteen silver fox males were randomly chosen from the domesticated population. Blood was withdrawn from animals on 29 October, 2 December, 26 January and 28 February. Blood was collected from vein *saphena* without anaesthesia, centrifuged and the plasma stored at  $-20^{\circ}\text{C}$ .

Testosterone, estradiol and cortisol in the plasma samples were measured by radioimmunoassay (RIA) using commercial kits (Sea-Ire-Sorin, France) with preliminary extraction with ethyl ether. The recovery from ether extraction (extraction yield of added tritiated steroids) was 0.9 to 1.0. The sensitivity of the assays expressed as the minimum detectable amount of hormone was 0.08 ng/ml for testosterone and estradiol and 4.0 ng/ml for cortisol. The intra- and interassay coefficients of variation were 6.0% and 10.0% for testosterone, respectively, 10.5% and 18.4% for estradiol and 5.4% and 9.6% for cortisol.

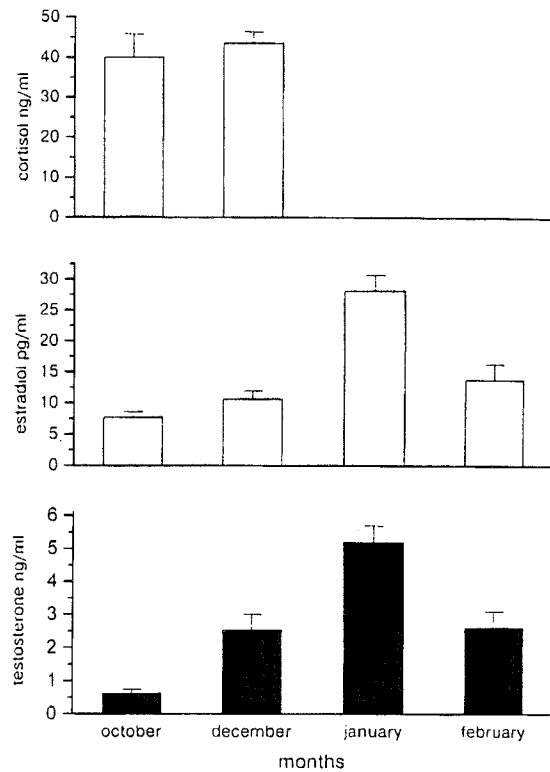
The experimental animals were regarded as breeders, and they were allowed to mate according to the established schedule. The reproductive results were recorded for the experimental fox group. Estimates of male reproductive performance were based on the number of mated females, number of pups born per mated female (litter size) and the total number of pups from a male per breeding season. After the first breeding season, the experimental males were retrospectively divided into two groups according to the number of mated fe-

males. The sexually active group consisted of eight males, which mated from 1-11 females and the inactive group of five males, which were unable to mate. Reproductive performance was also recorded in sexually active males during the second breeding season when the sexually inactive males were pelleted.

All the values are means  $\pm$ SEM. One-factor analysis of variance was applied to analyse the temporal changes in the hormonal concentrations. To compare reproductive results in males, Student's t-test was used.

**Results**

Plasma testosterone, estradiol and cortisol concentrations in yearling fox males during the transitional period from the non-breeding to the breeding season and the expected peak of sexual activity are shown in Figure 1. The basal concentrations of testosterone and estradiol exhibited marked ( $P < 0.05$ ) seasonal variations. They decreased outside the breeding season and increased during it ( $P < 0.05$ ). During the nonbreeding period, plasma cortisol concentrations did not vary widely during the two months (October  $40.13 \pm 5.71$  ng/ml and December  $43.76 \pm 2.71$  ng/ml).



**Figure 1.** Plasma testosterone, estradiol and cortisol levels in yearling males of the silver fox during the transition into the breeding season and the breeding months.

**Table 1.** Steroid hormone concentrations in yearling silver fox males (n=13) during the transitional period from the non-breeding to the breeding season and the expected peak of sexual activity.

	Cortisol ng/ml	Testosterone ng/ml	Estradiol pg/ml
<b>OCTOBER</b>			
Inactive	36.67 $\pm$ 4.99	0.53 $\pm$ 0.13	7.22 $\pm$ 0.97
Active	44.6 $\pm$ 10.68	0.72 $\pm$ 0.18	8.21 $\pm$ 1.23
<b>DECEMBER</b>			
Inactive	48.82 $\pm$ 5.96	3.46 $\pm$ 0.49	13.40 $\pm$ 2.88
Active	40.87 $\pm$ 2.31	1.96 $\pm$ 0.33	9.31 $\pm$ 1.03
<b>JANUARY</b>			
Inactive	Not assayed	5.53 $\pm$ 0.50	30.62 $\pm$ 1.69
Active	Not assayed	5.00 $\pm$ 0.74	26.93 $\pm$ 4.00
<b>FEBRUARY</b>			
Inactive	Not assayed	3.70 $\pm$ 0.75	10.90 $\pm$ 1.40
Active	Not assayed	1.95 $\pm$ 0.56	15.65 $\pm$ 3.85

The effect of a group on circulating testosterone, estradiol and cortisol concentrations is shown in Table 1. There were no significant group differences in the pattern of seasonal variation in hormone concentrations between the two groups (See section **Material and methods** for the method used).

The reproductive performance of males of the experimental groups is shown in Table 2. Five males (38%) failed to mate during the first reproductive season. Nonmated males and males with low sexual activity (mated with less than four vixens) were sacrificed during the pelting period in November according to the routine practice.

It is interesting to note that the other males (fulfilling the criterion accepted by fur breeders) showed good breeding results in their second reproductive season.

## Discussion

The results demonstrate seasonal changes of steroid hormone concentrations in young silver fox males. The highest hormonal levels occurred together with the expected peak of sexual activity (January and February). Our data are in accordance with other evidence obtained on adult and yearling silver fox males (Forsberg, Madej, 1990; Forsberg, 1992; Osadchuk, 1993; 1998b). Throughout the breeding season, plasma testosterone concentration was increased in the middle of the breeding season compared to its onset and end (Osadchuk et al., 1998b). Similar changes in the time course of testosterone concentration were described in red fox (Joffre, 1977) and blue fox males (Smith et al., 1985). The plasma testosterone and oestradiol concentrations observed in this study are in agreement with the data during the same periods of reproductive cycle observed for males of silver and red fox (Joffre, 1977; Forsberg and Madej, 1990; Osadchuk, 1993; Osadchuk et al., 1998b).

**Table 2.** Reproductive performance of silver fox males (n=13) in the first and second breeding season

No. animals	Breeding season					
	First			Second		
	No. mated vixens	No. pups born	Litter size	No. mated vixens	No. pups born	Litter size
1	0	0	0	pelted		
2	9	46	5.1	5	27	5.4
3	1	0	0	pelted		
4	6	23	3.8	5	39	7.8
5	0	0	0	pelted		
6	0	0	0	pelted		
7	0	0	0	pelted		
8	1	6	6	pelted		
9	1	0	0	pelted		
10	1	0	0	pelted		
11	0	0	0	pelted		
12	4	23	6.8	7	36	5.1
13	4	13	3.3	2	5	2.5
Total	2.1±0.8	8.8±4.1	1.9±0.7	4.8±1.0	26.8±7.6	5.2±1.1

The low sexual activity in some males remains an open issue in fox breeding. Up to the present, we are unable to predict with certainty the future breeding capacity of male silver fox. As mentioned above, in farm-bred undomesticated silver foxes, there is also a high proportion of nonmaters or males with reduced sexual activity among yearlings (*Osadchuk, 1998a*). While the sexually inactive males were eliminated from the breeding population, the sexual activity of two-year old males increased. Similar results were obtained for undomesticated silver foxes (*Osadchuk, 1998a*). This shows that the same reasons underlie reduced or lost sexual activity of young fox males. The observations led to a suggestion that reduced sexual activity in some fox males may result from developmental disturbances of sexual behaviour.

In the present paper, the relationship between sexual activity during the breeding season and the pattern of seasonal variation in steroid hormone concentrations was analysed. During the transition to the breeding season, notable differences in testosterone and estradiol concentrations were not observed between the maters and nonmaters. This can be taken to mean that loss of sexual activity is not necessarily associated with lower baseline steroid concentrations.

Reproduction is not the function of one organism and it involves at least a male and a female. A complex of complementary functions, including range of behavioural, hormonal and social reactions provides it. It is known that testosterone and estradiol are necessary to maintain normal sexual behaviour (*Allen, Adler, 1985*). There is a close relationship between the endocrine activity of the testes and sexual behaviour in males (*Bronson, Desjardins, 1982*). Hormonal activity of the testes and sexual arousal of males are controlled by pheromones of the female (*Coquelin, Bronson, 1979*). Male sexual arousal in all species studied in this respect to date is accompanied by a typical hormonal response, an increase in blood concentrations of testosterone and LH (*Bronson, Desjardins, 1982*). This suggests that sexually inac-

tive males may not respond to a receptive female with an increase in testosterone concentrations. The incidence of a hormonal response that accompanies sexual arousal in silver fox males may be fairly regarded as a predictive sign useful in breeding practice. Whether the low reactivity of the hypophysial-testicular axis to the sexual pheromones of the female is a prerequisite for lower sexual activity, will be checked in future experiments.

### Acknowledgements

This work was supported in part by grants from the Russian Foundation for Fundamental Research N 97-04-49941 and the Russian State Program "Frontiers in Genetics".

### References

- Allen T.O., Adler N.T., 1985. Neuroendocrine consequences of sexual behavior. Handbook Behav. Neurobiol. Vol. 7: 725-766.
- Auclair D., Sowerbutts S.F., Setchell B.P. 1995. Effect of active immunization against oestradiol in developing ram lambs on plasma gonadotrophin and testosterone concentrations, time of onset of puberty and testicular blood flow. J Reprod. Fert. Vol. 104: 17-16.
- Belyaev D.K. 1979. Destabilizing selection as a factor in domestication // J. Heredity. Vol. 70: 301-308.
- Bronson F.H., Desjardins C. 1982. Endocrine responses to sexual arousal in male mice. Endocrinology. Vol. 111:1286-1291.
- Chandolia R.K., Evans A.C.O., Rawlings N.C. 1997. Effect of inhibition of increased gonadotrophin secretion before 20 weeks age in bull calves on testicular development. J Reprod. Fert. Vol. 109: 65-71.
- Coquelin A., Bronson F.H. 1979. Release of luteinizing hormone in male mice during exposure to females: habituation of the response. Science. Vol. 206 (4422): 1099-1101.
- Forsberg M. 1992. Seasonal breeding and the significance of light. In: Reproduction in Carnivorous fur bearing animals (Eds A.H. Tauson, M. Valtonen), pp. 17-38.

Nordiska Jordbruksforskarens Forening. Copenhagen.

Forsberg M., Madej A. 1990. Effects of melatonin implants on plasma concentrations of testosterone, thyroxine and prolactin in the male silver fox (*Vulpes vulpes*). J Reprod. Fert. Vol. 89: 351-358.

Jalkanen L. 1992. Sperm quality in silver fox, variation and relation to the breeding results. In: Reproduction in Carnivorous fur bearing animals (Eds A.H. Tauson, M. Valtonen), pp. 139-143. Nordiska Jordbruksforskarens Forening. Copenhagen.

Joffre M. 1977. Relationship between testicular blood flow: testosterone secretion and spermatogenic activity in young and adult wild red foxes (*Vulpes vulpes* L.). J. Reprod. Fert. 51:35-40.

Lanszki J., Udvardy J., Lengyel K. 1996. The effect of age on sexual activity of arctic and of silver fox males. Applied Science Reports, Polish Society of Animal Production. Vol. 27: 223-240.

Magistrini M., Vidament M., Clement F., Palmer E. 1996. Fertility prediction in stallions. Anim. Reprod. Sci. Vol. 42: 181-188.

Osadchuk L.V. 1993. Sexual steroid hormones in the reproductive cycle of silver fox Norw. J Agricul. Sci. Vol. 7: 189-201.

Osadchuk L.V. 1997. Steroid hormones and reproductive behavior in silver fox males. Inter. J Mam. Biol. Suppl. 2: 164-169.

Osadchuk L.V. 1998a. A comparative study of sperm, sexual hormone concentrations and sexual activity in yearling and adult males of the silver fox (*Vulpes vulpes*). Animal Science (in press).

Osadchuk L.V., Jalkanen L., Philimonenko A.A. and Gultjaeva V.V. 1998b. Changes of testosterone level and sperm production and morphology in male silver foxes *Vulpes vulpes* throughout the breeding season. Scientifur. Vol. 22: 121-126.

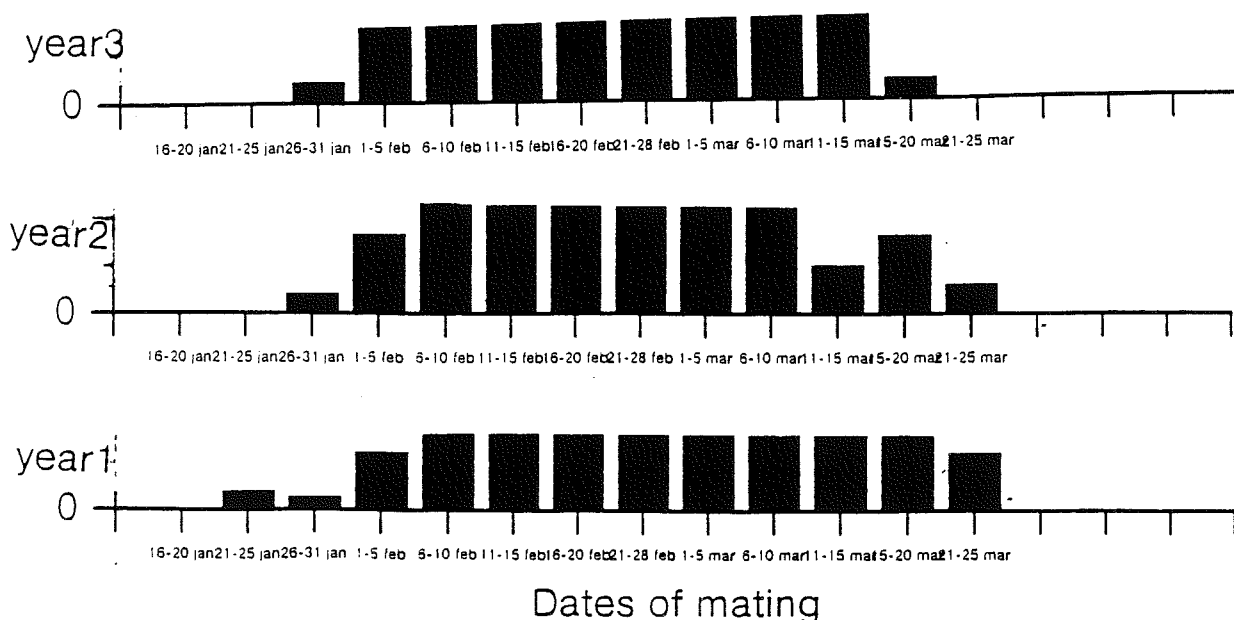
Osadchuk L.V. 1999. Age-dependent features in the reproductive performance of domesticated silver fox males. Scientifur (in press).

Sadow J. 1986. Hypothalamic control of reproductive function: ontogenetic aspects. In: Monogr. Neural Sci. Basel. Vol. 12: 79-89.

Trut L.N. 1995. Domestication of the fox: roots and effects. Scientifur. Vol. 19: 11-18.

Smith A. J., Mondain-Monval M., Moller O.M., Scholler R., Hansson V. 1985. Seasonal variations of LH, prolactin, androstenedione, testosterone and testicular FSH binding in the male blue fox (*Alopex lagopus*). J Reprod. Fert. Vol. 74: 449-458.

DATES FIG: 1 (page 116 )





### Is mastitis in mink females a factor when the greasy kit syndrome occurs?

Tove Clausen, Hans Henrik Dietz

The mammary glands of 7 female mink with "greasy kits" and 5 mink females without "greasy kits" were inspected, palpated and examined bacteriologically and histologically. It was concluded that mastitis is not part of the "greasy kit" syndrome.

*Technical Year Report 1998, pp. 197-199 (PFR, February 1999). In DANH, Su.ENGL. 1 table, 6 refs.*

### Caries and odontoclastic resorptive lesions in a chinchilla (*Chinchilla lanigera*)

D. A. Crossley, R. R. Dubielzig, K. G. Benson



Fig. 1. Suspected occlusal caries affecting the third right mandibular molar in a prepared chinchilla mandible. Also note the large periodontal pocket lateral to the lingually tipped left second molar.

It is well recognised that domesticated chinchillas (*Chinchilla lanigera*) suffer from a range of dental problems, the most frequent of which is the result of reduced and uneven coronal wear of the premolar and molar (cheek) teeth with resultant root elongation and secondary malocclusion. Although rarely detected clinically, destruction of dental hard tissue can often be recognised at post-mortem and in pre-

pared skulls. This paper reports the histological confirmation of caries and odontoclastic resorptive lesions in a chinchilla.

*Veterinary Record 1997 141:13 337-339. 7 figs., 12 refs. Authors' abstract.*

### The prevalence of antibodies to calicivirus in foxes

J. Dedek, K. Frölich

Sera from 352 foxes (*Vulpes vulpes*) were tested for rabbit haemorrhagic disease antibodies with an ELISA kit. The hemagglutination inhibition (HI) test was also used on 90 sera which gave a positive or inconclusive result in the ELISA. Eighteen sera (5.1%) were positive in the ELISA of which 8 were also positive in the HI test. This is the first study to indicate the presence of calicivirus infection in European foxes. It seems likely, because of the specificity of the test, that the antibodies detected to caliciviruses were induced by the rabbit haemorrhagic disease virus.

