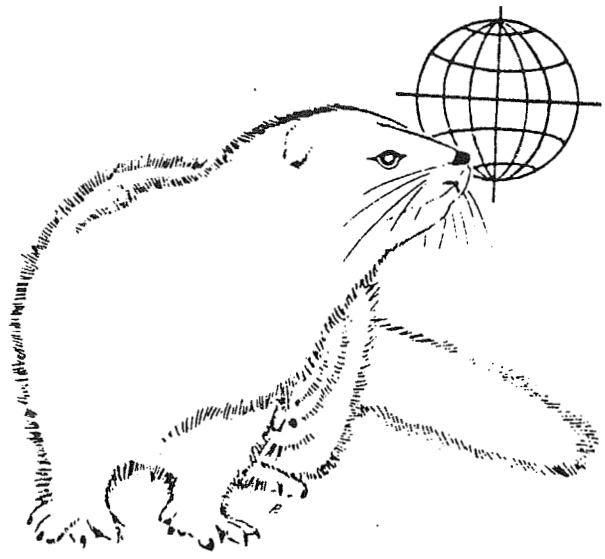

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INTERNATIONAL FUR ANIMAL SCIENTIFIC ASSOCIATION

OSLO PLAZA HOTEL,
AUGUST 13th - 16th 1992

Vth INTERNATIONAL SCIENTIFIC CONGRESS IN FUR ANIMAL PRODUCTION

NOTES
SCIENTIFUR
Vol. 16 No. 4
November 1992

Organized by IFASA

NOW GLORIOUS HISTORY

From August 13 to 16 the Vth International Scientific Congress in Fur Animal Production took place in Oslo, Norway. The very well arranged and successful congress, the first to be arranged by IFASA, was attended by nearly 200 persons from 20 different countries. On the official list of participants we found: Argentina 1, Canada 8, Czechoslovakia 3, Denmark 42, Eire 1, Finland 15, France 1, Germany 3, Greece 1, Iceland 2, Italy 1, Japan 3, Korea 1, Norway 28, Poland 13, Russia (SNG) 10, Spain 4, Sweden 8, The Netherlands 15, and USA 14.

At the congress there were oral presentations of 60 reports and presentation of 30 posters. Abstracts from all presentations are given in this issue of SCIENTIFUR. The Proceedings: PROGRESS IN FUR ANIMAL SCIENCE were printed as a 636 page Supplement (No. 9, 1992) of the Norwegian Journal of Agricultural Sciences. Additional copies of the mammoth proceedings (ISSN 0801-5341) can be obtained at the Norwegian Agricultural Advisory Service, Moerveien 12, N-1430 Ås, Norway (Tel.: +47 9 94 13 65) at a price of NOK 300.- + postage.

We congratulate the scientific committee with the scientific programme and the proceedings. Members of the committee were: Prof. Dr. Anders Skrede (chairman), Dr. Bjarne Braastad, Prof. Dr. Einar J. Einarsson, Dr. Jan A. Fougner, M.Sc. Kai-Rune Johannessen, Prof. Dr. Adrian Smith, and M.Sc. Morten Bakken (secretary).

Also the technical committee consisting of Terje Smith, Tone K. Holmen and Hans Åge Kulbotten as well as the entire organizing committee with the Minister of Agriculture Gunhild Øyangen and the President of IFASA, Einar J. Einarsson, Ingebret Hodre, Martin Holtung, Knut Nordstoga, Anders Skrede, Terje Smith and Einar Storsul are highly commended for the very fine overall arrangement and the effective management of all the activities.

The personal impressions and the mammoth proceedings will for many years to come remain a glorious monument for the persons responsible for the entire arrangement and for Fur Animal Science.

On the following pages, under the heading INFORMATION FROM IFASA, the organizational activities as well as the approved constitutions are presented.

The formal establishment of the 5 working groups within IFASA, which will be presented in a coming issue of SCIENTIFUR, will hopefully also speed up international activities in Fur Animal Science between congresses.

At the congress, SCIENTIFUR could present the almost finished ELECTRONIC VERSION of THE SCIENTIFUR INDEX covering all titles from the 15 first Volumes of SCIENTIFUR (1977-1991). This covers the majority of scientific literature on fur animals all the way back to 1960. The price of the Index, DKK 300.- for members of IFASA, and DKK 500.- for non-members, should make it possible for everybody, who can benefit from this very important and rational source of information, to find the money to purchase the Index.

At the congress we had a fruitful discussion with the American and Canadian groups regarding the possibility of finding a useful and economically attractive way of combining the scientific information of SCIENTIFUR with "local" information for the American and Canadian breeders through coproduction of local issues. In the interest of all parties concerned we hope that

the future development of this idea will prove to be fruitful. The idea of combining scientific and technical information with other necessary organising and market information will be an advantage to the breeders and to the organization as well as to SCIENTIFUR.