*Tierärztliche Umschau 52 (3), pp. 149, 1997. In GERM, Su. ENGL. 1 table, 20 refs. Authors' abstract.*

### Vaccine-induced canine distemper in European mink, *Mustela lutreola*

Meg R. Sutherland-Smith, Bruce A. Rideout, Andrea B. Mikolon, Max J. G. Appel, Patrick J. Morris, Amy L. Shima, Donald J. Janssen

This report describes vaccine-induced canine distemper virus (CDV) infection in four European mink (*Mustela lutreola*) induced by the administration of a multivalent, avian-origin vaccine. Clinical signs consisting of seizures, ataxia, facial twitching, oculonasal discharge, hyperkeratosis of footpads, and anorexia developed 16-20 days postvaccination. Conjunctival smears from one animal were positive for CDV antigen by direct fluorescent antibody testing, confirming the clinical diagnosis. The four mink died 16-26 days postvaccination.

Gross and microscopic lesions that were diagnostic for CDV infection included interstitial pneumonia, lymphoid depletion, nonsuppurative encephalitis, and dermatitis. Vaccine-strain virus was isolated from tissues of three animals. Cases of vaccine-induced distemper in mustelids using avian-origin vaccine have seldom been reported.

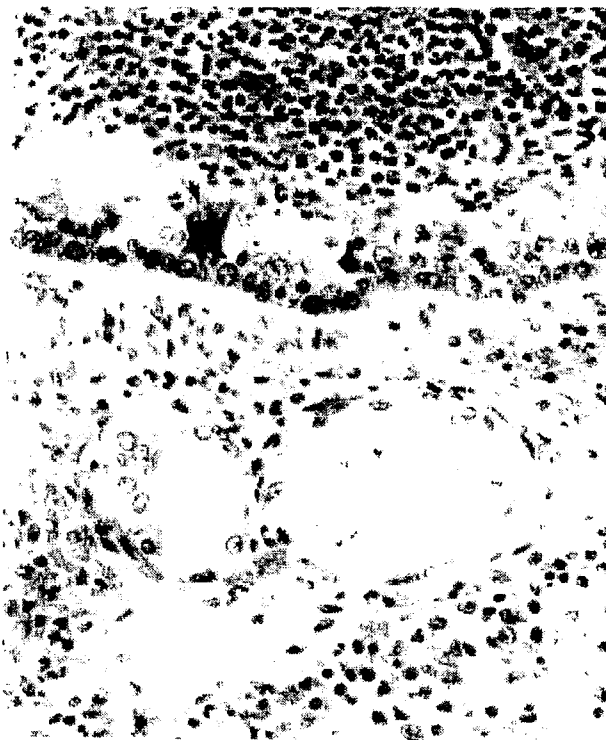


Fig. 2. Lung from mink 3 showing a bronchiole filled with inflammatory cells. Note the syncytial cell in the bronchiolar epithelium (arrow). H&E, x400.

*Journal of Zoo and Wildlife Medicine* 28 (3), pp. 312-318, 1997. 2 tables, 2 figs., 26 refs. Authors' abstract.

#### The dependence of resistance cage breeding mink to Aleutian disease from litter size

V.A. Ilukha, L.B. Uzenbayeva, H.I. Meldo

AD in 450 standard and 450 Hedlund mink litters were analysed. The dynamics of infection by AD virus were investigated in 80 standard mink. For diagnose of AD CIEP iodine test, as well as determination of the level of serum protein and its fraction composition were si-

multaneously used. As a result in the litters of standard mink with 1-4 kits no sick animals were detected, while in litters with 5 or more kits their proportion was significant. In Hedlund mink sick animals were present in litters consisting of 4 kits. The average litter size with sick animals at pelting was higher than litters containing only healthy mink (for standard  $6.58 \pm 0.20$  against  $6.08 \pm 0.09$ ,  $t=2.28$ ,  $P<0.05$ ; for Hedlund  $6.44 \pm 0.17$  and  $5.28 \pm 0.12$ ,  $t=5.57$ ,  $P<0.001$ , respectively). At the peak of the disease healthy animals were found only in small litters. Lower resistance to AD in kits from large litters is connected with their genetic predisposition to AD, or with their physiological relaxation and, hence, greater sensitivity to disease.

*Selskohozyaistvennaya biologiya (Agricultural biology)*; N4; 110-113, 1996. 1 fig., 1 table, 15 refs. In Russian, Su. ENGL. Authors' summary.

#### Ultrasonography of adrenal glands in normal ferrets

Robety T. O'Brien, Joanne Paul-Murphy, Richard R. Dubielzig

The adrenal glands of 20 normal ferrets were imaged with ultrasound. Of the forty glands, only 4 (three right and one left) could not be clearly identified. Mean ( $\pm$ standard deviation) dimensions of the right ( $7.6 \pm 1.8$  mm length by  $2.6 \pm 0.4$  mm width) and left ( $7.2 \pm 1.8$  mm length by  $2.8 \pm 0.5$  mm width) glands were similar. Both adrenal glands were wider ( $p<0.05$ ) sonographically in males than females. Measured length and width of the right gland positively correlated ( $p<0.05$ ) with body weight. The glands had a hypoechoic outer zone and hyperechoic central region, were elongate to ovoid in shape and located medial and, variably, at the level of the cranial pole of the ipsilateral kidney. This study demonstrates that normal adrenal glands can be imaged in ferrets.

*Veterinary Radiology & Ultrasound*, Vol. 37, no. 6, pp. 445-448, 1996. 4 figs., 13 refs. Authors' summary.

## Methods for measuring pelt properties

*P. V. Rasmussen*

In mink fur production grading of the pelt is traditionally done by subjective (sensorial) methods. The individual judgement of several sub-traits of the fur naturally demands great experience and skill. These sub-traits are determined by even more morphological properties such as hair fibre diameter and length, hair density, relations between guard hairs and wool hairs, the orientation of the guard hairs in combination with optical properties such as colour and gloss. In each of these variables a pretty large variation is observed. However, it is possible to measure some of them in order to get a very detailed description of individual pelts - details which all things considered make up the basis of product development of pelts. The article deals with different methods for measuring and studying form and structure (morphology) of hair fibres and the whole fur and its surface appearance. Both macroscopic, microscopic and physical methods are mentioned and several examples are given.

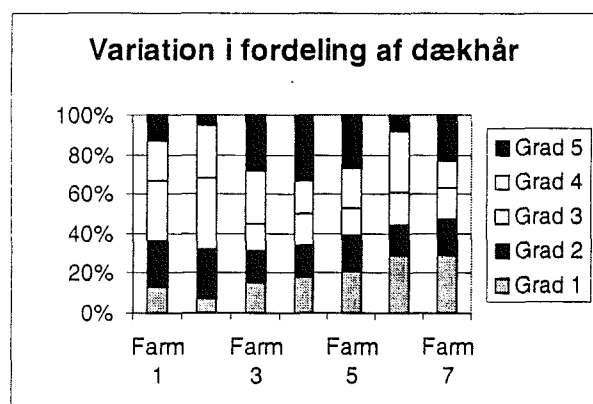


Fig. 3. Variation in the distribution of guard hair thickness (lanceolate part) in mink. Grad 1 = thin hairs. Grad 5 = thick hairs. Seven farms, each represented by five mink pelts, are compared.

*DIAS Internal Report No. 111, 1998, pp. 15-21. In DANH, Su. ENGL. 1 table, 4 figs., 7 refs. Author's abstract.*

## Biochemistry and skin quality - tools and perspectives

*Bent Riis*

The pelt is the largest organ of any mammal, and its quality is crucial for fur animal farmers. Biochemically, a pelt is a difficult structure to characterize, because of its very complex structure. Morphologically, it is easy to separate hairs and skin, but chemically this distinction is not totally clear. This is because some molecules from the hairs are also found in the skin, and a hair is essentially a specialized structure stemming from the skin.

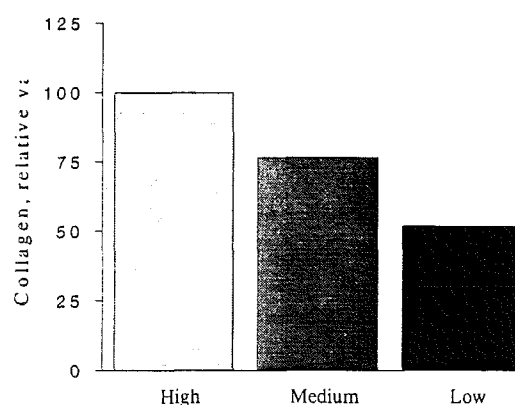


Fig. 1. Correlation between skin quality and the amount of collagen.

Many different molecules and atoms determine the quality of the skin. In that respect the collagens and the elastins are very crucial, because they are found in large amounts in the skin. Preliminary results have found a correlation between skin quality (fig. 1), as judged by traditional means, and the amount of soluble collagen. However, many other molecules also play a role in that respect.

A growing mink or fox hair contains many different proteins, but the fully-grown hair consists of 90-95% keratins. These proteins are very special and insoluble and rather difficult to study chemically. Using capillary electrophoresis we have been able to study

some hair defects in the so-called "curly foxes" and to characterize basic levels of keratin in mink hairs.

Using model animals with pelt defects has given some insight into the chemistry of normal hair and skin. This approach is very useful for answering some specific questions about which molecules are crucial for the quality of hair and skin.

In the future, it can be predicted that gene manipulation techniques will be used for studying and likely improving the pelt quality. These techniques may also be used for creating new products, i.e. medical products, from the carcasses of the fur animal. It is important to realize that these possibilities are not immediately around the corner. On the other hand: fur animal farmers must start discussing if they want to use such options.

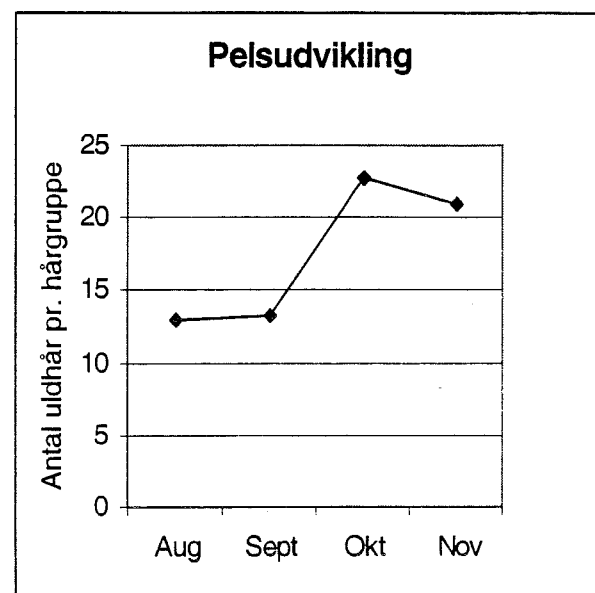
*DIAS Internal Report no. 111, 1998, pp. 23-28.. In DANH, Su. ENGL. 8 figs., 5 refs. Author's summary.*

#### Fur development can be investigated microscopically

*P. V. Rasmussen*

Optimal fur development is an important precondition for a high pelt quality. Regarding fur animals first having a summer pelage followed by a winter pelage, it is furthermore important that the autumn moult is complete and that the winter pelage is mature, before the animal is killed and skinned. In practice the

different stages of fur development are studied visually. However, if more detailed and accurate information about fur and hair development is required, it is possible to investigate minor skin samples (taken under anesthesia) by light microscopy. This also gives information about the number of hairs and their grouping. The article deals with fur development in young animals generally. It exemplifies how different stages of normal and abnormal fur development and the effect of different nutritional conditions can be documented by microscopic methods.



**Fig. 1.** Development of wool hairs in adolescent male mink. The mean number of wool hairs per hair follicular bundle in the hip region is shown.

*DIAS Internal Report no. 111, 1998, pp. 29-33.. In DANH, Su. ENGL. 3 figs., 6 refs. Author's abstract.*

## II International Symposium

Physiological bases for increasing the productivity  
of predatory fur animals

Petrozavodsk  
Sept. 15-17, 1998

ABSTRACTS

in Russian and English, totally 121pp.

Edited by: N.N. Tyutyunnik (responsible editor), V.A. Ilukha, L.K. Kozhevnikova, V.M. Oleinik



For further information regarding the abstract  
collection and contact to specific authors please  
contact:

Dr. Viktor Ilukha  
Institute of Biology of KRC, RAS  
Pushkinskaya street 11  
Petrozavodsk, Russia  
Email: ILYUHA@MAZE.CENTRE.KARELIA.RU

**PLENARY SESSION****The use of biologically active substances for raising efficiency in farmed mink**

*N.A. Balakirev, T.M. Demina, O.V. Rastimeshina*

Animal efficiency largely depends on the quality of their nutrition diet. The most available way of raising the quality of nutrition for fur animals is to use biologically active substances (BAS). Various BAS protect and preserve feeds, enrich them with vitamins and microelements, raise their gustatory characteristics, as well as stimulate metabolic processes in the organism.

For the past 10 years, researchers from the V.A. Afanasiev Research Institute for Fur Animal and Rabbit Breeding studied the effect of various BAS on physiological status and fertility of fur-bearing animals. It was found that such preservatives as orthophosphoric acid at the dose of 0.25%, and acetic acid 0.01% added to the ration increased the number of defect-free mink skins by 14.5%, and average sale price by 3.0%.

For mink, the optimal doses of antioxidants are found to be the following (mg/kg): ionol – 50, deludin – 40, fenozan – 25, kormolan – 75-100, sodium glutamate – 100. The use of these preparations in the rations for young animals can increase live weight by 3-8%, number of large size skins by 7-22%, total skin quality by 2-11%. Antioxidants in the diet for mink females increased litter size by 4-7% and the number of barren females decreased almost twofold (from 5.0 to 2.7%).

Various biostimulators (multivit, mick-bak, purivitin, etc.) used in the diet for mink females have been found to increase litter size per female by 0.5-1.3 kits; and total skin quality by 5-22%, when added to the feeds for young animals.

The use of the enzymes lizorecifin (50 mg/kg), amilosubtilin, and pectofetiden (150 mg/kg) increased the number of especially large skins by 15%, and total skin quality by 6%.

The experimental data concerning the effect of various BAS on mink efficiency are in full agreement with the values showing the BAS effect of the same BAS used in the rations for other farmed animals (fox, Polar fox, sable, nutria) and rabbits.

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 65.*

**Changes in digestive enzyme activity in nutrias and chinchillas dependent on diet composition**

*B. Barabasz, V.M. Oleinik*

The recent promising trend in fur animal breeding has been rearing of valuable species of herbivorous animals, nursing of which, in contrast with predatory ones, requires less financial expenses. Studies on the ability of digestive system in these species to adapt to changes in the diet could be of help when making the optimal rations.

Experiments have been conducted on nutrias and chinchillas, which were given feeds with different protein, fat and carbohydrate levels for 10 days. Five groups of nutrias and four groups of chinchillas were formed with five specimens in each. In different groups of nutrias, the amount of protein was from 23.4 to 30.0% of the total energy in the feed, fat – from 8.8 to 12.4%, and carbohydrate from 61.2 to 66.4%. In chinchillas, the amount of protein was from 22.2 to 25.1%, fat – from 6.1 to 8.6%, and carbohydrate from 66.8 to 73.4%. The activity of pepsin in the stomach mucosa was determined; in pancreatic tissue and small intestine mucosa, the total proteolytic activity (TPA) and amylase activity were estimated.

In nutrias, the increase in the protein level in the diet caused a tendency to increase TPA in the pancreas and small intestine, although no direct dependence between the content of protein in the food and pepsin activity in the stomach was found. Fluctuations of amylase activity both in the pancreas and in the small

intestine were not based on direct dependence upon the level of carbohydrate, fat or protein in the diet.

In chinchillas, the pepsin activity in the stomach was higher in groups with the increased protein level. In the small intestine mucosa, the TPA was, on average, higher in the animals fed the feed containing a large amount of protein; in the pancreas no reliable differences between groups in the level of TPA and amylase activity were found. The level of amylase activity in the small intestine showed a weak dependence on the carbohydrate level in the diet.

The studies have shown that the reaction of the digestive system in nutrias and chinchillas in response to a change in the diet is not identical. However, the reactions of both species of herbivorous animals have common features, distinguishing them from omnivorous. In both investigated animals, the level of digestive enzyme activity changes more in the small intestine mucosa and, to a lesser extent, in the pancreas when changing a qualitative diet composition.

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 66-67.*

#### **Influence of somatotropins of gene engineering on physiological state of mink**

*L.K. Ernst, N.N. Tyutyunnik, L.N. Sirotkina, L.F. Adigamov*

The problem of productivity optimisation in fur-bearing animals bred on farm complexes, stimulation of their growth and development can be solved by using biologically active substances of different origin, including anabolyca preparations made with the help of gene engineering. The preparations are found to exert synergism on various functional systems regulating protein synthesis. In order to conduct the study, recombinants of bovine somatotropin

produced by "Monsanto" and "Eli-Lilli" companies were chosen.

Observations on the growth and development of mink treated with recombinants of bovine somatotropin (STG) show the growth-stimulating action of the preparations tested. However, their active basis reveals itself differently. A more pronounced effect was observed in animals given the somatotropin made by "Eli-Lilli" company. This effect takes place already a month after injection of the preparation. Studies conducted on standard mink with signs of hypogalactia in the lactation period have shown that subdermal introduction of somatotropin promoted an increase in body mass of the kits, and after weaning and introduction of STG preparations, a growth stimulating effect was found. Analysis of the blood-forming organs, metabolism, endocrine, immune and digestive systems has shown that giving preparations raised the activity of the enzymes ASAT and LDH which can be considered as an energy metabolism stimulation.

As a result of the studies it is possible to make the following conclusions: 1. Increase in the body weight of the kits is evidence of the growth stimulatory action of the recombinants of somatotropins. 2. Treating the kits with somatotropins during growth and development does not disturb the processes of molting and pelage. Pelts from experimental animals proved to be larger and had good quality. 3. The use of somatotropins during lactation stimulated milk formation since litter weight increased by 19-72%, and promoted more intensive individual development of cubs after weaning: in males by 33%, and in females by 6%. 4. The data obtained enabled us to assume that the recombinants of somatotropins can be used for stimulation of mink growth and development, and increase in milk synthesis activity in lactating females.

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 67-68.*

### Attempts to improve reproductive performance of farmed foxes

*M. Harri, J. Mononen, T. Rekilä, L. Ahola, T. Pyykönen*

It is known that all farmed silver and blue fox vixens do not conceive and all cubs born do not survive until pelting. The Council of Europe [T-AP (96) 19] recommends that "Where there is significant incidence of infanticide, a farm production system shall be changed, for example, by changing the housing conditions for breeding vixens or genetic strains". This recommendation predicts that: 1) foxes' reproduction should be better in nature and 2) in more extensive housing conditions than those currently in use on farms, or 3) that we can improve foxes' reproduction by improving housing design. In this review these three predictions are discussed.

The impression of a superior reproductive performance in nature as opposed to on farms is based on differences in the way reproductive data are expressed. Whelping results of farm foxes are generally expressed as the number of weaned cubs per mated female, whereas litter size for wild foxes most often is based on the number of placental scars in autopsy specimens. Taking into account the proportion of barren foxes and neonatal losses of entire litters, the mean productivity per vixen was 2.61 cubs in a Bristol red fox population (*Harris and Smith, 1987. J. Appl. Ecol. 24: 75-86*). Despite not including postnatal cub mortality this figure is lower than the mean whelping result for farmed silver foxes. Furthermore, in all those experiments in which silver or blue foxes have been raised in a semi-natural environment, their reproductive performance has been inferior to farm situations.

Attempts to improve reproductive performance on farms have been focused on improving a nest box configuration, social organisation of breeding vixens before and after the breeding season and on selection for more confident breeding animals. It has been shown that both fox species have lower cub mortality in nest

boxes equipped with a tunnel entrance. To our knowledge, this is the only statistically significant relationship between housing design and reproductive success that is experimentally confirmed. Information on the effect of social hierarchy of breeding vixens on their reproductive success is too fragmentary to draw any conclusive evidence. However, statistical analyses provide evidence that on a population level confident vixens have better reproductive success than fearful ones.

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 68-69.*

### The results and development of research in the field of ecological physiology of fur-bearing animals

*N.N. Tyutyunnik*

One of the most important problems of ecological physiology is the study of interactions and regularities in the functions of different organs and systems, ensuring adaptation of the animal to the new environment. It is necessary to note that under conditions of captivity and industrial breeding, the relations of animals with the environment has greatly changed, and the possibilities to determine their individual features has become limited. Keeping of fur-bearing animals in large complexes makes prevention of many diseases difficult, particularly referring to the group of so-called "diseases of metabolism" which as a rule result from wrong feeding, or as a result of including in the rations new understudied, unbalanced or ecologically unsafe ingredients. Animals bred in captivity are constantly subjected to environmental factors mainly causing stress due to the technology of breeding such as: vaccination, rearrangement of live-stocks, weaning, noises of agricultural machines etc., which, in turn, brings about disturbance in the functions of blood organs, immunological, endocrine and digestive systems. The influence of climatic factors on animals should also be born in mind. In the North-West of our country, temperature fluctuations, wind power and velocity, and air



moisture are of great importance and influence the fertility and safety of fur-bearing animals. In this connection the study of the influence of environmental factors in different climatic areas was considered to be of vital importance for understanding the mechanisms of adaptation of fur-bearing animals to environmental conditions.

Alongside with this, it was expedient to continue research into physiologo-biochemical mechanisms of response reaction in separate organs and systems (digestive tract, ductless glands, blood system) of fur-bearing animals and rodents to the whole complex of environmental factors, connected both with the specific technology of breeding, climatic and anthropogenic factors. It was important to find the conditions of homeostatic balance in the organism (enzyme and isoenzyme systems, hormone, vitamins, factors of immunological protection etc.) under different feeding levels and depending on periods of individual development and physiological status (pregnancy, lactation, phases of intensive growing pelage, etc.) and seasons of the year.

Activity of the enzyme of glycolysis (LDH) and its isoenzymic spectrum, activity of antioxidant enzymes under individual and species adaptations of the fur-bearing animals and rodents, under some diseases, and influence of environmental factors, including climatic, have been studied.

Thiamine metabolism was investigated, methods of early diagnostics on hypo- and avitaminosis were designed. This allowed us to improve adaptation of the animals to farm conditions.

The complex study of the activity of digestive enzymes, their topography within the digestive tract in animals with different types of feeding was conducted, and knowledge was gained on a molecular bases of nutrients hydrolysis.

The level of sexual hormones in mink, polar foxes and vixens in postnatal ontogenesis de-

pending on the species and season of the year in the North-West was determined.

Of great importance were the studies on the ways of optimisation and correction of physiological state with efficient biologically-active preparations (metabolites, substrates of energy metabolism, stimulators of anabolic and immunological action). This allowed us to solve such important problems of practical fur-breeding as reduction in the number of empty females, reduction in kit mortality before registration, normalisation in the immunological systems and sexual activity.

Thus, on the one hand, the results of the studies undertaken can serve as a theoretical foundation for determining of regularities in the adaptive processes and, on the other hand, have allowed us to develop ways of controlling the physiological status in fur animals.

Control on the state of health of animals under the influence of disturbing factors can be successful if one strictly follows the main stages of biochemical monitoring.

1. The work in this direction should begin with accumulation of reference (standard) values of hydrocarbon, protein, fatty metabolism in the blood (plasma) serum in animals of different ages to derive "an index of health", which is necessary for future evaluation of animal health state.
2. In this case we generally work with the group of animals for which biochemical indices are determined and the main metabolic test (MMT) of an animal group is established.
3. Having the information on MMT of the group we work with the confidence interval ( $M \pm SD$ ) determining the ranges of physiologically normal variations of different biochemical values of the blood.
4. By testing the state of animal stock we should observe the duration of high or low background of the blood indices indicating the intensity of damage.

5. With a systematic control on the state of health in animals we should work only with most informative "reference" values whose objective is to reflect effects of environmental factors.

We think that in the field of ecological physiology of fur-bearing animals it is necessary to conduct further studies in the following directions:

1. To continue the study on enzyme activities of lipid, carbohydrate, protein metabolism and antioxidant enzymes, under some forms of pathology, the environmental impact as well as the behavioural-reaction development in fur-bearing animals.
2. To investigate hemoluminescence in the blood serum, suspension of leukocytes, homogenates of organs as an intensity-factor indicator of the level of antioxidant activity in tissues under the environmental impacts.
3. To study vitamins and hormonal status of fur-bearing animals under individual adaptation, in the process of adapting to new feeding factors, and under the influence of the environment, to detect relations between sexual and thyroid hormones, and their relationship with reproduction efficiency.
4. To investigate adaptive possibility of the digestive tract of fur-bearing animals, enzyme activity in its parts when using new, non-traditional feeds and under feeding deficiency, to conduct studies on stimulating and correcting functional digestive system activity, and develop methods of life-long diagnostics of the digestive tract.
5. To study biologically active preparations of metabolic and immunological profile (metabolites, non-hormonal factors of growing, immuno-modulators etc.) on fur-bearing animals for optimisation and correction of their status, growth and development regulation, and stimulation of reproductive functions.

The earlier research work at the Laboratory of Ecological Physiology of Animals was con-

nected with the accumulation of knowledge in the field of physiology and biochemistry of mammal predators with different ecogeneses; establishment of a theoretical basis for testing the physiological status of animals and monitoring greater numbers of animals. The laboratory staff have written many theses, monographs and thematic collections of papers. The materials of their studies have been published in international and central journals and have been read at international conferences.

The laboratory research has received financial support from the Ministry of Science and Technologies of the RF (International project: Russia-Finland-Poland), Russian Foundation for Basic Research and Federal Program "Integration".

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 69-72.*

#### **SECTION 1: Physiological-biochemical control and regulation of the physiological status**

##### **Parasitological data as a method of evaluation of the physiological state of fur animals**

*V.S. Anikova, L.V. Anikieva*

Much attention has currently been given to an opportune control for the physiological state of fur animals. Expensive, labour-consuming immunological and biochemical methods are mainly used nowadays. They usually impose a constant stress action on animals due to handling and blood taking. No parasitologic researches for these purposes are known.

Our long-term investigations has been carried out on fur-animal farms in Karelia have shown that polar foxes and mink are mainly infected with parasites with a direct cycle of development (*Anikanova, Anikieva, 1996*). The dynamics of egg excretion of the nematode *Toxascaris leonina* and coccidian oocysts of fam. *Eimeriidae* by polar foxes was investigated under conditions of both artificial breeding and in the ex-

periment. It is determined that the abundance and distribution of the parasites are connected with the physiological state of the host and adequately reflect their physiological heterogeneity. The most varied response to parasites is developed by puppies at one month of age. The genetic heterogeneity of resistance to invasion in polar foxes seems to be strong at the early postnatal stage of ontogenesis. High infection levels due to insufficient immunity may indicate an unsatisfactory state of the herd (*Anikanova, 1994*). The analysis of the relationship between parasites and hosts on individual and populational levels allowed us to evaluate the biological resistance of hosts to the parasite's factor. It is shown that animals reared in captivity are heterogeneous physiologically. Among them there are individuals with increased and lowered susceptibility. The sex of the animals plays a definite role in the resistance to parasites. Females are more tolerant to parasites though they respond to invasion in a more varied way. Males are less resistant to parasites but responses of the infected individuals are less varied (*Anikieva, Anikanova, 1994*).

The results obtained allow us to recommend parasitological investigations as a method for evaluation of the physiological state of fur animals. The developed test-selection of animals on the basis of resistance to parasitic invasion will permit, on the one hand, to keep the number of parasites on a low level but, on the other hand, can be of help in breeding fur animals that are low-sensitive to stress without additional expenses.

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 73-74.*

### **Hemolytic resistance of erythrocytes and functional properties of hemoglobins in some vertebrates**

*A.G. Borisova, A.S. Goryunov*

To study erythrocyte membrane resistance in relation to oxygenation- de-oxygenation prop-

erties of corresponding hemoglobins is of great importance for finding interdependence between physiological processes and cell and protein behaviour.

Studied were the resistance of red blood cells in some mammals (man, polar fox, sheep, ox) and fish (white sturgeon and trout) to thermohemolysis and surfactants, with sodium abietate as an example. The results obtained have been analysed in complex with oxygen affinity. Thermohemolysis of erythrocytes was studied by an equilibrium method within a temperature range of 40-66°C, and corresponding hemoglobins by differential scanning microcalorimetry. The cell resistance was defined by a mean rate constant and energy of activation.

The data obtained show that mammalian erythrocyte resistance to high-temperature hemolysis is higher than that of fish. On the other hand, erythrocytes containing hemoglobin with lower oxygen affinity had higher thermal resistance than those where hemoglobin was in high-affinity conformation. The relationship between the constant of thermohemolysis rate and activation energy in this process and hemoglobin thermodenaturation has not been found.

The data on hemolysis kinetics in the presence of sodium abietate at 22°C and 58°C show that more heat-resistant erythrocytes are simultaneously more resistant to this salt. Membrane defects found at low sodium abietate concentrations can be observed at raised temperatures. Abietate, as anionic amphipate, can destroy protein-lipid contacts and hydrophobic links between lipid molecules by building-in in the membrane.

Fish membranes function within a much lower temperature range as compared with mammals. This is reflected in differences in relative polyunsaturated and saturated fatty acids in cell membranes. Therefore, the data obtained suggest an agreement of differences in oxygen affinity in various hemoglobins and phospholipid membrane composition which determines the cell thermal resistance.

This work is supported by the Russian Foundation for Basic Research (grant 97-04-48247).

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 74-75.*

### **Interferon status of fur bearers in normal and pathological states**

*L.Ye. Boyarintsev, V.V. Klimenko, N.N. Tyutyunik*

The universality of interferon (IFN) system that makes it the most significant factor of non-specific resistance was the basis for establishing the concept of the IFN-status (Yershov, 1996). This concept includes the parameters defining the state of the IFN-system: the presence of various types of IFN in the circulating blood, the ability of the blood leukocytes to produce IFN of different types at a certain induction – interferon reaction of leukocytes (IRL).

The main indices of the IFN-status of fur-bearers (mink, polar fox, fox) were studied. In healthy animals it was characterised by low concentrations of interferon in the blood serum and by a pronounced ability of leukocytes of these animals to produce this polypeptide in response to adequate induction by interferonogens. Individual differences in the animals were found according to these indices. The decrease of interferon reaction of leukocytes in 20% of mink studied shows an inborn and acquired deficiency of the IFN-system, which can be the result of various factors: age, individual features, stresses.

The most frequently observed disturbances in the IFN-status in animals are various rates of titer rise of circulating interferon with a simultaneous fall of IRL. Low IFN indices reflected a decrease of resistance in fur-bearers. It should be noted that an increase of serum IFN titres can be evidence of an acute phase of disease, and low IFN indices are evidence of the severity of the pathological process.

The decrease of IFN-alpha and – gamma number means the deficiency (inborn or acquired) of the IFN-system and indicates that it is necessary to apply the IFN-stimulating therapy.

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 75.*

### **Isolation and identification of immuno-competent lymphocytes from polar fox blood**

*I.A. Domskey, Z.N. Beltyukova*

To estimate cell immunity in medicine and veterinary science (in farm animals and birds) methods are used which are based on interaction of erythrocyte-markers with lymphocytes isolated by sedimentation of blood cells in a one-stage density gradient. There is no experience in isolation and identification of such lymphocytes in fur-bearing animals.

The aim of the present work is to study the possibilities of isolating a lymphocyte population and to identify immuno-competent fractions in them. Lymphocytes from diluted heparinized blood of young Polar fox (age 2.5-3 months) were isolated by centrifugation in the density gradient of ficol-veragrafin.

When identifying rosette-forming cells (RFC) the ram erythrocyte suspension was used. E-RFC lymphocytes were determined by the reaction with heterological erythrocytes, and EAC-RFC lymphocytes with erythrocytes sensitized by the complex containing a complement. As a result of blood tests carried out in the young Polar fox (n=16), the following indices of the blood-cell count were obtained:

number of leucocytes	8.03±1.08 ths/microlitres
number of lymphocytes	4.43±0.12 ths/microlitres (52.31±0.4%),
Including:	
E-RFC lymphocytes	0.76±0.05 ths/microlitres (17.25±1.01%)
EAC-RFC lymphocytes	0.53±0.05 ths/microlitres (11.94±1.24%)

The immuno-competence of isolated populations of rosette-forming lymphocytes has been proved by the antigenic impact on the animals that results in pronounced changes of quantitative and qualitative characteristics of those cells. The methods of investigation we employed and the data obtained may be used to estimate the general resistance and the immune response of fur-bearing animals.

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 76.*

#### **Comparative characteristics of non-specific resistance indices in farmed mink and nutria**

*V.Z. Gazizov, N.A. Suntsova*

Humoral factors of natural resistance in the blood serum (lysozyme and beta-lysin) and cell factors (lymphoid aggregations in the intestine wall) in mink and nutria according to age were studied. Our studies have shown that in post-natal ontogenesis the activity of lysozyme and beta-lysin in the blood serum, and the number of lymphoid aggregations in the intestine wall are characterised by certain age changes. The highest activity of lysozyme and beta-lysin in mink and the number of lymphoid aggregations in nutria are noted at the age of one month:  $10.2 \pm 0.34\%$ ,  $36.4 \pm 2.52\%$ ,  $422.20 \pm 55.15$ , respectively.

From the age of three months these indices begin decreasing, and by the age of 6 months they reach the former level or can even be somewhat higher:  $10.6 \pm 0.41\%$ ,  $40.7 \pm 2.36\%$ ,  $348.57 \pm 42.84$ , respectively. A correlation dependence of non-specific resistance factors in carnivorous and herbivorous fur-bearing animals according to age was revealed.

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 77.*

#### **Distribution of superoxide dismutase and catalase in organs and tissues of fur animals**

*V. Ilukha*

The activity of key antioxidant enzymes (the SOD and catalase) is of considerable importance for the stability of the organism and its different organs in reaction to influences of various environmental factors. Domestication of fur animals has excluded the influence of some natural factors. An attempt was made to evaluate the activity of these enzymes in the organs of some mammalian species. Polar foxes, silver foxes, raccoon dogs, mink, ferrets, chinchillas, and coypus, bred on fur farms, and rats kept in laboratory conditions were investigated. Common and specific activities of SOD and catalase in liver, kidneys, heart, spleen, lungs and skeletal muscle were determined.

All species studied had a similar type of SOD and catalase activity distribution in organs characteristic for another mammals although some specificity was noted. The activity of antioxidant enzymes in the same organ in systematically-related species differed considerably.

In semi-aquatic animals (mink and coypu) the increase of the catalase activity in the same organs was marked, which can be explained by the necessity of the additional oxygen production for diving. The higher SOD activity in all organs of chinchillas who naturally live in mountainous hypoxia conditions was caused by hyperoxia due to their migration to plains. Obviously, the specific profile of the indicated enzymes in raccoon dogs is connected with the winter hibernation instinct preserved in them even under conditions of captivity.

The ecological specialization of the species is too poorly reflected in liver SOD and catalase

activity to enable use of them for evaluating the influence of various factors on the physiological status of the animals.