The future of SCIENTIFUR still depends on the full support of the Fur Breeders Associations. With the hope that the sponsorship for SCIENTIFUR can continue in the years to come we wish to express our thanks for the 1992 sponsorship of DKK 233,919.- from the Fur Breeders Associations in Denmark, Finland, The Netherlands, Sweden, Norway, Germany, Iceland, and Belgium.

We also thank the Schering-Plough Animal Health Division for supporting SCIENTIFUR with advertisements in 1992.

Also my thanks to all contributors and subscribers to SCIENTIFUR for their help and assistance in 1992.

Contributors are asked to remember that from 1993 reports exceeding 6 printed pages will be invoiced DKK 1200,- per exceeding page.

Privately I wish to thank the ladies behind SCIENTIFUR, i.e. Janne Hansen and Hanne Artved for the language control, Dorthe Nielsen for typing and layout, and Jytte Madsen for taking care of the financial side. Also thanks to the printing office at the Copenhagen Fur Center, Børge Bruusgaard and his staff.

Thanks again to all of you for 1992 and my best wishes for a MERRY CHRISTMAS and a HAPPY NEW YEAR.

Your Editor

Gunnar Jørgensen

SCIENTIFUR SUBSCRIPTION

THE SUBSCRIPTION PRICE FOR 1993 (VOL. 17) IS UNCHANGED: DKK 450 FOR PERSONAL MEMBERS OF IFASA AND DKK 550 FOR NON-MEMBERS. THE RATE FOR PERSONAL MEMBERSHIP OF IFASA IS DKK 150 WHICH WILL BE INVOICED TOGETHER WITH THE SUBSCRIPTION TO REGISTERED MEMBERS. INSTITUTIONAL MEMBERSHIP (RATE DKK 1500) INCLUDES 1 SUBSCRIPTION TO SCIENTIFUR + 1 PERSONAL MEMBERSHIP (THE NAME OF THE PERSONAL MEMBER HAS TO BE FORWARDED TO IFASA/SCIENTIFUR TOGETHER WITH PAYMENT).

INVOICES FOR 1993 WILL BE SENT AROUND THE MIDDLE OF DECEMBER 1992 AND HAVE TO BE PAID BEFORE FEBRUARY 1ST 1993, IF THE SUBSCRIPTION IS TO CONTINUE WITHOUT INTERRUPTIONS.

YOUR EDITOR

IFASA

INFORMATION FROM IFASA
(International Fur Animal Scientific Association)

In connection with the Vth International Scientific Congress on Fur Animal Production in Oslo August 14-16, 1992, a Board meeting as well as a Council meeting were held on August 13.

The BOARD MEETING, attended by E.J. Einarsson (Norway), N. Glem-Hansen (Denmark), Stanislaw Jarosz (Poland), Gunnar Jørgensen (Denmark), and Bruce D. Murphy (Canada), confirmed and discussed the agenda for the Council meeting.

Also the annual accounts of IFASA and SCIENTIFUR were discussed and approved by the Board.

The Board decided that INSTITUTIONAL MEMBERSHIP should include one subscription to SCIENTIFUR and one individual membership. The individual membership should be given by name.

The COUNCIL MEETING was attended by the Board members mentioned above plus 18 Council members (representatives) from the different member countries (see SCIENTIFUR Vol. 16, No. 2 pp. 90). Agenda for the meeting was:

1/92 Approval of the agenda and the councillors.
2/92 Approval of the Constitution.
3/92 Election of the Board and the President.
4/92 Place of the VIth International Congress in 1996.
5/92 The working groups of IFASA.
6/92 Miscellaneous.

Discussions, conclusions and votings during the Council meeting were as follows:

1/92 The agenda was approved.
It was agreed that the Council meeting was advertised according to the provisional Constitution of May 1988. It was concluded that the Council meeting was competent to act in accordance with the agenda.

2/92 The Council discussed the constitution based on a proposal for changes from the Board and proposals that came during the meeting. The revised and thereby authorized constitutions for IFASA are given in full length on the following pages.

3/92 The Board proposed that the Board be reelected. Other nominations were, however, welcome. Election of the President, the Vice president and the Board members was done by secret ballot and gave the following result:

President:	Einar J. Einarsson
Vice president:	Gunnar Jørgensen
Board member:	Bruce D. Murphy
- -	Stanislaw J. Jarosz
- -	Niels Glem-Hansen

The following personal alternates were elected:

Professor Anders Skrede (for Einarsson)
Professor Maija Valtonen (for Jørgensen)
Professor William Wehrenberg (for Murphy)
Dr. Alexander Taranin (for Jarosz)
Wim Verhagen (for Niels Glem-Hansen)

The Board members and the alternates are elected until the VIth congress in 1996.