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 77-78.*

### **The levels of vitamins A and E in blood serum of polar foxes at different ages**

*T.N. Ilyina, T.N. Ruokolaynen*

The fat-soluble vitamins A and E play an important role in the regulation of biochemical processes in animals. We determined the concentration of vitamin A and E ( $\alpha$ -tocopherol) in the blood serum of female and male polar foxes at the ages of 3, 6 and 9 months. The concentration of vitamins in the serum was determined by high-performance liquid chromatography. The first experimental group received additional vitamins, the second group were fed a farm diet. At the age of 3 months the level of vitamins in the blood was rather high in both groups, however in the females of the experimental group, it was essentially higher in comparison with the control group. At 6-months of age, an increase of vitamin A concentration and lowering of  $\alpha$ -tocopherol were observed in comparison with the previous period. At the age of 9 months, the vitamin A content in group 1 remained practically at the former level, and in group 2 it decreased in males. Significant changes in the  $\alpha$ -tocopherol content were not fixed in comparison with the previous research. However, an increase of metabolite concentration was detected in comparison with females. This can be connected with the preparation of animals to pre-mating in this period. The data testify that the levels of vitamins A and E vary greatly in the early stages of ontogenesis when the degree of their utilisation is high. Later various factors can result in significant changes of the blood levels of both these vitamins due to a necessity for their sufficient supply during special physiological periods.

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 78-79.*

### **Histology of mink thymus in immunopathology**

*T.A. Ivanova, S.I. Lyutinsky, A.N. Aliev*

The thymus of a physiologically immature 6-month-old mink hypotrophic and sick with Aleutian disease (AD) was investigated.

It was established that at hypotrophy part of the cortex of the thymus quarters reduced. Zones free from lymphocytes were formed. The density of their arrangement diminished sharply. Lymphocytes and reticuloepithelial elements suffered from destructive alterations.

With AD gland plasmatisation was observed as well as islands with germentative centres of lymphoid knots in the cortex and cerebral substances. They were surrounded by lymphocytes and had reticular tissue as a basis. The necrosis of cells in the centre of the knot has drawn our attention. Some islands were surrounded by epithelial capsule and contained a great number of lissirated cells.

Thus, various species of an immunopathology of mink are characterised by dissimilar morphofunctional changes in the thymus, the central organ of immunogenesis.

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 79.*

### **Testing antimicrobial effect of two antibiotics in fur animal feeds using disk-diffusion susceptibility test**

*T. Juokslahti, E. Smeds, K. Wallin*

Fur animal feed is invariably contaminated with microbes, fairly often with pathogenic bacteria (Juokslahti, 1980). The microbes derive from raw materials, slaughter house offal and other by-products. Despite the progress in feed hygiene, there are occasions when feed-borne infections hazard the health of mink and foxes. At certain periods of the production year the animals are more susceptible and may acquire

disease from the feed bacteria. From practical experience it is known that similar feed-microbial challenges do not provoke disease during all periods. The individual susceptibility of the animals is also important.

The most risky production periods of mink and foxes are pregnancy, the neonatal period, and the weaning period. A number of microbes, frequently transmitted from feed or drinking water, may give sepsis or localized inflammatory changes resulting in single or multiple deaths. These include *staphylococci*, *hemolytic streptococci*, *E. coli* and *Pseudomonas aeruginosa* among others (Norstoga, 1992). Martino & Stanachi (1997) studied the effect of fourteen antimicrobial agents on pathogenic microbes isolated from neonatal mink. The bacteria encountered were *staphylococci*, *Proteus spp.* *E. coli* and *Pseudomonas aeruginosa* among others. Kostro et al. (1997) identified pathogenic bacteria, such as *Corynebacterium spp.*, *Enterococcus faecalis*, *Enterococcus faecium*, *E. coli* and *Streptococcus equi*, a reason for epidemic mortalities amongst fox vixens, fetuses and new born whelps. The source was infected feed.

Prophylactic administration of antimicrobial drugs has made a remarkable contribution in controlling infectious diseases in animals (Prescott & Baggot, 1993). Preventive medication, as exemplified by dry-cow therapy with antibiotics, is based on knowledge that disease is present or may threaten the population and will continue to affect individuals in the population (Prescott & Baggot, 1993).

The potential disadvantages of prophylactic use of antibiotics are toxicity, the encouragement of drug resistance, drug residues, and cost (Prescott & Baggot, 1993).

To test if laboratory analysis of bacterial susceptibility to antibiotics can be of help in assessing the potential usefulness of antibiotics in preventive medication the following test was made. 28 samples of normal fur animal feed were analysed. A dilution of the feed sample was made in a sterile solution 1:100. Of the diluted sample 0.1 ml was administered on a

blood agar plate, and antibiotic test discs were placed on the discs. Terramycin (oxytetracycline 30 µg) and Clamoxyl (amoxycillin 10 µg) discs were used. After incubation at +37°C, 24 h, the zone of inhibition was metered around the discs. The mean ± SD width of the zone of inhibition for Terramycin was 10.6 mm ± 8.5 mm, and for Clamoxyl 10.3 mm ± 6.1 mm. The pH of the samples was 5.9 ± 0.3. There was no correlation between pH and the inhibition zones in the samples.

**Table 1.** The percentage distribution of feed samples (28 samples) in inhibition zone categories tested with Terramycin and Clamoxyl

Zone of inhibition (mm)	Terramycin	Clamoxyl
<2	14.3	14.3
2-6	27.0	10.7
6-14	28.6	57.1
>14	32.1	17.9

The table shows that the tested antibiotics have good antimicrobial effect against bacteria encountered in fur animal feeds.

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 80-81.*

#### **Concentration of chosen minerals in the fur of coypu females of various genotypes in relation to physiological condition**

*D.Mertin, K. Süvegová, P. Fl'ak, P. Sviatko, I. Tocka*

The objective of the research was to determine Ca, K, Na, Mg, Fe, Zn, Cu, Mn, Co concentrations in the fur of female coypus of various mutations (standard, Greenland, silver and white), in the central dorsal and ventral body parts, and in relation to the physiological condition. Three groups of animals were studied: 1. primipares, age 8 months – fur maturity; 2. females on the day of delivery; 3. females on the day of weaning. Element contents were

determined from the fur by atomic absorption spectral photometry. Ca concentrations in the coypu were: 1.220.45 in the dorsal region and 1.409.07 mg/kg dry matter in the ventral region. Maximum concentrations were observed after delivery. K concentrations amounted to 404.43 and to 195.01 mg/kg dry matter in the dorsal and ventral regions, respectively. Maximum values were recorded in the dorsal region after delivery and in the ventral region after weaning. Na concentrations were 244.48 and 125.43 mg/kg dry matter in the dorsal and ventral regions, respectively. Na concentration was highest in the dorsal region after delivery and in the ventral region after weaning. Mg concentrations were 584.50 in the dorsal region and 601.93 mg/kg dry matter in the ventral region. The highest concentration was recorded at the age of 8 months. Fe concentrations were 139.97 and 128.70 mg/kg dry matter in the dorsal and ventral regions, respectively. Fe concentrations showed their increase in relation to the physiological condition. Zn concentrations were 152.85 in the dorsal region and 152.93 mg/kg dry matter in the ventral region. Cu concentrations were 6.29 in the dorsal region and 6.87 mg/kg dry matter in the ventral region. The lowest concentration was measured after delivery. Mn concentrations in the coypu were 2.46 and 3.90 mg/dry matter in the dorsal and ventral regions, respectively. Lower Mn concentrations were observed at the age of 8 months. Co concentrations were 0.71 in the dorsal region and 0.65 mg/kg dry matter in the ventral region. The higher values were observed at weaning. The highest Ca, K, Fe concentration was observed in standard, Na, Zn in white and Cu in Greenland coypus. It can be concluded from the results that mineral composition of the fur of adult female coypus varies in relation to age, genotype and physiological condition.

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 81-82.*

### Comparative characteristics of digestive hydrolase activities in predatory fur animals

*V.M. Oleinik*

To provide adequate nourishment for predatory farm bred fur-bearing animals one has to know the ability of the digestive system of predators to utilize various sorts of feed. This knowledge can be based on the study of the activity of digestive hydrolases, which decompose proteins, fats and carbohydrates.

The enzyme activity in the stomach mucosa, pancreatic tissue and small intestinal mucosa was investigated in the comparative study of five species of fur-bearing animals belonging to two families of the order Carnivora: mink, ferret, blue fox, silver fox and raccoon dog, as well as rat and rabbit – representatives of omnivorous and herbivorous animals.

Pepsin activity in the stomach mucosa in mink, ferrets, blue foxes and silver foxes is much higher than in the rest of the investigated animals. Amylase activity in the pancreas is maximum in rats and raccoon dogs, and minimum in ferrets and silver foxes; similarly, lipase activity is maximum in raccoon dogs and rats, and minimum in mink and ferrets; total proteolytic activity is minimum in rabbits and silver foxes. In small intestine mucosa carbohydrase activity (amylase, sucrase) in predators is much lower than in rats. Total proteolytic activity is maximum in ferrets, and minimum in rabbits and raccoon dogs. The activity of monoglyceride lipase in predators is much lower than in rats. The level of dipeptidase activity differed little in the investigated animals.

Thus, predatory carnivorous animals (mink, ferret, blue fox, silver fox) as compared with omnivorous and herbivorous animals, have a powerful proteolytic enzymatic chain, moderate lipolytic and weak carbohydrate chains.



Values of the activity of the majority of digestive enzymes in these animals show no considerable differences – the species differences between them lie within the limits of intraspecies variability. However, the peculiarities of the enzyme spectrum of the digestive tract characteristic of carnivorous animals are more expressed in the representatives of mustelidae family, than in the animals of canidae family.

Raccoon dog, also classed as predator, stands closer to omnivorous animals in the level of digestive enzyme activities. The pancreas of raccoon dog displays high activity of amylase, lipase and proteases, and the small intestine mucosa show high activity of amylase and low of protease.

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 82-83.*

#### **Comparable characteristics of the lymphoid tissue of the small intestine in farm mink and polecat**

*A.B. Panfilov*

Topography of the lymphoid tissue, density of the lymphoid follicles on 1 sm<sup>2</sup> of the wall of the small intestine and of the lymphoid plaques were studied.

Single and aggregated lymphoid structures in the small intestine of mink and polecat were found. The density of the single lymphoid follicles on 1 sm<sup>2</sup> of the wall of the small intestine in polecat varied from 0.34±0.20 to 0.42±0.06 in mink. There are 6 aggregated follicles in the submucous layer of the jejunum of mink and 10 in polecat. The lymphoid plaque in the form of the tongue was found in the submucous layer of the wall on the whole length of the ileum. Its size is 2.84±0.54 sm<sup>2</sup> in mink and 3.87±0.84 sm<sup>2</sup> in polecat.

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 83-84.*

#### **Analysis of the origin of depigmentation in animals under domestication**

*L.A. Prasolova, I.N. Oskina, L.N. Trut*

Wild animals have been domesticated under the conditions when their natural habitats were sharply changed and where only calm individuals not showing fearful defense response to humans could survive. The changes in natural habitats under domestication were associated with the emergence of wide variations in morphological and physiological parameters. Long-term selection experiments on animal domestication performed at the Institute of Cytology and Genetics by using different models (silver fox, American mink, otter, wild grey rat) have demonstrated that the appearance, at high frequency, of individuals with depigmentation of the coat is one of the first morphological changes taking place under selection of animals for tame behaviour. However, the function of the pituitary-adrenal axis has been found to decrease in animals selected for tame behaviour. We observed in silver fox that a delay of about 2 days in the migration of melanoblasts from the neural crest to the skin can serve as an embryonic mechanism of depigmentation. We revealed that the same embryonic mechanism determines the white piebaldness in wild grey rat, our other domestication model. Furthermore, experimentally produced change in the function of the pituitary-adrenal axis during embryogenesis (administration of dexamethasone to females on days 12-14 of pregnancy) also resulted in a delay (compared to controls) of the migration of melanoblasts to embryo skin. The data obtained allow us to suggest that the hormones of the pituitary-adrenal axis are involved in the regulation of the migration and development of melanoblasts.

Thus, changes in the function of the pituitary-adrenal axis in animals selected for domestic behaviour appear to be one of the causes of the emergence of depigmentation in animals under domestication.

This work was supported by a grant (96-04-49972) from the Russian Foundation for Basic Research.

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 84.*

### **Lipoproteins in the blood serum in mink and polar fox, the main representatives of farmed fur-bearing animals**

*T.L. Regerand, E.I. Lizenko, V.S. Sidorov*

The comprehensive examination of lipid composition in the serum lipoproteins in the main representatives of farmed fur-bearing animals, mink (*Mustela vison*) and polar fox (*Alopex lagopus*), was done using centrifugation, thin layer chromatography and spectrophotometry. Consistent precipitation was used for lipoprotein isolation, which made it possible to separate the total lipid fraction into three subclasses: low density lipoproteins LDL, and the high density lipoproteins HDL-2 and HDL-3. Both studied species were domesticated and their industrial breeding has greatly changed the environment, mode of life and nutrition as compared with wild animals. The results were compared with data obtained by analogous methods with blood serum taken from humans and some vertebrates. It was determined that qualitative and quantitative composition of lipoproteins separated from the blood of the studied animals did not differ from wild animals of the same species. HDL, which are considered to be anti-atherogenic in human and animals, are the main class in blood serum of farmed mink and polar fox. Now it is determined that HDL actively remove cholesterol from walls of blood vessels, cell membranes in humans and animals and transport it out from the organism. Atherogenic lipoproteins have the opposite function: they transport cholesterol to blood vessel walls. The content of LDL in the studied farmed mink and polar fox is 2-3 times less than in humans and animals predisposed to atherosclerosis. Calculations with respect to the atherogenicity index (total chole-

sterol content in LDL/HDL ratio) in the serum of mink and polar fox showed the unique ability of lipid metabolism in these animals to reverse transport cholesterol as ether forms from the organism in HDL composition.

The conclusion has been made that changes in the mode of life, nutrition and stress situations do not disturb the genetic status of farmed mink and polar fox concerning the formation of the lipoproteins system of cholesterol transport and, therefore, domestication is not responsible for their predisposition to atherosclerosis.

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 85.*

### **Gut associated lymphoid tissue in farmed nutria**

*N.A. Suntsova*

Lymphoid organs of the nutria gut have specific differences from the previously studied representatives of the rodent order (rabbit, rat, guinea pig). For example in nutria the total quantity of the aggregated lymphoid structures is 69 times more than that in rabbit, 17 times more than in rat and 7 times more than in guinea pig.

Lymphoid plaques in nutria are arranged on the mesenteric side of the duodenum, cecum and longitudinal fold of Kerkringoff relief in the big colon. In other parts of the gut they are arranged antimesenterically. Such arrangements of lymphoid plaques provide the closest contact with the contents of the gut. A great number of lymphoid plaques (up to 432 at the age of 8 months) on the wall of the gut is presumably connected with the nutria's semi-aquatic way of living. So, in the process of evolution there were formed much more lymphoid plaques on the gut wall in nutria than in other rodents.

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 86.*

### Reproduction disturbances in female blue foxes

*O. Szeleszczuk, P. Niedbala, G. Maloszyk, V. Ilukha*

One of the important factors influencing the profitability of monoestrous breeding fur-bearing animals is the number of born and weaned cubs. Besides barrenness of females, abortions and puerperal complications, reduced breeding efficiency results from embryo mortality and cub mortality at birth. Over the recent years, losses due to all these factors have been increasing and becoming a mass phenomenon, and at present they significantly exceed average values.

The aim of the present study was to evaluate fertility and fecundity of female blue foxes on the selected farms in southern Poland.

Studies were conducted on 3 blue fox farms located in the provinces of Katowice, Wroclaw and Rzeszow. Evaluation was based on data derived from breeding and farm records and personal communications of farmers. The following parameters were considered: total number of females, number of covered and whelped females, litter size at birth, cub mortality from birth to weaning and pelting. Chemical compositions of feed samples were analysed. Farm health status was assessed on the basis of veterinary service records and clinical examination. The culled females from the foundation stock were subjected to autopsy with special consideration being given to their reproductive organs.

Furthermore, parasitological examinations were conducted which aimed at the determination of gastrointestinal parasites.

In the period of 1983-1993, a significant decrease in the number of females covered and whelped was observed on the selected farms. A noticeable decreasing trend was also found in a number of born and weaned cubs. However, on some farms a drastic fall, as low as to 1.36 cubs weaned per female of the foundation stock, was recorded. Coproscopic examination

allowed us to detect eggs and larvae of *Toxocara canis*, *Toxoscaris leonina*, *Uncinaria stenocephala* Teania sp., *Triphocephalus vulpis* and *Echinochasmus perforiatus*. Similar but less expressed trend of fox breeding results was observed on fur farms of Karelia in 1992-1997.

Fertility and fecundity decrease on the farms under examination was caused, besides genetic factors, by environmental conditions such as poor feeding or inadequate care for cubs, etc. Intrauterine invasion route and infection via mothers milk, especially by migrating larvae, could enhance fetus mortality and cub mortality at birth.

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 86-87.*

### Genetical polymorphism in *Mormota bobac*

*E.A. Tirnaeva, L.G. Markovich, T.L. Kazakova, G.A. Fedoseeva, V.N. Pomytko*

In this investigation, the genetic structure of two groups of two-year old *Mormota bobac* is studied for the first time. The animals were kept in standard sheds in 1996 (group 1) and 1997 (group 2) on the "Pushkinsky" Fur Farm Moscow Region.

The following biochemical markers were investigated: albumin (AL), postalbumin (Pa), transferrin (Tf), posttransferrin (Ptf) serum and hemoglobin (Hb) of the red blood cells, by electrophoresis with our modifications. All the systems in *Mormota* were polymorphic as in other types of fur and agricultural animals.

The following polymorphism was observed: two types in albumin locus, three types in Pa, Tf, Ptf in each of the locus and four types in hemoglobin-locus. The similarity in animals of the both groups was observed.

6 genotypes in postalbumin-locus were found in group 1 (n=27) and group 2 (n=50), similar concentration of C-allele and level of homozygosity were determined. Low frequency of

C-allele was exposed in the posttransferrin-locus.

The following differences were discovered: The animals of the first group had a high concentration of A1 A=0.555, in the second group there was a high concentration of A1 B in the albumin-locus. The animals of the first group had 4 genotypes in the Tf and Ptf-locus, 5 genotypes in the Hb-locus. The animals of the second group had 5 genotypes in the Tf and Ptf-locus, and 6 genotypes in the Hb-locus. The Tf and Ptf-locus had a higher level of homozygosis in the second group. In the Hb-locus the authors have found, for the first time, a rare allele variant Hb 1 with a low concentration.

The found similarities and differences of the allele frequency distribution are thought to occur due to selection processes in a population. Increasing frequency of individual alleles and genotypes as well as appearance of earlier unknown variants can serve as the basis for relationships between alleles and genotypes with economically valuable traits.

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 87-88.*

#### **Vitamin B<sub>1</sub> metabolism in mink kits in different biological periods and growth phases**

R.V. Trebukhina, I.P. Chernikevich, L.K. Lashak, V.G. Petushok

The growth and development of mink kits caused changes in their requirement for vitamins. Since the mink organism does not synthesize thiamine, it was interesting to study thiamine metabolism at different biological periods. The idea of seasonal examination of the blood called for studies of the effect of both natural (feed) and internal (growth requirements) factors on the vitamin status in mink. This would allow us to reveal early hypovitaminosis and to prevent the development of more severe complications of vitamin B<sub>1</sub> deficiency. We studied the blood of dark brown

mink from the Ostromechevo fur-animal state farm (Brest region) after weaning (June, July) and moulting (September, October). We measured the activities of the enzyme thiamine pyrophosphokinase (TPK) responsible for the level of thiamine diphosphate (TOP), transketolase (TK) – enzyme of the pentose phosphate pathway of carbohydrate metabolism and TOP effect as an index for thiamine deficiency.

In June the estimates of the vitamin status in mink did not differ from control values. The amount of TOP was 11 mg%; TPK activity was  $3.0 \pm 0.09$  nkat; TK-activity was  $17.3 \pm 0.48$  mM/ml/h. The high level of the "TOP effect" was found in 2 animals of 22 mink. Early in June a decreased TOP concentration was found in 30% of the mink. The same animals demonstrated 20%-decreased TK-activity and the high coefficient of vitamin deficiency was found in 15% of the mink studied. In autumn (September) the TOP concentration and TK activity in the mink blood were within the control values. However, 27% of the animals showed a 2-fold diminished TPK-activity. Low activity of TOP biosynthetic enzyme was found in 36% of the mink in October. The additional assay of the feed showed that its long-term storage can result in reduced protein in such products as the liver, lungs, spleen and muscle. The examination of the "Pushnovit" has shown that it contains 60% vitamin B<sub>1</sub>; 52% vitamin C and 62% vitamin B<sub>2</sub>. The relationship between the feed value and vitamin supplements, and thiamine metabolism in mink is discussed.

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 88-89.*

#### **Lactate dehydrogenase isoenzymes in tissues of fur animals with various ecogenesis**

A.R. Unzhakov, L.K. Kozhevnikova

One of the main problems of physiology is to investigate the biological ways of animal adaptation to environmental conditions. In the mechanisms of metabolic adaptation to environmental conditions multiple molecular forms

of the enzymes are of great importance. Close correlation is known to exist between the character of the isoenzymatic LDH spectrum of tissues and metabolic types of organs (*Rider, Taylor, 1983*).

Five LDH molecular forms, from LDH-1 to LDH-5 were found in the heart, kidneys, skeletal muscle, spleen and lungs in mink, polecats, silver foxes, polar foxes, and raccoon dogs using enzyme-electrophoresis in agar gel (*Wieme, 1959*). In chinchilla, the isoenzyme LDH-5 is revealed only in skeletal muscle. As in the majority of mammals (*Markert, 1984*) a high content of anodic fractions was observed in isoenzyme spectra of the heart and kidneys of fur animals. In the heart, the relative share of LDH-1 and LDH-2 fractions in polar fox was  $90.3 \pm 0.9\%$ , in fox –  $73.8 \pm 1.2\%$ , in mink –  $69.8 \pm 0.6\%$ , and in chinchilla –  $66.1 \pm 0.8\%$  of the total activity of LDH, which testifies to the intensive aerobic pathway of glycolysis in this organ. In the liver of terrestrial animals, polecats, the relative content of the anaerobic fraction LDH-5 was found to be  $49.6 \pm 0.7\%$ , in semiaquatic animals, mink (marten family) and nutrias (order Rodentia), it was more than 70% of the total activity of LDH. In the liver, the aerobic fractions of LDH-1 and LDH-2 in nutria and LDH-5 in chinchilla were not found. It is necessary to note that the relative LDH-5 content in skeletal muscles ( $57.6 \pm 2.4\%$ ), lungs ( $48.7 \pm 2.2\%$ ), and spleen ( $35.8 \pm 1.4\%$ ) of mink were highest, i.e. in the given tissues of these predators, the shift to anaerobic glycolysis is clearly pronounced. Species specific isoenzymic LDH distribution in tissues inherent to fur-bearing animals with various ecogenesis reflect the animals' adaptation to environmental conditions (*Carra, Mulcahy, 1990*). Thus, in mink and nutria, adapted to life in two types of environment (water and land), M-subunits of LDH, responsible for the anaerobic pathway of glycolysis, became dominant presumably due to long-term evolution conditioned by frequent diving which causing forced hypoxia. Biochemical adaptation of tissues to a deficiency of oxygen at the level of the isoenzymic systems can serve as an example of subtle biochemical

specialization in response to environmental conditions.

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 89-90.*

### **Role of cytochemical tests in evaluation of morphological-functional properties of leucocytes**

*L.B. Uzenbayeva, E.E. Alexandrova*

Cytochemical analysis has perspectives in the study of the morphological-functional organization of leucocytes. Its inclusion in the system of testing expands the framework of research connected to health protection of farmed animals. The cytochemical study of alkaline (AP) and acid phosphatases, unspecific esterase (ANAE) activity and also the NTB-test index in leucocytes in mink and polar fox were done.

Only segmentonuclear leucocytes of mink and polar fox were found to contain AP. Comparisons with data obtained by other authors testify that mink and fox AP contents differ both from animals having a high AP level (rabbit, rat, guinea pig) and from species with no AP in the leucocytes (dog, cat, white mice).

Acid phosphatase in mink was detected in lymphocytes, monocytes, neutrocytes, eosinocytes and platelets. The population of lymphocytes is heterogeneous by the enzymic content. The majority of lymphocytes are enzyme-positive and contain enzymes as granules or of diffuse colouring.

The availability of ANAE in mink and polar fox was noted in lymphocytes, monocytes, neutrocytes, eosinocytes and platelets. In neutrocytes low granularity was observed; in mink it was higher than in polar foxes. The polar fox platelets, on the contrary, differed by more expressed ANAE colouring. The high level was typical for monocytes. The esterase-positive lymphocytes showed various types of granularity: dots on the cytoplasm and above the nucleus, and also as brightly-coloured areas of

different sizes and "powdered" (tiny dye particles around the nucleus). The mixed type of reactivity is characteristic of some lymphocytes.

The NTB-test evaluation has shown the ability of segmentonuclear neutrocytes in mink and polar fox to restore nitro-blue tetrazolium. The activated polynuclears with "diformazan blocks" are frequently found in standard and white mink. Thus, the specificity of the enzymic distribution and leucocytic reactivity in mink and polar fox was detected. A wide range of individual variability and dependence of cytochemical values on the organism status as well as on some BAS have been shown.

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 90-91.*

## **SECTION 2: The effect of environmental factors on the organism and optimisation of breeding**

### **Non-traditional feeds in mink rations**

*N.A. Balakirev, M.V. Wolkova*

In the past years scientists of the Institute have studied feeding and nourishing characteristics of yeast grown on different substrata (paprin, aprin, gaprin, meprin, fodder yeast, biotrin) and by-products of their production: microbial biomass, mycelium residues of the antibiotic production (tetracyclin, penicillin, gentamycin, and mycelium as a product of citric acid) and other agents.

Digestibility trials have shown that mink digest 89% of the raw protein of paprin, 92% of aprin, 78% of gaprin, 75% of fodder yeast, 84% of microbial biomass of activated PVC-84, 73% of mycelium of penicillin, and 84% of tetracycline; the digestibility of the raw fat is 85, 83, 80, 90, 84, 89, 99%, respectively.

The feeds studied were found to have high protein contents. Thus, 100 g air-dry fodder yeast contains 36-54 g digestible protein. The biological value of the proteins in the feeds un-

der study was sufficiently high, with an index of essential amino-acids within 59-83%.

In diets for young mink in the summer-autumn period, 10-30% of the animal proteins were replaced by protein of the feed in question. The size of the animals and their pelt quality were not decreased when compared to those in control groups.

Feeding mink with these feeds in the above amounts was found to have no negative effects on the protein metabolism, which is evidenced by results of the blood biochemical tests. No changes in the morphological structure of the parenchymatous organs were detected.

Introduction of 10-20% of these feeds to the diet of female mink during winter and spring has no negative effect on their reproduction.

Giving high-protein dry feeds to mink can save meat and fish feeds since 1 kg of the dry feed is worth 2-3 kg of raw fish or slaughter offal.

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 92.*

### **Immune status of mink-hypotrophics and its immunocorrection**

*L.Ye. Boyarintsev, V.V. Klimenko, N.N. Tyutyunik*

Early mink hypotrophy is accompanied by metabolic disturbances (*Berestov, V.A., 1987*).

When carrying out an immunologic study of mink-hypotrophics we found a decrease in the relative and absolute contents of E-rosette-forming cells (E-RFC) and EAC-rosette-forming cells (EAC-RFC). When counting subpopulations of T-lymphocytes it was found that the numbers of both helper and supressor cells in the blood of healthy mink were much greater than in the blood of physiologically immature animals. When comparing differentiation coefficients, it was determined that in mink-hypotrophics the process of T-cell maturing is de-

layed. A relative number of poorly differentiated O-lymphocytes in mink-hypotrophics was greater than in mink-normotrophics. The percentage of lymphocyte migration in the reaction of inhibition of lymphocyte migration (RILM) was 18% greater in normotrophics. This is evidence of disturbance of active T-lymphocytes in sick animals that results in the disturbance of the lymphokines in forming immunocompetent cells. When studying cellular immunity, a decrease was detected in the activation level of oxygen-dependent mechanisms of bacterial growth-inhibitory activity of phagocytes in hypotrophics in the test of recovery of nitroblue tetrazolium.

In the immunal B-system, it was found that EAC-RFC made up 40% in sick mink compared to healthy mink. In G and M immunoglobulin counts, a tendency towards a decrease of their quantitative indices in hypotrophics was observed. In the reaction of inhibition of lymphocyte blast-cell transformation (RILB) with the use of mitogens of phytohemagglutinin and lipopolysaccharide, a blast-cell-forming ability of T- and B-lymphocytes in normal and pathological states was determined.

To correct immunodeficiency in mink-hypotrophics, immunomodulator Ligavirin was used.

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 93.*

#### **Control of canine distemper in fur animals using vaccination**

*A.L. Elakov, V.I. Ulasov, V.M. Kolyshkin, A.V. Vasiliev*

Vaccination is used for canine distemper prevention in fur animals. The efficacy may be estimated on the basis of antibodies to canine distemper virus present in the serum of the animals. We have worked out and introduced "Erythrocytar Diagnostics for Antibody to Canine Distemper Virus in RIGA Detection Kit".

RIGA procedure requires no special equipment and results are available within 3-4 hours.

We tested the dynamics of antibody titers in RIGA and RN in two-month old mink, Polar foxes, red and gray foxes, and raccoon dogs which were vaccinated against canine distemper with the vaccine on the basis of the EPM strain. The results displayed high antigen activity of the vaccine based on the EPM strain in all observed fur animals.

The final humoral immune response was formed by day 21-28 post-inoculation. During this period the antibodies titers in RIGA were  $9.9 \pm 1.0 - 13.0 \pm 0.5 \log_2$ , in RN  $3.9 \pm 0.7 - 5.2 \pm 0.4 \log_2$ . After three months, post inoculation titers of antibodies slightly decreased in all the animals to  $8.6 \pm 1.3 - 10.2 \pm 0.8 \log_2$  in RIGA and  $2.9 \pm 0.6 - 4.2 \pm 0.4 \log_2$ . Antibody titers of this level are sufficient for prevention against canine distemper.

Titer rates in RIGA and RN display a close relationship. Taking into account that titers 1:4 - 1:8 ( $2-3 \log_2$ ) in RN prevent canine distemper, titers higher than 1:256 ( $8 \log_2$ ) in RIGA can also be considered as preventative. Our research makes it possible to recommend "Erythrocytar Diagnostics for Antibody to Canine Distemper Virus in RIGA Detection Kit" for vaccination quality control.

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 94.*

#### **Seasonal changes in glucocorticosteroids in fur-bearing animals**

*V.Z. Gazizov, O.Yu. Bespyatykh*

Glucocorticosteroid hormones control the rate and direction of metabolic processes and take part in adaptation of the organism to different seasons.

The concentration of 11-oxycorticosteroid (11-OCS) in the blood plasma in mink and nutria in

different seasons of a year was studied. The highest level of 11-OCS was observed in mink in winter (in February –5.49 microgram %), in nutria – in spring (in April – 5.02 microgram %). In summer, the hormone level in mink decreases as much as 2.31 microgram %; and by the autumn it increases as high as 3.62 microgram %. In nutria the concentration of hormones in summer remains as high as before – 4.16 microgram %, and by autumn it reaches its minimum values – 2.44 microgram %. The revealed changes in the functional activity of the adrenal glands may reflect seasonal changes in living conditions and the annual cycle of reproduction.

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 95.*

#### The effect of environmental conditions on reproduction in two genotypes of mink

A.V. Kharlamova

Environmental effects on reproduction in standard genotype and heterozygotes in the "Black crystal" (Cr) mutation of American mink were examined. This mutation was first bred on the Experimental farm of Novosibirsk Institute of Cytology and Genetics, in the course of selection for domestic behaviour (Trapesov, 1997). 722 crosses, made during the period of 1991-1995 were analysed.

N cr.	Crosses female x male	crosses n	litters n	litter size	survived (on 20 day)
1	Cr/+ x +/+	187	165	5.22±0.15	4.22±0.16***
2	+/+ x Cr/+	307	256	5.55±0.13	4.24±0.14***
3	+/+ x +/+	228	193	5.89±0.14	5.05±0.15

No differences in litter size between "Black crystal" and standard females were found. Not only mutant, but also normal females crossed with mutant males, demonstrated lower survival of the young. Dispersion analysis allowed us to detect that there was a significant effect of environment on mutant mink (cross n.1:  $F_{3,161}=0.42$ ;  $P<0.007$ ; cross n.2:  $F_{4,251}=3.81$ ;  $P<0.005$ ) and no effect of environment on standard mink:  $F_{4,187}=0.42$ ;  $P<0.80$ . Environmental factors have

an opposite effect on early postnatal mortality. In crosses n.1 and n.2 (mutant mink) this index is not dependent on whelping year (n.1:  $F_{3,161}=1.87$ ;  $P<0.14$ ; n.2:  $F_{4,251}=1.19$ ;  $P<0.32$ ). In cross n.3 such dependence is significant ( $F_{4,187}=4.21$ ;  $P<0.003$ ).

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 95-96.*

#### Digestibility of nitrogen and fats from feed rations for mink with various proportions of poultry by-products

D. Mertin, K. Süvegová, I. Tocka, P. Fl'ak

This experiment studied the digestibility of nitrogen and fats in mink feed at various percentages of poultry by-products (heads), as well as the digestibility of nitrogen and fats.

Five unrelated males of standard mink at the age of four months were studied in the experiment. They were housed in special balance cages. The animals were fed the basic feed ration on the first stage; the content of the tested feed stuff in the feed ration was 33.0% of the original matter in the second stage, 43.6% in the third stage, and 55.3% in the fourth one. The parameters necessary for the calculation of the coefficient of digestibility of feed rations and tested feed intake were the following: remains of non-consumed feed, and amount of faeces. The given parameters were observed and samples were taken twice a day, always an hour before feeding (at 7 a.m. and at 14 p.m.). The direct method was used to calculate the digestibility of nitrogen and fats in the studied feed rations at various proportions of poultry by-products (heads), and the indirect method was used to calculate the digestibility of the studied nutrients in the tested feed ingredient.

Nitrogen digestibility in feed rations for mink was kept approximately on the same level (80.77-81.25%), and with 55.3% representation of the tested feed ingredient in the feed ration it decreased significantly to 76.94%. Fat digestibility rose significantly in dependence on the



percentual proportion of poultry heads, namely from 89.88% to 94.22%. Nitrogen digestibility decreased significantly with a 55.3% supplement of poultry heads (81.45-73-58%), and fat digestibility was approximately on the same level (97.73-94.15%).

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 96-97.*

### **Level of digestive hydrolases in the blood of predatory fur-bearing animals during the annual life cycle**

*V.M. Oleinik, E.B. Svetchkina*

It is known that the activity level of many serum enzymes in predatory fur-bearing animals undergoes significant fluctuations during the annual life cycle which reflects changes in the level of metabolic processes connected with the seasonal pattern of reproduction in these animals. To control the functional state of the digestive system it is necessary to know the regular seasonal fluctuations of levels of digestive hydrolase in the blood.

In order to get reliable values, the activities of  $\alpha$ -amylase and trypsin were estimated in standard mink females during 6 years in the periods of proestrus (December), beginning of the rut (February), pregnancy (April), lactation (May), and in cubs - in the second phase of growth (September).