4/92 POLAND was approved as the host of the IFASA CONGRESS in 1996.

5/92 It was decided to appoint the chairman of the Scandinavian working groups to be responsible for electing/appointing a provisional board of three members for each of the working groups. This was done during the congress and the working groups will be published later in SCIENTIFUR.

International Fur Animal Scientific Association

Constitution (August 1992)

Article I - Name

The name of this organization is the International Fur Animal Scientific Association, referred to as the IFASA.

Article II - Objectives

1. To promote the advancement of knowledge of all aspects of fur animal science and the fur industry.
2. To act as a formal link between scientists, the Fur Breeders Associations and governmental agencies on an international level.
3. To be responsible for the arrangements of international fur animal congresses and other international meetings within the field of fur animal science.
4. To cooperate with other international organizations in achieving these aims.

Article III - Membership

1. Application for membership shall be made to the secretary to be approved by the Board.

2. Type of membership.
   a. Individual membership may be held by any person who is interested in the objectives of the Association.
   b. Organizations, companies or institutions can be associated members.
   c. Honorary members, elected by the Council.

3. The Council may appoint as Honorary Life Members such members as it consider to have made a noteworthy contribution to the work of the Association or to fur animal science.

4. The annual fee is to be paid before February 1st of each year to the secretary of IFASA. If the fee is not paid before July 1st the same year, the member's name shall be removed from the list of memberships.

5. A member may forfeit his membership for failure to act in accordance with the objectives of the Association set out in Article II.

Article IV - Council and Board Members

1. Council

The Council will consist of representatives from each country according to the following schedule:

No. of individual memberships	No. of representatives of the Council
1 - 5	1
6 - 20	2
more than 20	3

The councillors shall be elected for a period of four years. If a councillor resigns between elections, the President shall appoint a new number under advise from the same country. Quorum shall be 30% of the numbers of the Council.

The President will circulate the agenda 45 days prior to the meeting.

2. Board

The Association shall be managed by the members of the Board, according to the guidelines set forth in this Constitution and the policies established by the Council. The Board shall consist of a President, a Vice President, three members and the Past President. The members of the Board are elected for a period of four years. Election of the Board will take place at the Council meeting held at the IFASA international congresses.

The Board shall be responsible for the approval of the projected annual programs and budgets of IFASA. Each Board member has a personal alternate. If the President is unable to attend the Board meeting, the Vice President will replace him. In absence of both the President and the Vice President, the members of the Board will elect an interim chairman. The quorum for the Board will be four.

3. Nominations and voting
Nominations for Board members may be made by any individual member. The nominations must reach the secretary not later than thirty days before the election. The members of the Council and of the Board may also nominate new Board members. Voting for Board members will be by secret ballot. The simple majority is sufficient for election to the Board. Each Board member is elected individually, beginning with the President.

The past President remains a regular member of the Board for the subsequent term.

Article V - Working Groups

The working groups must be approved by the Board of IFASA. The working groups may have their own board, but their by-laws and activities must be in accordance with the IFASA constitution. All members of a working group must be members of IFASA.

Article VI - Publications

1. An official organ of IFASA will be published (an international journal).
2. The official language of IFASA is English.

Article VII - Meetings

1. The Council of IFASA shall meet at least once every fourth year, and at the same time as the International Congress.

2. The Board of IFASA shall meet at least once a year.

3. Upon a request signed by at least six members of the Council representing at least four countries, the Board will be required to communicate by post with all members of the Council and seek their votes on any matter which has been raised.

4. Between annual board meetings the President together with the Vice President will have the authority to make decisions on behalf of the Board. Financial commitments will require a written approval by the quorum of the Board.

Article VIII - Honorary Members

An individual member can be elected as an honorary member by the Council.

Article IX - IFASA's Congresses

1. World congresses shall be held every fourth year.

2. The Council shall decide the venue of the next congress.

3. Countries that wish to host the Congress, should send an invitation to the Board at least sixty days before the Council meeting.

Article X

An annual report, including a financial statement, will be circulated to the membership by the Board of Directors.

Article XI - Disposal of Assets

If it is decided by two thirds of the Council that the Association should be dissolved, the Council will decide on the disposal of the assets.

The above articles were approved unanimously by the Council in Oslo, August 13th, 1992.

Original Report

Hematologic and blood chemistry values of the northern river otter (Lutra canadenesis)

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Abstract

Hematologic and serum chemistry determinations were performed on blood samples from northern river otter (*Lutra canadenesis*) to provide "normal" reference values for this species. The data reported include hematologic profiles, serum chemistry, and element values for 12 "clinically normal" adult male otter which were trapped and subsequently maintained in captivity on a prepared diet.