Average amylase activity remains almost unchanged during the annual cycle. In mink it is maximum in February and, in polar foxes, in May. Seasonal differences are not very great and have no regular disposition. Trypsin activity in mink was noticeably higher in April than in other periods of our study. Moreover, this increase was regular during the six years. In polar foxes, a similar dependency was observed, though less pronounced. In both types of animals the seasonal dynamics of the activity of the two investigated enzymes did not coincide. The coefficient of correlation between

the levels of amylase and trypsin activity calculated on monthly average values for the whole period of observation was found to be -0.20, in mink, and in polar fox even smaller. The positive correlation between seasonal fluctuations of trypsin in mink and polar foxes is marked ( $r=0.67$ ,  $P<0.01$ ). However, no definite dependence between changes in amylase activity in the two types of animals was discovered.

The results show that the activities of digestive enzymes in the blood of predatory fur-bearing animals undergo some significant fluctuations in different physiological periods. However, as opposed to other serum enzymes, these fluctuations are not closely connected with the season, i.e. with the biological cycle of reproduction of the animals. Only during pregnancy in the blood of females, does trypsin activity increase. That is most likely connected with the intensification of protein metabolism required for the development of a new organism.

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 97-98.*

### **Computer optimisation of fur-bearing animals feeding**

*D.N. Pereldik, O.H. Duletsky*

At present a high production cost is one of the main reasons preventing Russian furs from equal competition in the world market. Feeding expenses account for up to 80% of the total production cost of skins. We have developed software ("Calculation of optimum diet. Fur-bearing animals") which allows us to reduce feeding expenses by 10-30% as well as to control about 40 parameters of the diet nutrition value which have favourable effects on skin size and fur quality. As an example, the table below shows 4 computer-optimised August diets for young pedigree mink reared on one of the Russian fur-breeding farms. Similar feeding cost reduction has been achieved on all farms using our software on a regular basis.

1 – **Basic diet** traditionally used on the farms. 2 – **Optimised diet I** contains 50 to 150% of the basic diet amount of each type of feed. The amount of digestible nutrients corresponds to recommended diet amounts. 3 – **Optimised diet II** contains the same amounts of feeds as optimised diet I, the amount of digestible protein calculated based on 10 essential amino acids (EAA); their ratio was compared to ideal protein and the amount is not less than recommended diet amounts. 4 – **Optimised diet III** contains 0 to 200% of the basic diet amount of each type of feed, i.e. any particular feed can be excluded, the amount of digestible nutrients corresponds to recommended diet amounts. 5 – **Optimised diet IV** uses the same limitations as optimised diet III, but the amount of protein is based on EAA.

Indices	Limits	Diets				
		Basic	Opto,osed			
		1	2	3	4	5
Diet content	Price, Rub/kg	g per 100 kcal ME				
Beef	2600	2.1	3.2	3.2	4.2	4.2
Beef/pork by-prod.	2300	12.4	8.8	6.7	5.0	0.8
Bone crushed	1500	2.7	1.9	1.9	1.2	1.2
Cod heads	1840	12.3	13.3	11.9	14.8	14.0
Fresh whole fish	2500	9.5	4.8	4.8		
Fish meal	3400	3.7	5.6	5.6	7.4	7.4
Fat-free curds	2300	3.1	1.6	1.6		
Barley meal	650	10.9	11.3	11.3	11.4	11.4
Animal Fat	5100	2.1	2.2	2.8	2.4	3.5
Nutrients digestible	Recom. diet amt.	g per 100 kcal ME				
Limit EAA						
Protein	8.0-9.0	8.0	8.0	7.6	8.0	7.4
Fat	4.3-5.5	4.6	4.5	4.7	4.5	4.8
Carbohydrates	2.6-5.4	5.2	5.4	5.4	5.4	5.4
Methionine+cystine	0.245	0.270	0.283	0.274	0.295	0.285
Tryptophane	0.073	0.085	0.083	0.080	0.081	0.076
Lysine	0.525	0.525	0.566	0.544	0.569	0.537
100 kcal ME cost	Rub	121.3	108.0	103.9	95.0	89.3
	%	100.0	89.0	85.7	78.3	73.6

\*Average 1996 prices

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 98-99.*

## Food and oxythiamine deficiency of vitamin B<sub>1</sub> in mink

G.G. Petrova, T.N. Ilyina, N.N. Tyutyunnik, I.P. Chernikevich, S.P. Izotova

We investigated a complex of specifically interconnected indices of thiamine metabolism in farm mink under conditions of vitamin B<sub>1</sub> deficiency caused by feeding raw fish containing the enzyme thiaminase, inactivated thiamine and application of the thiamine antimetabolite oxythiamine (OT). Insufficiency stimulated using the herring Ivasi in the ration for 50 days in the amount of 70-90% of the meat fish protein in the feed developed more quickly, and the main indices of thiamine metabolism changed in accordance with the expected dynamics similar to laboratory animals. The levels of the most sensitive physiologically active forms – thiamine diphosphate (ThDP), thiamine triphosphate, and inorganic phosphate were the first to decrease. The activity of the biotransformation enzymes of the vitamin, thiamine kinase, thiamine diphosphate kinase (ThDP kinase) and thiamine diphosphatase (ThDPase) was inhibited and the ThDP-effect was increased. Visual valuation of the animals, weighing, hemoglobin and erythrocytes analysis, and analysis of the protein picture in the blood did not reveal any deviations from the physiological norm, i.e. this stage of deficiency showed a state of hypovitaminosis diagnosed at a biochemical level.

At the same time intramuscular injection of OT at a dose of 1.5 mg/kg, caused acute deficiency accompanied by a sharp increase instead of the expected recession, already after 7 h, in the physiologically active thiamine forms, despite inhibition of ThDP kinase and activation of ThDPase probably because of the damaging effect of this OT dose in connection with hypersensitivity to it in mink. In spite of the fact that OT does not penetrate through the hemato-encephalic barrier, the deficiency was accompanied by characteristic neurological symptoms.

This can apparently be connected with the damage of barrier functions in the brain or with the consequent deficiency developed in the organism. Thus, insufficiency of thiamine in mink reproduced by various paths essentially differed in the dynamics of a number of main indices of thiamine metabolism and physiological state of the animals.

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 99-100.*

### **Effect of temperature and humidity on fur-bearing animals**

*I.A. Plotnikov, V.Z. Gazizov, S.N. Yarygin*

It is necessary to estimate the effect of environmental temperatures on the organism taking into account the relative air humidity. To find out the effect of various temperature and humidity conditions, a series of experiments on mink, muskrat, nutria and marmot were carried out. In a climatic chamber with humidity of 30 and 60%, different temperature conditions, from 10 to 50°C, were established. At a constant temperature of 30°C, different humidity conditions were established: 30%, 60%, 90%. The duration of every condition exposure was one hour. Physiological and hematological indices (more than 20) were taken into account. At R=30% with the temperature increase, metabolic changes took place. At 40°C, a maximum increase of all metabolic processes was noticed, then a decrease, and at 50°C the exhaustion of the organism defenses and adaptation abilities occurred. At R=60% similar changes took place at 5°C lower. At R=90% and t=30°C the organism resistance sharply decreased. Mink and nutria were found to be stronger. At R=60% the upper temperature point of the indifferent zone was 35-40°C. In muskrats and marmots, the upper point is as high as 30°C. In all species females tolerated extreme conditions better than males.

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 100-101.*

### **Periparturient behaviour of reproducing farmed blue fox vixens**

*T. Pyykönen, J. Mononen, T. Rekilä*

Maternal infanticide and periparturient behaviour were studied in silver foxes in Norway. These studies consider infanticide as a remarkable reproductive and economic problem. In Finland blue foxes have greater economic importance in fur animal production than silver foxes. Our study, therefore, describes the variation in periparturient behaviour of multiparous (4) and primiparous (6) blue fox vixens. The behaviour of the vixens was video-recorded inside the breeding box, and analysed in six phases: 5 days and 1 day prior parturition, the parturition period, and the first three days after parturition. Nine out of ten vixens whelped between 23:30 – 11:30. True litter size at birth was  $11 \pm 3$  cubs. The period elapsing between individual births was  $30 \pm 21$  min. The parturition period lasted  $267 \pm 92$  min.

The time budget of behaviour showed a pronounced individual variation in all phases. Five days before parturition there were no differences in behaviour of multiparous and primiparous vixens. A day prior to parturition old vixens rested ( $33 \pm 13$ ) more inside the nest box than primiparous vixens ( $13 \pm 10$ ). The use of the nest boxes increased from  $23 \pm 20\%$  to  $49 \pm 26\%$  from 5 days to 24 h prepartum. This increase consisted of increasing time spent resting in the box. Also digging, inspecting and moving around in the box increased. About  $42 \pm 9\%$  of the parturition phase was spent cleaning, grooming and inspecting the cubs. Vixens spent  $29 \pm 14\%$  of their time resting. Vixens were only outside the box  $2.7 \pm 2.6\%$  of the period. During the three days postpartum vixens rested  $80 \pm 3\%$  of the time, though sleeping bouts lasted at most an hour. Total cub-care decreased slightly from  $17 \pm 3\%$  to  $12 \pm 2\%$  of total time during the first three days postpartum. Vixens were seen to retrieve cubs that got too far from their mothers. Vixens left

their boxes the first time at an average of  $7.4 \pm 0.3$  h after parturition (range from 15 min to 33 h). Infanticide was not observed, but foxes were seen to eat their dead cubs.

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 101-102.*

### **Genetic determination of motion activity in ferrets**

*J. Rafay*

We recorded the number of line crossings in the tested area by "open field" test during a 5-minute interval of motion activity in ferrets. Two lines of ferrets (pastel and standard colour) and their reciprocal offsprings were tested.

From the statistical evaluation of the number of crossings, it follows that the inter-group variability of genotypes and sex was highly significantly influenced by the time factor and individual features in animals. From the regression and correlation coefficients, it follows that the linear regressions of the square crossing by descendants were not statistically significant from crossings by ancestors. The insignificance of both linear regression coefficients and correlations shows practically no dependence of the descendants' behaviour from the parents' behaviour in the reaction to the test conditions in open field. This indicates that the behaviour of animals evaluated by motility is practically determined by the environment (e.g. maternal instincts, breeding manipulation). It is impossible to generalise that motility is not hereditary. However, in our experiment the additivity effect probably is also covered by the non-additive effects of genes. This can also be influenced by the small sizes of the groups (in each group,  $N=10$ ). It is possible that there also exists clusters of animals, which should be evaluated separately from the viewpoint of genetic determination of the studied trait.

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 102.*

### **Effect of fatness on the reproductive indices in foxes of different behavioural types**

*N.N. Shumilina, T.M. Chekalova*

The effect of fatness on the reproductive indices has been thoroughly studied on mink but the data related to foxes are quite contradictory. The trials made on fox females in 1982-1988 show that there are some individuals which have more than average fatness and high reproductive indices. While studying fatness and reproduction, some aspects were taken into account which could be induced by the type of fox constitution. In our investigations we used I.P. Pavlov's classification based on the concept that higher nervous activity is primary and constitution type is formed in accordance with the type of higher nervous activity. It has been established that the share of the effect of behavioural type on fecundity is very low - 0%, while that of fox fatness is somewhat higher - 3.5%. The share of the effect of the factors in combination is twice as high as the effect of the factors taken separately.

Average fecundity is significantly higher in the placid female with more than average fatness and is maximal in cowardly and vicious females with less than average fatness.

The effect of all the studied factors on the amount of the kits raised to weaning is also significant. The dispersion of fatness exceeds that of behaviour type but the value of dispersion on the joint effect of these factors exceeds each of them by almost 10 times. Moreover, fatness and behaviour type have a greater influence on the amount of kits raised to weaning than on fecundity. It occurs because the factors of fatness and behaviour type influence the losses of kits before they are recorded, and the number of females which did not give birth. Maximum kit losses are observed in placid females with less than average and average fatness, in cowardly ones with more than average fat and in vicious ones with less than average fat. In placid animals with less than average and average fatness, and vicious ones with

more than average fatness a high percentage of the females which did not give birth was observed. Therefore, the best indices on the amount of kits raised till weaning were observed in placid females with more than average fatness, cowardly ones with less than average and average, and vicious ones with lower than average fatness.

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 104.*

**Physiological effects of different dietary fat:carbohydrate ratios during the life cycle of blue foxes (*Alopex lagopus*)**

A. Skrede, Ø. Ahlstrøm

The annual cycle of adult blue foxes can be divided into a period of body fat deposition, normally lasting from August until December, and a fat mobilisation period, which may last from December until weaning, usually in July. Thus, the dietary nutrient requirements would depend greatly on physiological status and phase of production.

During the late part of the growth period, a high dietary energy density and a high dietary fat:carbohydrate ratio are advantageous for maximum body weight gain and skin size. It is shown that fat comprises about 50% of the body mass of blue foxes at pelting in November. As an energy source for fat deposition, dietary fat is much more effectively utilised than protein and carbohydrates. It has been shown that digested fatty acids can be directly deposited into body stores with less energy expenses than those associated with the conversion of protein and carbohydrates into body fat. This is an important aspect of the economical optimisation of diets for fattening blue foxes.

In the late stage of gestation, and especially during early lactation, there is a high demand for glucose for fetal development and milk production. Mobilisation of body fat combined with a high dietary fat:carbohydrate ratio in this period increases the risk of elevated

plasma acetoacetate levels and ketogenesis in the breeding female. Ketone bodies are poorly utilised by the fetus and may be detrimental to the viability of the newborn. Ketosis in the breeding female also affects late prenatal and early postnatal feed consumption, lactation performance, and the ability to take care of the cubs. Thus, cub viability and growth performance may be reduced.

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 105.*

**The effect of tameness and aggressiveness on fights and hormonal status in farm rearing mink**

O.V. Trapezov, O.V. Antonenko, I.N. Oskina, R.G. Gulevich

This study examined the effect of dominance on fight contacts in six different combinations of aggressive and tame pairs of young mink. Aggressive and tame mink lines have been produced in the course of the 17 generations since 1980.

Pairs of tame and aggressive unfamiliar young male and female mink were taken from the 15th generation of a selection program and reared in pairs in cages with wooden boxes. Their relationships were examined during 5 months from weaning at 45 days to pelting time by controlling body weight, degree of adrenal activity, pelt biting parameters and the bite target topography with the frequency of fights. In the short period following weaning they grew increasingly intolerant of one another and after a period of competition one animal emerged as attacker ( $\alpha$ -animal). Statistical analysis showed that aggressive animals exhibited more aggression conflicts than tame counterparts.

Examination of bite marks recorded on the inside of the leather displayed that aggressiveness provoked agonistic behaviour, i.e. the mean number of scars increased drastically from  $\alpha$ -aggressive to  $\beta$ -tame animals. But it is

interesting to speculate why unsuccessful combatants for  $\beta$ -tame animals were followed by a significant lower basal level of cortisol?

The results indicate a strong relationship between stress sensitivity and behaviour. Physiological stress response in pairs cause different physiological reactions: aggressive mink could be long-term stressed with a degree of adrenal hypertrophy and react with a significantly increased release of cortisol. Our results allow us to propose that selection of mink for tameness and aggressiveness differentiates the animals in the levels of cortisol and transcortin in blood. In aggressive males the level of total and free cortisol in the blood become higher, and of transcortin lower than in mink with the tame type of behaviour. Under pair-wise raising of males with opposite behaviour, the pattern of hormonal changes depended on both the type of behaviour and weight gradation.

The work was supported by the Russian Foundation for Basic Research, grant No. 96-04-49972.

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 106.*

#### **Influence of salts of mercury on the HS-protein contents in the organs of laboratory animals**

*N. Volokhova, N. Galibina, V. Ostashkova, I. Bolotnikov*

The influence of double-valency salts of mercury  $HgI_2$  and  $Hg(NO_3)_2$  on the level of HS-protein in brain cell and liver of white rats was investigated. The experimental animals received 100 mg mercury added to the feed (calculated per cation of the respective salts) per animal per days for 14, 30 and 60 days. Control groups had the same diet but without addition of salts. After these periods the animals were decapitated, and mercury contents was determined in the tissue under study, as well as the quantity of sulphhydrylic groups using the Ellman method in microsome-cytoplasm fraction

and microsome of the brain and liver. Simultaneously, we investigated the protein content using the Lowry method. HS-protein concentration was expressed as mm of HS-protein groups of restored glutathione per mg protein cell. It was established that already by day 14 the contents of mercury in the brain increased 5 times and in the liver 10 times in comparison with the control. On such a background, the quantity of HS-containing protein in the brain was increased as in the microsomal-cytoplasmic fraction (with  $87 \pm 6.6$  to  $161 \pm 5.3$  mm/mg protein). A similar picture was observed in the liver. The data testify that accumulated mercury can activate the synthesis of HS-protein.

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 107.*

#### **Long-term starvation in fur animals**

*Yu. S. Zabolotskikh*

Many investigations show a significant influence of fatness on fur-bearing animals fecundity (Zaitsev, 1961, 1970; Kuznetsov et al., 1974; Mamayeva, 1974, 1976, 1977; Semyenov, '1990). The strongest control over the state of fatness is necessary during the period when animals prepare for reproduction. A simple but highly effective method of maintaining good breeding conditions is long-term full starvation. The duration of starvation is set according to the animals' nutritional state, their age, physiological state and the species' biological adaptation to a lengthy starvation period. The most suitable period for using the starvation method in camivorae begins in mid-November and should be stopped two-three weeks before the onset of heat. The method of long-term starvation favours an economical use of feed without any detriment to animal health, gives a high selection effect due to culling of weak animals unsuitable for breeding, raises inner resources of the organism and increases reproductive potential of a foundation stock.