Introduction

A knowledge of normal blood values for wildlife species is essential for assessing their well-being, especially when they are maintained in captivity. Baseline or reference hematologic profiles and serum chemistry values are useful to those in disciplines such as biology, nutrition, toxicology and veterinary medicine in order to provide routine care to captive animals, as well as to diagnose and treat diseases in unhealthy animals. Information on normal blood values in the literature is lacking or limited for many mustelids including the northern river otter.

Kane (1979) reported hematologic values for the river otter (*Lutra canadenesis*) and the oriental small-clawed otter (*Aonyn cinerea*) maintained in zoological gardens. A comparative study on the hematology and blood chemistry of the sea otter (*Enhydra lutris*) and other mustelids and diving marine mammals was conducted by Williams and Pulley (1983). Colares and Best (1991) recently determined various blood values for two species of captive amazon otters (*lutra longicaudis*) and (*Pteronura brasiliensis*). Hematologic and blood chemistry values for northern river otter obtained during a reintroduction program were reported by Hoover et al. (1984, 1985). However, these latter values may not be indicative of "normal" animals because seven of the 20 otter died from various complications (including trauma, respiratory tract disease, bacterial and parasitic infections, renal disease, pneumonia, salmonellosis, and inanition) prior to or shortly after release in the wild.

The hematologic and serum chemistry values reported in this study were determined to provide baseline data for use in a toxicological investigation on the effects of environmental con-

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taminants on the northern river otter. These values are presented to serve as a reference to assist in determining the health status of this species.

Materials and methods

Twelve live-trapped male northern river otter were obtained from the Bayou Otter Farm (Theriot, Louisiana 70397, USA) and transported to the Michigan State University Experimental Fur Farm (East Lansing, Michigan 48823, USA) on January 20, 1991. The otter were housed individually outdoors in wire-mesh cages (2.44 m long x 1.22 m wide x 1.22 m high) suspended above the ground, with attached wooden nest boxes (0.91 m long x 0.61 m wide x 0.51 m high). The cages were surrounded by a five foot high wire-mesh fence to keep out other animals and to facilitate capturing any otter that escaped from their pens.

The otter were netted and anesthetized with 130 mg Ketamine hydrochloride (Ketaset, Fort Dodge Labs, Fort Dodge, Iowa 50501) and 4 mg xylazine (Rompun, Mobay Corp., Animal Health Division, Shawnee, Kansas 66201) administered intramuscularly. They were weighed and received a physical exam by a veterinarian. Fecal samples were collected and examined for evidence of internal parasites. The animals were immunized against mink virus enteritis and botulism (Biocom, United Vaccines, Madison, Wisconsin 53711) and given a booster for canine diseases (Vanguard 5, Smithkline Beecham Animal Health, LIncoln, Nebraska 68501). They had been vaccinated with Galaxy 6 and Eclipse 4 (Solvay Animal Health, Inc., Mendota Heights, Minnesota 55118) at the time of capture.

The otter were acclimated to the facilities and basal diet (table 1) for 25 days prior to the collection of blood samples for analyses on February 14, 1991. During the acclimation period, the otter were observed daily for indications of illness or abnormal behavior. Feed (table 1) and water were provided ad libitum.

Table 1. Composition and nutrient analysis of otter diet.

Composition	%
Ingredients[a]	
Mink cereal[b]	20.00
Ocean fish scrap[c]	40.00
Poultry by-products[d]	15.00
Beef liver	6.50
Eggs	3.50
Water	15.00
d-biotin[e] (mg/kg)	0.11
Analysis ("as fed" basis)[f]	
Moisture	63.10
Fat	6.13
Protein, crude	15.70
Fiber, crude	1.03
T.D.N.[g]	32.80
Ash	3.95
Calcium	0.97
Phosphorus	0.61
Potassium	0.33
Magnesium	0.07
Sodium	0.24
Copper (mg/kg)	10.00
Iron (mg/kg)	88.00
Manganese (mg/kg)	18.00
Zinc (mg/kg)	31.00

[a] The fish, poultry, liver, and eggs were ground through a face plate with 9.5 mm holes prior to mixing with the other ingredients.
[b] XK-40 mink cereal; XK Mink Foods, Inc., Plymouth, Wisconsin 53073, USA.
[c] Cod, haddock, and flounder; Boston Feed Supply, Natick, Massachusetts 01760, USA.
[d] Tyson Foods, Fort Smith, Arkansas 72901, USA.
[e] United States Biochemical Corp., Cleveland, Ohio 44122, USA.
[f] Litchfield Analytical Services, Litchfield, Michigan 49252, USA.
[g] Total digestible nutrients.

Prior to collection of the blood samples, the otter were chemically restrained (as previously described) and re-examined and weighed. Approximately 17 ml of blood were collected from each animal by jugular venipuncture into three vacuum tubes (five ml in a lithium heparin-treated tube for hematology determinations, 10 ml in a clot tube for serum chemistry, and about 2.5 ml in an ethylenediaminetetraacetic acid (EDTA)-treated tube for triioothyronine (T_3) and thyroxine (T_4) determinations. A blood smear was also made and examined for the presence of parasites. Following collection, the blood samples were taken to the Michigan State University Animal Health Diagnostic Laboratory and the Veterinary Clinical Pathology Laboratory for examination and analyses.