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 107-108.*

### Fur animal weight decrease after full long-term starvation

*Yu.S. Zabolotskikh, Ye.V. Baibikov*

Experimental data on weight decrease during long-term starvation were obtained for fur-bearing animals of 8 different species. Among them: 1). those that do not hibernate (Arctic fox, fox, nutria, muskrat); 2). those that hibernate partially in the winter (North-American raccoon, raccoon dog); 3). hibernating animals (black-capped marmot, steppe marmot). The whole period of starvation was subdivided into five-day (or ten-day) periods. As the main characteristic, the coefficient  $K$  was calculated with the accepted equation for the weight decrease:  $dW/dt = -K W$ , and the curves of changes in that coefficient during starvation were drawn. The following interesting graph peculiarities for the animals of different systemic groups were found:

In the majority of species, the curves showing changes in the weight increase coefficient had three distinct parts: the beginning of the starvation period (a sharp decrease of weight and coefficient  $K$  decrease), the middle part (decrease of weight with nearly constant decreased coefficient), a further period (the weight is decreasing faster than during the middle period; the coefficient gradually increases). In the animals of different species, those parts of the curves are different both in the rate of  $K$  decrease and the length of periods. In species which do not hibernate the changes found in  $K$  are greatly pronounced while different periods of starvation are significantly shorter in time. At the same time in hibernating species these parts of the curve are wider, and the changes in  $K$  are not great. As a result their weight decrease is almost even during many months of starvation. The changes detected in  $K$  can be associated with the use of different physiological mechanisms during three periods of a long cycle of full alimentary starvation.

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 108-109.*

### SECTION 3: Stimulation of reproduction and development

#### Efficiency of the biopreparation "BIOZH" in fur-bearing animals

*V.V. Durova*

The biopreparation "BIOZH", the product of biotechnology obtained in vitro on the basis of cell cultures of higher plants, has in its composition the following bioactive substances: glycosides, a complex of necessary macro- and microelements, amino acids, and carbohydrates.

Research work carried out on the Fur Breeding Farm "Vyatka" with the foundation stock and the young veil Arctic fox has shown that this biopreparation has a pronounced adaptation effect, increases natural resistance of the organism, and stimulates metabolic and reproductive functions.

Males and females of veil Arctic foxes in the experimental groups were given this biopreparation in the feed at a dose of 2-5 ml/kg live weight every other day during the heat period.

It was found that supplement of the biopreparation "BIOZH" to the feed for Arctic fox had no negative effect on the physiological state of the animals. The feeds containing the biopreparation were completely eaten. In the animals fed the diet containing the biopreparation we observed an increase of reproductive capacity, female fecundity and kit survival. The addition of this biopreparation to a feed mix for the young Arctic fox given every other day from July until October at the rate of 3-5 ml/kg live weight raised live mass by 17.5 %, pelt size by 9.5%, and pelt quality by 50.6%.

The data show the efficiency and economic advisability of this biopreparation. It is innocuous and has a pronounced systemic effect on the living organism.

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 110.*

### Influence of vitamin E on the physiological state, productivity and milk composition in blue fox

V. Ilukha, L. Kozhevnikova, M. Valtonen, S. Kasanen, H. Meldo, N. Tyutyunnik

Vitamin E is sometimes called 'fertility vitamin' because it has been shown to be necessary for testis function and to prevent neonatal mortality. The aim of this study was to find out how dietary vitamin E supplementation during the reproduction period affects the physiological state, milk composition and productivity of blue foxes (*Alopex lagopus*).

The experiment was carried out on "Kondopogsky Zverovod" Ltd farm in Karelia. During 1992 two groups (control and experiment) of mated blue fox females were formed. They were given the same feed except that the experiment group received an extra 50 mg vitamin E per female daily starting two weeks before delivery and lasting until weaning. The cubs were counted immediately after delivery, and counted and weighed at the age of 3, 7, 14 and 21 days. Some of the females and their cubs were left for production for the next year. In 1993 there were six groups in this study: old females from the control and experiment groups, their daughters and sons. In 1993 all groups received the same feed without extra vitamin E.

In 1992 the vitamin E level in the blood of the females of the experiment group was higher than that in the control group. The hematological or clinico-chemical parameters studied both in females and cubs did not differ statistically between the groups. The reproductive performance was the same in both groups as well as the weight development of the cubs. In 1993 there were no significant differences in the reproductive performances between the groups of old females, their daughters or sons. However, there were less animals in the young experimental female group without cubs (6.71%) than in the young control female group (37.5%). The young experimental females also

had lower erythrocyte count and hemoglobin than the young control females.

Extra vitamin E seems to have no statistically significant effects on reproduction performance of female blue foxes or their offspring. But the effect when more female offspring are getting their own cubs might have economical value. One possible explanation for this result is that the excess of vitamin E affects the development of ovaries and ovas of the female cubs, not yet born, so that when these females mature, they are able to produce more cubs. The effects of vitamin E supplementation on milk composition are still under study.

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 111-112.*

### A new *in vitro* test of the pluripotency of mink ESC and ESC-like lines

H.A. Kizilova, S.Yu. Vatolin, E.D. Lopuhova, M.A. Sukoyan.

Embryonic stem cells (ESC) lines are a widely-used method in reproductive biotechnology and mammalian embryogenetics. But despite the establishment of pluripotency mink ESC and ESC-like lines, chimaeric mink have not yet been produced. Here we suggest a new *in vitro* test of the pluripotency of lines like those. It is based on the homo- and heterotypical interactions of ESC lines *in vitro*.

The mink ESC line which was transformed on lac Z (MES 12/lac Z) was heterotypically cocultured with highly pluripotential mouse ESC line (HM and homotypically cocultured with pluripotential mink ESC line (MES 16). The differential X-gal staining of the product of the lac Z expression (procaryotic beta-galactosidase) enabled us to follow the existence of cells in aggregates. Three methods provided us with embryoid bodies:

- 1) suspension culture;
- 2) hanging drop;



3) dense coculturing when chimaeric embryoid bodies spontaneously detach from the monolayer.

Histochemical and morphological analyses demonstrated that heterotypical embryoid bodies consisted of derivatives both of mink and mouse ESC but mouse cells tended to group autonomously. Homotypical chimaeric bodies consisted of derivatives of both mink lines and were in general totally mixed.

It is suggested that mammalian ESC in vitro along with the retention of pluripotency partly lose their capacity of inter- or intraspecific recognizing. This stimulates morphogenesis of chimaeric bodies and differentiation of the cells they contain.

It is believed that homo- or heterotypical coculturing of new mink ESC-like lines with highly pluripotential ECS lines can presumably serve as an additional in vitro test in the case of problematic chimaera production.

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 112.*

#### **Embryonic mortality in mink.: Morphological analysis of preimplantation embryonic loss**

*H.A. Kiziloya, A.I. Zhelezova, A.N. Golubitsa, S.L. Baiborodin*

Using light and electron microscopy 214 preimplantation embryos from 33 females (standard) were studied. These females were mated twice during the breeding season with an interval of 6-7 days. Maintenance conditions were standard under normal photoperiod. The females were not treated with hormones. Among the zygotes collected 44-46, 48-50 and 52-54 hours post coitum the proportions of abnormal embryos were 8%, 39% and 22%, respectively. The absence of pronuclei and the second polar body demonstrate that the pool consists of unfertilized oocytes. In 6% of cases (4 embryos, 1 female) the embryos did not reach the denudation stage. This oocytes were

almost completely destroyed. Bacterial invasion was observed in the corona radiata cells.

The proportion of abnormal embryos was 17% at the stage of 2-4 blastomeres, 13% at the stage of 8-16 blastomeres, and 5% at the stage of morula and beginning of cavitation. The following ultrastructural changes were characteristic of abnormal embryos at these stages: extensive areas of damaged plasmalemma, marked vacuolization of the cytoplasm, coagulation of the lipid granules and their frequent extrusion into perivitellin space. Among the diapaused blastocysts, activated blastocysts and those at the stage of embryonic disk formation, the proportions of abnormal embryos were 13%, 34% and 8%, respectively. Abnormal blastocysts were from two groups: group 1 delayed in growth showed deformation and local destruction of inner cell mass resulting in death of the embryoblast however with unaltered trophoblast; group 2-blastocyst more often collapsed. Here accelerated growth was associated with trophoblast and primitive endoderm damages. Spermatozoan tails were occasionally observed in these embryos. Thus, the proportions of embryonic death at the stages of zygotes, cleavage and blastocyst were 22%, 12% and 25% respectively. The main causes of preimplantation mortality in mink are presumably impairment of fertilization affecting the spermatozoa from the second mating and selective elimination the blastocyst from the first mating as a result of selective damages of trophoblast. Damaging and embryotoxic effect of the bacterial flora of the reproductive tract may occasionally be involved.

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 113.*

#### **Experimental study of the preparation ligavirin in Aleutian disease of mink**

*V.V. Klimenko, L.Ye. Boyarintsev, I.A. Domskey*

Development of an antiviral and immunomodelling preparation for the prophylaxis and treatment of Aleutian disease of mink (ADM) is

highly urgent. The testing of the preparation ligavirin (a superinductor of endogenous interferon and an immunomodulator) on female standard mink at the age of 10 months in groups of analogues was done. In the experimental group ligavirin was given only once on the day before the animals were infected. All the animals of both experimental and control groups were infected with ADM-native virus of the strain P-1 received from the All-Russian Research and Control Institute.

After infecting the animals, clinical symptoms of that disease were not found. The results of the experiment were judged by the presence of specific antibodies to the virus of Aleutian disease in the blood serum of animals in immunoelectro-osmophoresis reactions and immunoenzyme analysis.

The first seropositive reactions were noted in the animals of the control group on the 7-9th day after being infected, and on the 11th day all the animals showed clear reactions in both diagnostic tests. The presence of antibodies to the virus of Aleutian disease of mink after injecting ligavirin was noted in the animals on the 10th day by immunoenzyme analysis and on the 11th day by immuno-electroosmophoresis. Thus, comparing the results obtained in different animal groups we may conclude that there is a three-day delay in appearance of antibodies to the virus of Aleutian disease of mink after using ligavirin.

Therefore, ligavirin has a certain antiviral effect on the virus of Aleutian disease of mink.

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 114.*

### **Mival in the diet for young mink**

*P.P. Orlov*

The impact of silicoorganic biostimulant - mival (synthesized at Irkutsk Institute of Organic Chemistry) on young mink growth and fur quality was studied. The supplementing of this

preparation to the feed from July until October favours young mink growth (males). By the slaughter time the average body mass of the experimental males was 16% greater than that of the control ones. The females of the experimental and control groups had practically no difference in body mass.

The same results were obtained for body length and pelt length. The preparation had no noticeable effect on hair growth rate and hair length as had been expected (*Voronkov M.G., Dyakov V.M., 1978*). The hair length in the female pelts of the experimental and control groups did not differ, and in the males of the experimental group the hair was even somewhat shorter than in the males of the control group. During the research work the scheme and the dose of mival supplements for the feed of the young mink were found. They have the greatest effect on the growth and development of cubs.

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 115.*

### **The role of embryonic variability in hormonal mechanisms under domestication of silver foxes**

*L.V. Osadchuk*

Artificial selection of silver foxes for reduced aggressiveness towards humans (domestic behaviour) considerably changes not only the behaviour itself but also the endocrine status of the animals. Investigations on genetic and endocrine mechanisms of domestication also cover the field of early development of the endocrine system when hormones play a key role in coordination of the genetic program.

In this study, the basal and stimulated production of sexual hormones and cortisol were measured in silver foxes from control and domesticated populations during different time periods of prenatal life.

At the end of embryogenesis, the adrenal content and the in vitro production of cortisol were

significantly lower in embryos from selected mothers as compared to the unselected control. The addition of ACTH to the incubation medium increased cortisol biosynthesis at all stages studied, but the increase was less in the selected group than in the control one. Towards the end of prenatal development (days 45-50) the adrenal cortisol content was also significantly lower in embryos from mothers of the selected population than from the control one. The content and in vitro production of testosterone were much higher in testes than in ovaries throughout embryonic life.

There were no differences in basal testosterone production between domesticated and control animals. The response of testes to HCG was significantly higher and appeared earlier in domesticated animals compared with controls.

The results of this study show some embryonic alterations in hormonal systems regulating reproduction and adaptation in silver foxes as a consequence of long-term artificial selection for domestic behaviour. The data suggest that transformation of the endocrine system, including gonads and adrenals, may be based on hereditary changes in their development.

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 115-116.*

### **Paste of domestic fly maggots in diets for fur-bearing animals**

*I.A. Plotnikov*

At the All-Russian Research Institute of Game Management and Fur Farming the technology of growing, conservation and preparing a paste of domestic fly maggots for feeding was developed. At a humidity of 76.9 % this paste contains 13.6 % crude protein and 4.83 % crude fat. The coefficients of protein digestibility are 79.6 % and fat digestibility 80.6 %. Metabolizable energy content is 98.5 kcal. For the experiments 3,500 kg of the maggot paste were used.

It was found that substitution of 20% of the meat and fish feeds in the diet for young mink, Arctic fox and ferret (n=360) with the maggot paste during the whole period of raising had no negative effect on the growth and development of the animals, and did not decrease the quality and size of the fur skins. Substitution of 15% of meat and fish feeds with the paste in the diet of adult mink (n=180) during the period from preparing for rut to weaning had no negative effects on the morphological and biochemical blood indices, physiological state and reproductive ability. In the experimental group the number of live-born cubs was 15% greater than in the control group.

After drying, the paste may be added to granules for carnivorous and herbivorous animals as a source of valuable protein.

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 1116-117.*

### **Implantation of biologically active substances to fur-bearing animals**

*O.L. Rapoport*

Since 1983 we have been creating medical forms of biologically active substances, which look like granules, used for implantation under the skin of fur-bearing animals. The application of melacril with the active agent melatonin (the Synthetic hormone of epiphiz) results in a reduction of the breeding span of fur-bearing animals. This method has been used in many fur-breeding farms in Russia and other countries, resulting in substantial economic effects. In view of the fact that many vitamins are being destroyed in the feed during its preparation, transportation to the farm and distribution, we have constructed granules containing complexes of vitamins - polyvitalong.

Single treatment with polivitalong in fur-bearing animals in July provides normal metabolism for four months by supplying the animals

with vitamins. That enables exclusion of the addition of vitamins from the diet during the whole breeding periods. The application of polivitalong is 3.5 times cheaper than daily addition of vitamins to the feeds. Polyvitalong is used on many fur-breeding farms in Russia.

The addition of synthetic amino acids to feed does not provide the desirable effect, whereas single implantation of granules containing the limiting amino acids promotes more intensive growth in younger animals. It is especially effective to use granules of prolonged action with amino acids in diets of 8.0-8.5 gr. of protein per 100 kcal.

We have developed and tested granules to constantly provide fur-bearing animals with micro-elements. Single treatment of animals with such granules helps prevent iron-deficient anaemia for four months.

We have received patents from the Russian Federation for medical forms of melatonin, vitamins, amino acids and microelements.

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 117-118.*

#### **Effect of enlarged breeding nest box on reproductive success of blue foxes (*Alopex lagopus*)**

T. Rekilä, M. Harri, L. Jalkanen

The body size of Finnish blue fox females has increased during the last years being about 10 kg presently. The size of a breeding nest box has, however, not increased accordingly. In the present study we studied whether a larger breeding box would improve reproductive success, especially among the biggest animals.

Blue fox females from three private farms having the biggest animals in Finland were included. The size of females was estimated within each farm and females both smaller and larger than average were divided into two groups. The control group was provided with a

standard breeding box (40 cm x 40 cm x 40 cm) and the other group with an enlarged breeding box (45 cm x 45 cm x 45 cm). The standard boxes had been used earlier as breeding boxes whereas the enlarged boxes were brand new. The number of liveborn cubs (litter size) was recorded at birth and at weaning. Differences in the litter size were analysed with the two-way ANOVA.

Litter sizes for the control group and the enlarged box group were  $7.3 \pm 3.8$  and  $7.2 \pm 4.1$  ( $P > 0.05$ ) at birth and  $7.0 \pm 3.0$  and  $6.0 \pm 3.0$  ( $P > 0.05$ ) at weaning, respectively. There were differences in litter size between the farms at weaning ( $P < 0.01$ ) but not at birth ( $P > 0.05$ ). The size of the female did not affect her litter size at birth or at weaning, nor did the size of her breeding box.

Enlargement of the breeding nest box did not improve reproductive performance of blue foxes. Additionally, large females gave birth to and weaned as many cubs as small females. The present results show that the breeding nest box commonly in use is large enough for the big females to reproduce normally or the enlargement of the box was insufficient to give a noticeable change in litter size. The present result may have been confused by the different age of the breeding boxes used for the groups (old vs. new).

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 118.*

#### **Growth stimulation in young mink**

N.A. Shulyatyeva, P.P. Orlov

Active growth of young mink was observed when, during the period of their intensive growth (from July 1 to August 31), they were given the biostimulant mival in their feed and, later on (from September to October), cresacin. Both biostimulants were synthesized at Irkutsk Institute of Organic Chemistry. By November 1 the average mass of males in the experimental group was 15.5% greater and the average mass

of females was 17% greater than in the control group. After a primary treatment the length of pelts from the animals of the experimental group with good-quality hair was 8% longer in males and 6.3% longer in females than in the animals of the control group.

Thus, supplements of mival (July-August) and cresacin (September-October) in the feed for young mink favoured growth intensification in both males and females and fur of high quality was obtained. The doses and schedule of giving these biostimulants to young mink were found to intensify the growth of the young with the greatest efficiency.

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 11.*

#### **Complex research into endocrine thyroid gland, adrenal cortex and gonadal functions in fur animals**

*L.N. Sirotkina, N.N. Tyutyunnik*

Research into endocrine thyroid gland, adrenal cortex and gonadal functions in dark-brown and coloured mink, Polar fox and silver fox in relation to physiological condition (mating period, pregnancy and lactation), stage in the postnatal ontogenesis period, influence of the season and species was carried out. Steroid hormones - triiodothyronine (T<sub>3</sub>), thyroxine (T<sub>4</sub>), cortisol, testosterone, progesterone and oestradiol-17 $\alpha$  in the blood serum were radioimmunoassayed using a commercial kit of RIA produced by the farm "Beloris". Dark-brown mink and 2 month old Polar foxes, showed high triiodothyronine values in the blood,  $2.24 \pm 0.17$  and  $2.28 \pm 0.16$  nmol/l on average. Thyroxine activity in the animals was also high and corresponded to  $87.2 \pm 8.8$  nmol/l in mink, and  $100.8 \pm 10.4$  in Polar fox. In September, T<sub>3</sub> level declined and did not exceed  $0.7 \pm 0.2$  in wild (Demi-buff) mink, and  $1.4 \pm 0.2$  and  $1.9 \pm 0.3$  nmol/l in dark-brown mink and Polar fox, all 4-5 months of age, respectively. T<sub>4</sub> activity in

Standard and coloured mink 4 months of age was reduced more than threefold ( $P < 0.01$ ), while in Polar fox T<sub>4</sub> activity level remained high. In healthy silver fox 4 months of age, thyroxine content in the blood did not exceed  $58 \pm 7.8$  nmol/l, and in weak cubs traces of thyroxine were detected. T<sub>3</sub> values in the blood of weak fox-cubs were also low and made up  $0.87 \pm 0.03$  nmol/l, while in healthy animals T<sub>3</sub> level was twice as high ( $P < 0.01$ ). In February T<sub>3</sub> activity was increased in sapphire, standard, wild mink and Polar fox 10 months of age. Essential changes in T<sub>4</sub> values in mink aged 10 months were not observed. In the spring, during pregnancy and in the lactation period biological T<sub>3</sub> activity was slightly reduced both in mink and Polar fox ( $P < 0.05$ ). In Standard mink, 2 months old, cortisol concentration was rather high ( $58 \pm 3$  ng/ml). The average cortisol level in mink at 4-5 months of age remained stable; in Polar fox its value was thrice as low. In mink at 8 months of age, changes in cortisol activity were insignificant; in dark-brown mink and silver fox at 10 months of age, cortisol activity reached its peak values; in white, sapphire mink and Polar fox, its value did not exceed 60 ng/ml. Throughout pregnancy and in the lactation period, mink showed high cortisol activity. The sex hormones testosterone and progesterone values during early postnatal ontogenesis were not high. At the age of 10 months, testosterone activity values were found to increase considerably. In early March estradiol level was found to increase in mink at 10 months of age. In silver fox, the first peak values of estradiol activity were detected in December.

High correlation coefficients between the intensity of growth and values of T<sub>3</sub>, T<sub>4</sub>, cortisol and testosterone were recorded in mink aged 2 - and 4 months which can be used as a criterion to evaluate the physiological state of the herd when selecting kits for breeding.

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 119-120.*

### Effect of the biostimulant mival on mink reproductive function

*Y.J. Sivkova, P.P. Orlov*

The effect of mival synthesized at Irkutsk Institute of Organic Chemistry was studied in two groups of mink (experimental and control) over three years. The preparation was added to the feed before the heat period and during the second half of gestation, the dose being 5 ml per 1 kg of body weight. As a result, after three years of stimulation the number of unfertilized females in the experimental group decreased by 1.9% and in the control group by 0.6%. The number of females successfully giving birth to kits in the experimental group increased by 1.1%, and in the control by 0.45%. Pre-registration kit death in the experimental group decreased by 4.28% against 3.84% in the

control. As a result the average output per foundation female in the experimental group was 5.96 kits, and its increase during three years was 0.49 kit. In the control group those indices were 5.95 kits and 0.37 kit, respectively. A favourable impact of mival on metabolism in mink is proved by the blood analyses of the control and experimental animals, and by results of the pathological and anatomical studies.

The biostimulant mival supplement in mink feed during reproduction had no negative effects on the reproductive ability of the mink.

*Proceedings 131 pp, 1998. Abstracts in Russian and English, pp. 121.*



For further information regarding the abstract collection and contact to specific authors please contact:

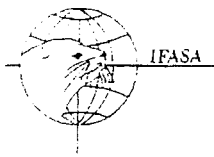
Dr. Viktor Ilukha  
Institute of Biology of KRC, RAS  
Pushkinskaya street 11  
Petrozavodsk, Russia  
Email: ILYUHA@MAZE.CENTRE.KARELIA.RU

**List of addresses**

- Anikanova, V.S. Institute of Biology Karelian Research Centre RAS, Petrozavodsk, Russia  
Balakirev, N.A. V.A. Afanasiev Research Institute of Fur Animals and Rabbits Breeding, Rodmiki, Moscow Region, Russia  
Barabasz, B. Agricultural University of Cracow, Cracow  
Borisova, A.G. Institute of Biology, Karelian Research Centre RAS, Petrozavodsk, Russia  
Boyarintsev, L.Ye. Scientific and Production Firm "Agrobiocentre", Kirov, Russia  
Boyarintsev, L.Ye. Scientific and Production Firm "Agrobiocentre", Kirov, Russia  
Buskov, Steen. Chemistry Department, Royal Veterinary and Agricultural University, Thorvaldsensvej 40, DK-1871 Frederiksberg C, Denmark  
Børsting, Christian Friis. Danish Institute of Agricultural Sciences, Department of Nutrition and Physiology, Research Centre Foulum, P.O. Box 50, DK-8830 Tjele, Denmark  
Clausen, J. Dansk Pelsdyravlerforening Langagervej 60 DK-2600 Glostrup  
Clausen, Tove N. Research and Advisory Unit of the Danish Fur Breeders Association, Herningvej 112, Tvis, DK-7500 Holstebro, Denmark  
Crossley, R.R. Animal Medical Centre, 511 Wilbraham Road, Chorlton, Manchester M21 0UB, UK  
Dedek, J. Thierfelder Str. 18, D-18059 Rostock, Germany  
Dietz, Hans Henrik. National Veterinary Laboratory, Department of Poultry, Fish and Fur Animals, Section of Fur Animals, Hangøvej 2, DK-8200 Aarhus N, Denmark  
Domskey, I.A. The All-Russian Research Institute of Game Management and Fur Farming of RAAS, Kirov, Russia  
Durova, V.V. The All-Russian Research Institute of Game Management and Fur Farming, RAAS, Kirov, Russia  
Elakov, A.L. ASSCI, Moscow, Russia  
Ernst, L.K. Russian Agricultural Academy, Moscow  
Gazizov, V.Z. The All-Russian Research Institute of Game Management and Fur Farming, RAAS, Kirov, Russia  
Halbrook, R.S. Cooperative Wildlife Research Laboratory, Southern Illinois University, Carbondale, Illinois 62901-6504, USA  
Hansen, Bente Krogh. Danish Institute of Agricultural Sciences, Department of Animal Breeding and Genetics, Research Centre Foulum, P.O. Box, DK-8830 Tjele, Denmark  
Hansen, Steffen W. Danish Institute of Agricultural Sciences, Department of Animal Health and Welfare, Research Centre Foulum, P.O. Box 50, DK-8830 Tjele, Denmark  
Harri, M. Department of Applied Zoology, University of Kuopio, Box 1627, 70211 Kuopio, Finland  
Hejlesen, Carsten. Research and Advisory Unit of the Danish Fur Breeders Association, Herningvej 112, Tvis, DK-7500 Holstebro, Denmark  
Ilukha, V. Institute of Biology, Karelian Research Centre RAS, Petrozavodsk, Russia  
Ilyina, T.N. Institute of Biology, Karelian Research Centre RAS, Petrozavodsk, Russia  
Ivanova, T.A. GAVM, St. Petersburg  
Jensen, Søren Krogh. Danish Institute of Agricultural Sciences, Department of Nutrition and Physiology, Research Centre Foulum, P.O. Box 50, DK-8830 Tjele, Denmark  
Juokslahti, T. Helsinki University, Faculty of Veterinary Medicine, Finland  
Kharlamova, A.V. Institute of Cytology and Genetics, Novosibirsk, Russia  
Kizilova, H.A. Institute of Cytology and Genetics, Novosibirsk, Russia  
Klimenko, V.V. Scientific and Production Firm "Agrobiocentre", Kirov, Russia  
Lauria, D. Argentina  
Lærke, Helle Nygaard. Danish Institute of Agricultural Sciences, Department of Nutrition and Physiology, Research Centre Foulum, P.O. Box 50, DK-8830 Tjele, Denmark  
Malmkvist, Jens. Danish Institute of Agricultural Sciences, Department of Animal Health and Welfare, Research Centre Foulum, P.O. Box 50, DK-8830 Tjele, Denmark  
Mertin, Dusan. Research Institute of Animal Production, Hlohovska 2, 949 01 Nitra, Slovakia  
Morgan, M.K. Department of Animal Science, Michigan State University, East Lansing, MI 48824, USA  
Møller, Steen. Danish Institute of Agricultural Sciences, Department of Animal Health and Welfare, Research Centre Foulum, P.O. Box 50, DK-8830 Tjele, Denmark

- O'Brien, Robert T. Department of Surgical Sciences, School of Veterinary Sciences, University of Wisconsin-Madison, 2015 Linden Drive West, Madison, WI 53706, USA
- Oleinik, V.M. Institute of Biology, Karelian Research Centre RAS, Petrozavodsk, Russia
- Orlov, P.P. The All-Russian Research Institute of Game Management and Fur Farming, RAAS, Kirov, Russia
- Osadchuk, L.V. Institute of Cytology and Genetics, Siberian Branch of the Russian Academy of Sciences, Novosibirsk 630090, Russia
- Overgaard, Lise. Research and Advisory Unit of the Danish Fur Breeders Association, Herningvej 112, Tvis, DK-7500 Holstebro, Denmark
- Panfilov, A.B. Vyatka State Agricultural Academy, Kirov, Russia
- Pereldik, D.N. Research Institute of Fur-Animal Farming and Rabbit Breeding, Moscow Reg., Russia
- Petrova, G.G. Institute of Biology, Karelian Research Centre RAS, Petrozavodsk, Russia
- Plotnikov, I.A. The All-Russian Research Institute of Game Management and Fur Farming, RAAS, Kirov, Russia
- Prasolova, L.A. Institute of Cytology and Genetics, Siberian Division, Russian Academy of Sciences, Novosibirsk, Russia
- Pyykönen, T. Department of Applied Zoology & Veterinary Medicine, University of Kuopio, Finland
- Rafay, J. Research Institute of Animal Production, Nitra, Slovakia
- Rapoport, O.L. The Firm "OLEZIN", Russia
- Rasmussen, Palle V. Danish Institute of Agricultural Sciences, Department of Animal Product Quality, Research Centre Foulum, P.O. Box, DK-8830 Tjele, Denmark
- Regerand, T.L. Northern Water Problem Institute, Karelian Research Centre RAS, Petrozavodsk, Russia
- Rekilä, T. University of Kuopio, Department of Applied Zoology and Veterinary Medicine, Kuopio, Finland
- Riis, Bent. Danish Institute of Agricultural Sciences, Department of Animal Product Quality, Research Centre Foulum, P.O. Box, DK-8830 Tjele, Denmark
- Risager, H.-J. Midtjyllands Pelsdyravlforening, Herningvej 112, Tvis, DK-7500 Holstebro, Denmark
- Sales, J. Department of Animal Science, University of Stellenbosch, Stellenbosch, 7600, South Africa
- Shulyatyeva, N.A. The All-Russian Research Institute of Game Management and Fur Farming, RAAS, Kirov, Russia
- Shumilina, N.N. K.I. Skryabin Moscow State Academy of Veterinary Medicine and Biotechnology, Moscow
- Sirotkina, L.N. Institute of Biology, Karelian Research Centre, RAS, Petrozavodsk, Russia
- Sivkova, Y.J. The All-Russian Research Institute of Game Management and Fur Farming, RAAS, Kirov, Russia
- Skrede, A. Department of Animal Science, Agricultural University of Norway, P.O. Box 5025, N-1432 Ås, Norway
- Suntsova, N.A. Vyatka State Agricultural Academy, Kirov, Russia
- Sutherland-Smith, Meg R. Department of Veterinary Services, San Diego Zoo, P.O. Box 551, San Diego, California 92112, USA
- Szeleszczuk, Olga. Agriculture University of Cracow, Department of Fur Animal Husbandry, Cracow, Poland
- Tirnaeva, E.A. V.A. Afanasiev Research Institute of Fur Animal And Rabbit Breeding, Rodniki, Moscow Region, Russia
- Trapezov, O.V. Institute of Cytology and Genetics, Novosibirsk, Russia
- Trebukhina, R.V. Institute of Biochemistry, National Academy of Sciences of Belarus, Grodno
- Tyutyunnik, N.N. Institute of Biology Karelian Research Centre RAS, Petrozavodsk, Russia
- Unzhakov, A.R. Institute of Biology, Karelian Research Centre RAS, Petrozavodsk, Russia
- Uttenthal, Åse. Danish Fur Animal Laboratory, Langagervej 74, DK-2600 Glostrup, Denmark.
- Uzenbayeva, L.B. Institute of Biology, Karelian Research Centre RAS, Petrozavodsk, Russia
- Volokhova, N. State University of Petrozavodsk, Petrozavodsk, Russia
- Zabolotskikh, Yu. S. The All-Russian Research Institute of Game Management and Fur Farming, RAAS, Kirov, Russia





## IFASA/SCIENTIFUR

### INFORMATION REGARDING IFASA (The International Fur Animal Scientific Association) and SCIENTIFUR (Scientific information on Fur animal Production)

#### IFASA

The objectives of the International fur Animal Scientific Association are:

1. To promote the knowledge of all aspects of fur animal science and fur animal production.
2. To act as formal link between scientists, Fur Breeders Associations, and Government agencies on an international level.
3. To be responsible for arranging international fur animal congresses and other international meetings within the field of fur animal science.
4. To co operate with other international organisations to achieve these aims.
5. To publish the scientific journal SCIENTIFUR.

To reach these goals, a board has been elected at the 5th international congress in Oslo in 1992. The board elected at the 6.th international congress in Warsaw in 1996 consist of:

Prof. Einar J. Einarsson, Norway (President), Dr. Med. Vet. Bruce D. Murphy (Canada), Vicepresident and chairman of the Editorial Board, Prof. Dr. Med. Vet. Maija Valtonen, Finland, Dr. hab. Marian Brzozowski, Poland and Ing. Wim Verhagen, Holland.

**MEMBERSHIP:** All persons and institutions interested in fur animal production and -science can become members of IFASA and thereby support the international co-operation in this field. Members also have the right to reduced fees for participating in Meetings and congresses as well as a reduced subscription price to SCIENTIFUR.

**MEMBERSHIP FEE** is NOK (Norwegian Kroner) 170,- for individual members and NOK 1700,- for institutional members.

Please send your application to the Oslo office . Address below.

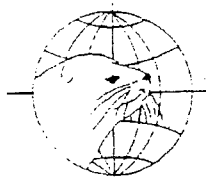
**SCIENTIFUR**-scientific journal and newsletter- is the official organ of IFASA.

**SCIENTIFUR** has been published since 1977, and managed by IFASA since 1990.

**SCIENTIFUR INDEX** covering vol. 1-22 (approx. 8000 titles of scientific reports regarding fur animal production) is available in an electronic version (2 diskettes) at a price of NOK 350,- for IFASA members and NOK,- 500 for others.

ASK FOR A **SAMPLE COPY** OF SCIENTIFUR AND PERHAPS FURTHER INFORMATION AND AN APPLICATION FORM REGARDING MEMBERSHIP OF IFASA.

*WE LOOK FORWARD TO WELCOME YOU AS AN IFASA MEMBER AND/OR A SCIENTIFUR SUBSCRIBER. WRITE, FAX OR SEND E-MAIL TO THE ADDRESS BELOW.*



## IFASA/SCIENTIFUR

### SCIENTIFUR SERVICES.

**SCIENTIFUR ELECTRONIC INDEX**, covering Vol. 1 -22 incl. Approx. 8000 titles of scientific reports regarding fur animal production.

Updating of existing indexes .....	NOK	200.-
Complete Index, Vol. 1 - 22 (IFASA Members).....	NOK	350.-
Complete Index, Vol. 1 - 22 (Others).....	NOK	500.-

**MINK PRODUCTION** (ISBN 8798 1959-0-5) 399 pages richly illustrated.

Single copies .....	NOK	250.-
10 copies or more .....	NOK	200.-
100 copies or more .....	NOK	150.-

**BEAUTIFUL FUR ANIMALS - and their colour genetics** (ISBN 87-98 1959-5-6) 271 pages incl. More than 300 very high quality colour photos. Also available in Danish, Norwegian and Swedish).

Single copies .....	NOK	250.-
10 copies or more.....	NOK	200.-
100 copies or more .....	NOK	150.-

#### PREVIOUS VOLUMES OF SCIENTIFUR:

Vol. 1 - 20 incl. Electronic Index .....	NOK	2500.-
Single volumes 1-20 .....	NOK	150.-
Vol. 21 & 22 .....	NOK	800.-

**COPY SERVICE:** You can order copies of all reports abstracted in SCIENTIFUR. When ordering, please state title of report, name of author and vol. & no. Of SCIENTIFUR issue where the abstract appeared. Prepayment of NOK 100.- per report not exceeding 20 pages. For every additional 10 pages or fractions hereof NOK 20.- per per report must be added. Air delivery included. Ask for special price for larger number of copies..

**ALL PRICES ARE EXCL. POSTAGE !!!**      **100 NOK equal appr. 15 US \$**

**SCIENTIFUR**  
**P.O. BOX 175, ØKERN**  
**N-0509 OSLO , NORWAY**  
**FAX + 47- 226443591**  
**E-MAIL ifasa-scientifur@oslo.online.no**