A Technicon H1 system (Technicon Diagnostic Systems Division, Tarrytown, New York 10591) was used for the determination of the red blood cell (RBC) count, white blood cell (WBC) count, hemoglobin (HGB), hematocrit (HCT), mean corpuscular volume (MCV), mean corpuscular hemoglobin concentration (MCHC), spun packed cell volume (PCV), plasma total solids (plasma TS) and differential cell count.

The serum chemistry analyses and calculations were performed with an Abbott Spectrum analyzer (Abbott Laboratories, Dallas, Texas 75381) to determine calcium (Ca), chloride (Cl), iron (Fe), phosphorus (P), potassium (K), magnesium (Mg), sodium (Na), carbon dioxide (CO_2), anion gap, total protein, albumin, globulin, albumin globulin ratio (G/G ratio), creatinine, alkaline phosphatase (Alk phos), alanine amino transferase (ALT), amylase, aspartate amino transferase (AST), creatinine kinase (CK), gamma glutamyl transpeptidase (GGTP), sorbitol dehydrogenase, cholesterol, glucose, triglycerides, blood urea nitrogen (BUN), and osmolality. Serum electrophoresis analyses for albumin, amino acids, alpha 1, alpha 2, beta and gamma globulins, and total protein were conducted with an EDC Electrophoresis Data Center (Helena laboratories, Beaumont, Texas 75657).

Serum element concentrations of aluminum (Al), boron (B), barium (Bs), Ca, copper (Cu), Fe, Mg, manganese (Mn), molybdenum (Mo), Na, P, and zinc (Zn) were determined by inductively coupled plasma-atomic emission spectroscopy (Jarrel-Ash, model 955, Plasma Autocomp. Direct Reading Spectrometer, Applied Chemical Corp., Waltham, Massachusetts 02154) as described by Braselton et al. (1981). Radioimmunoassay procedures (MSU Animal Health Diagnostic Loboratory) were used for the T_3 and T_4 determinations.

Results and discussion

The initial physical examination of the otter indicated that they were in good health, except for some minor foot injuries due to trapping on some individuals. The injured animals were treated with antibiotics and had healed satisfactorily by the time the blood samples were taken. The fecal examinations for evidence of internal parasites were negative.

The outdoor holding pens proved adequate for maintaining the otters. They all readily adapted to their cages and new environment and increased in body weight during the acclimation period. The animals were determined to be clinically healthy, except for the presence of microfilaria, identified as *Dirofilaria lutra*, which were detected in blood samples of all the animals. According to Orihel (1965), *Dirofilaria lutra* is a common parasite of otter from the southeastern United States. No treatment was presecribed for the parasites.

The blood values presented in tables 2-5 are intended to provide baseline data for recognition of abnormal blood chemistry and hematology. Wide ranges were observed for some values which may be normal or could be indicative of disease not detected during the acclimation period. The effects of captivity and administration of vaccines or anesthetics on these values were not determined nor was the influence of age or season (hemoconcentration) on these blood parameters addressed.

The hematologic values determined for the otter in this study were generally within the ranges reported for this species by Kane (1979) and Hoover et al. (1984, 1985), except for the greater number of RBCs and eosinophils noted in our animals. The eosinophilia may have been related to the presence of *Dirofilaria lutra* in the subcutaneous and muscle facia and the microfilaria in all otters. Other than the higher albumin and ALT concentrations determined for the otter in this study, the serum chemistry values were comparable to those reported by Hoover et al. (1984, 1985). No values for serum amino acids, alpha, beta and gamma globulins, or T_3 and T_4 for the northern river otter were found in the literature.

Table 2. Hematologic values for male northern river otter[a]

Parameter[b]	Mean ± S.E	Range
WBC count (x 10^3 cells/μl)	11.94 ± 1.49	7.11 - 18.33
RBC count (x 10^6 cells/μl)	10.43 ± 0.21	9.36 - 11.82
HGB (g/dl)	14.82 ± 0.37	12.61 - 16.81
HCT (%)	46.43 ± 1.18	40.70 - 53.80
MCV (fl)	44.87 ± 0.49	42.90 - 47.60
MCHC (pg)	14.21 ± 0.19	13.54 - 15.04
Spun PCV (%)	47.92 ± 1.23	39.02 - 55.03
Plasma TS (g/dl)	8.49 ± 0.17	7.70 - 10.04
Leukocyte differential cell count		
Segmented neutrophils (x 10^3 cells/μl)	8.18 ± 0.89	4.46 - 15.37
(%)	70.77 ± 4.19	44.03 - 86.00
Non-segmented neutrophils (x 10^3 cells/μl)	1.00[c]	---
(%)	1.00	---
Lymphocytes (x 10^3 cells/μl)	1.76 ± 0.31	0.78 - 3.70
(%)	14.91 ± 1.96	5.00 - 26.00
Monocytes (x 10^3 cells/μl)	0.27 ± 0.52	0.00 - 0.58
(%)	2.42 ± 0.50	0.00 - 5.00
Eosinophils (x 10^3 cells/μl)	1.72 ± 0.47	0.17 - 4.50
(%)	12.42 ± 2.96	2.00 - 29.00
Basophils (x 10^3 cells/μl)	---	---
(%)	---	---

[a] n = 12
[b] See text for explanation of abbreviations.
[c] n = 1

Table 3. Serum chemistry values for northern river otter[a]

Parameter[b]	Unit	Mean ± S.E.	Range
Total protein	g/dl	7.93 ± 0.18	6.90 - 9.20
Albumin	g/dl	4.02 ± 0.07	3.70 - 4.40
Globulin	g/dl	3.93 ± 0.13	3.00 - 4.80
Albumin/globulin	Ratio	1.04 ± 0.03	0.86 - 1.29
Calcium	mg/dl	9.48 ± 0.26	8.30 - 11.00
Chloride	mEq/l	115.92 ± 0.94	112.00 - 122.00
Phosphorus	mg/l	6.59 ± 1.38	5.30 - 9.70
Potassium	mEq/l	4.73 ± 0.09	4.30 - 5.40
Magnesium	mEq/l	2.27 ± 0.22	2.05 - 2.91
Sodium	mEq/l	156.83 ± 1.33	151.00 - 168.00
Iron	μg/l	127.92 ± 40.54	78.00 - 212.00
Glucose	mg/dl	91.83 ± 10.31	68.00 - 202.00
Anion gap	nmol/l	23.50 ± 1.19	20.00 - 32.00
Total CO_2	mEq/l	22.45 ± 0.55	17.50 - 25.10
BUN	mg/dl	43.67 ± 12.19	29.00 - 76.00
Creatinine	mg/dl	0.43 ± 0.03	0.30 - 0.60
Alk phos	U/l	63.08 ± 8.74	29.00 - 118.00
ALT	IU/l	167.17 ± 11.20	112.00 - 222.00
Amylase	U/l	11.00[c]	---
AST	IU/l	125.75 ± 11.07	77.00 - 199.00
CK	IU/l	794.42 ± 111.73	337.00 - 1722.00
GGTP	U/l	23.08 ± 2.87	12.00 - 42.00
Total bilirubin	mg/dl	0.20[c]	---
Cholesterol	mg/dl	185.17 ± 18.40	113.00 - 314.00
Sorbitol dehydrogenase (calc)	U/l	10.63 ± 4.68	5.20 - 23.70
Osmolality	mos/kg	334.58 ± 10.91	320.00 - 357.00
Triglycerides	mg/dl	80.00 ± 58.92	20.00 - 200.00
T_3	nmol/l	0.76 ± 0.07	0.47 - 1.31
T_4	nmol/l	18.50 ± 2.35	7.00 - 33.00

[a] n = 12
[b] See text for explanations of abbreviations.
[c] n = 1

Table 4. Serum electrophoresis values for northern river otter[a]

Parameter	Mean ± S.E.[b]	Range
Albumin (gm/dl)	3.36 ± 0.07	3.00 - 3.70
(%)	(42.50 ± 1.31)	
Amino acids (gm/dl)	0.20 ± 0.02	0.10 - 0.30
(%)	(2.53 ± 0.21)	
Alpha 1 globulins (gm/dl)	0.48 ± 0.04	0.40 - 0.80
(%)	(5.89 ± 0.39)	
Alpha 2 globulins (gm/dl)	0.46 ± 0.05	0.20 - 0.80
(%)	(5.86 ± 0.50)	
Beta globulins (gm/dl)	1.16 ± 0.06	0.90 - 1.60
(%)	(14.66 ± 0.71)	
Gamma globulins (gm/dl)	2.28 ± 0.11	1.60 - 2.70
(%)	(28.58 ± 0.92)	
Total protein (gm/dl)	7.94 ± 0.17	6.90 - 9.20
Albumin/globulin (%)	(0.75 ± 0.04)	0.57 - 0.96

[a] n = 12
[b] Numbers in parentheses refer to % of total protein.

Table 5. Element concentrations in serum from northern river otter[a]

Element	Mean concentration ± S.E. (μg/g)
Al	ND[b] (1.00)
B	ND (1.00)
Ba	ND (0.10)
Ca	90.34 ± 1.51
Cu	1.05 ± 0.08
Fe	2.13 ± 0.26
Mg	23.33 ± 0.78
Mn	ND (0.05)
Mo	ND (0.20)
Na	3409.17 ± 16.16
P	205.08 ± 13.88
Zn	0.69 ± 0.03

[a] n = 12
[b] ND = not detected at detection limits shown in parentheses.

Acknowledgements

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and the Veterinary Clinical Pathology Lab for analyzing samples.

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"We're going to name the drug after you, Haskins. We'd like you to change your name to miracle."

Original Report

The open field test: Fact or fiction?

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Introduction

Recent studies carried out on farmbred foxes and experiments in enclosure conditions have supported the theory that foxes often form social hierarchies when raised in groups (*Bakken, 1989; Macdonald, 1988; Wakely and Mallory, 1988; Korhonen and Alasuutari, 1992a*).

One method that has been employed to estimate the social status of farmed foxes is the "open field" test. This test records the locomotor activity of the animal after it has been placed into a test field. The test assumes that shy and submissive individuals (lower status) are often less active in the field than curious and more dominant (higher status) individuals. However, it is questionable to what extent the open field test reflects the true behavioural activity and social status of individual animals.

The present authors closely followed the hierarchical development of a blue fox group that was continuously housed in a seminatural enclosure for a 9-month period. Thus, our firm knowledge of the social rank order of the group enabled us to compare this order with that obtained from the open field test.

Materials and methods

The present subjects consisted of four male and female blue foxes housed in a 224 m^2 ground floor enclosure. The animals were born in mid-May and monitoring of their hierarchical structure began in mid-August (for details see Korhonen and Alasuutari, 1992b).

All agonistic behaviours of the group were pooled for the determination of dominance ranks. The dominance values were calculated as the arcsine of the proportion of wins (*Beilharz and Zeeb, 1982*).

The open field tests were carried out during two developmental periods as follows: (1) in mid-January when the hierarchical structure of the group was fully established, but no sexual activity was evident (*c.f. Korhonen and Alasuutary, 1992 a,b*); (2) in the beginning of March when increasing sexual tensions and pronounced hierarchical relationships were apparent.

The test was performed as follows: a ground floor open field measuring 4 m long x 2 m wide was constructed of wire mesh. Its walls (height 1.5 m) were covered with a clear plastic sheeting. Before

testing, the character of each individual was estimated according to its reaction to humans (1=shy, 2=normal, 3=curious). The animals were released into the test field through a conventional wooden nest box connected to the test field. The test began by placing the test animal into the nest box. After 1 minute, the door of the box was opened, allowing free access into the test field. The amount of time the animal spent inside the nest box after the door had been opened was logged. The test lasted for a total of 5 minutes. A video camera (Panasonic NV-G1) recorded the movements of the animals in the test field. The field was later divided into 9 equal sub-areas in order to calculate ambulation frequencies (locomotor activity).

The data were statistically treated by analysis of variance and by Spearman's and Pearson's correlations.

Results and conclusions

The dominance value indicates the social rank of an individual in a group: the greater the value, the higher the rank of that animal, and vice versa (*Beilharz and Zeeb, 1982*). As table 1 shows, male M-2 was the most dominant individual during both study periods, and correspondingly, female F-4 the most submissive individual. This was the case throughout the experimental period from August to May. For the detailed dominance values of each seasonal period, see Korhonen and Alasuutari (1992b).

Table 1. Body weight (kg), number of contacts at feeding time (%), dominance value, character, time in which animal left nest box (min), ambulation frequency (number of lines crossed in the field), ambulation frequency as adjusted to actual time animal spent in the field, number of visits to nest box in the test situation, circadian locomotor activity (%/24-h) in the housing enclosure, and social status according to dominace value (DV) and ambulation frequency (AF). The upper row gives the data for the first open field test period (mid-January) and the lower for the second period (beginning of March).

	M-1	M-2	M-3	M-4	F-1	F-2	F-3	F-4
Body weight	8.0	7.7	6.7	6.5	6.7	5.4	6.9	6.9
	-	7.6	5.9	6.2	6.1	5.1	6.3	6.7
Feeding contacts	14.5	25.4	9.1	13.4	10.6	12.0	9.5	5.5
	-	33.3	14.6	19.6	8.7	9.1	9.1	5.6
Dominance value	64.3	90.0	54.0	42.4	43.7	41.8	20.6	3.9
	-	90.0	56.3	67.5	30.0	22.5	26.3	18.8
Character	3	3	2	1	1	2	1	2
	-	3	2	1	1	3	3	2
Out from nest box	32	44	66	110	110	40	123	94
	-	5	115	100	50	65	50	300
Ambulation freq.	34	24	28	18	22	30	27	25
	-	43	27	37	27	54	51	0
Adjusted ambul.	7.9	10.7	8.4	10.6	8.6	8.7	6.6	8.2
	-	6.9	6.9	5.4	9.3	4.5	4.9	0
Visits to nest box	1	1	3	1	1	2	3	3
	-	1	4	1	1	0	4	0
Locom. activity	22.0	21.0	18.9	21.5	20.1	17.9	15.4	16.4
	-	39.2	34.8	42.2	38.1	33.8	31.5	33.1
DV social status	2	1	3	5	4	6	7	8
	-	1	3	2	4	6	5	7
AF social status	1	6	3	8	7	2	4	5
	-	4	5	3	5	1	2	7

The breeding season began dramatically due to quarrelling between the two most dominant males, M-2 and M-1. Finally, M-1 was so badly bitten that it died. Table 1 thus excludes the data for M-1 during the second test period.

According to the principle of the open field test, an animal's acticvity is typically measured by the number of lines it crosses in the test field (termed, "ambulation frequency" in the present paper). The animals are then classified into various social status classes according to this line crossing activity, as in the case of farmed silver foxes (*Bakken, 1989, 1990 a,b*). Table 1 shows the social status of each individual according to dominance value (DV) and ambulation frequency (AF). As can be seen, the rank orders are very different. The correlations between dominance values and ambulation frequencies were calculated also, but no statistically significant relationships ($p>0.05$) were found.

The classification can be interpreted in another way, too, by dividing the fox group into two parts as follows: the four highest in the rank are designated as high status animals (the most dominant) and the rest as low status animals (the most submissive). According to dominance value (DV), the four highest in the first and second test periods were M-1, M-2, M-3, F1 and M-2, M-3, F-1. M-4, respectively. Thus, three animals placed similarly during both periods. The results for ambulation frequency (AF) were: M-1, M-3, F-2, F-3 and M-2, M-4, F2 and F-4, respectively. Here, two placed the same during both periods.

A comparison of the DV and AF results indicates that two individuals placed similarly in both classifications. Therefore, it is obvious that these two estimations of status yield different status classifications.

Table 1 additionally gives the locomotor activities for our foxes based on the precise circadian behavioural data recorded under enclosure conditions (*Korhonen and Alasuutari, 1992b*). A comparison with the ambulation frequencies obtained from the open field test reveals that there was no significant dependence ($p>0.05$) between these two activity parameters. During the breeding season (2nd period) the locomotor activity of the animals in the enclosure significantly ($p>0.05$) increased. Although there was a tendency, open field activity was not significantly different between the two study periods.

In summary, it is tempting to conclude that the open field test employed in the present study is not necessarily valid for the estimation of the actual activity and social status of an animal. However, no final conclusions should be drawn yet on the testing systems of other researchers. Instead, further studies are needed in order to clarify the validity of such tests more precisely.

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Original Report

Defecation Patterns in the Cage and in Various Types of Whole-year Shelters in Farmed Silver Foxes and Blue Foxes

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Abstract

In this study, the distribution of faeces in 4 different whole-year shelters and in the cage were examined among 50 silver fox and 45 blue fox vixens from November 1987 to March 1989. The vixens had free access to a top box, a side box, an open box, and a shelf in the left hand section of their double fox cage. The vixens were fed in the right hand section of the cage the first year of the study and then in the left hand section, until the end of the study. In order to estimate the site of defecation in the cage, a plate divided in 8 squares was mounted beneath each cage. Faeces from all shelters were collected and weighed every second week and at the same time, the distribution of faeces beneath the cage was estimated in percent.

The results showed that both species deposited most faeces in the square beneath the first feeding site in the right hand section of the cage. This feeding site was situated farthest away from the entrances to the shelters. Both species also used the open box as a defecation site, but it decreased during the study, both in number of vixens defecating and in amount of faeces left in the box. Only small amounts of faeces were found in the shelters preferably used for resting and sleeping. Blue foxes defecated more in the shelters compared to silver foxes, both in numbers of vixens defecating and in amount of faeces deposited. During another experiment, concerning effects of marking objects, carried out from November 1989 to April 1990, it was revealed that removal of the open box did not cause the foxes to increase defecation in the other shelters. This indicated that it was more the placing of the open box than the existence of a solid floor, that caused a higher degree of defecation in this box. Different marking objects had little influence on the observed defecation patterns in the cage.

In comparison with known defecation patterns of wild foxes, farmed foxes showed similar patterns by defecating near territory boundaries and close to the feeding site. It was suggested that a stable environment could be a major factor in keeping the foxes from defecating on and in whole-year shelters.

Introduction

Studies of scent-marking of canids have dealt with urine marking and faecal deposition. Urine, faeces and chemical substances from odorous glands are used as signals to conspecifics, other species and the animal itself (*Eisenberg and Kleiman, 1972; Gorman and Trowbridge, 1989; Macdonald et al, 1985; Ralls, 1971*), and canids have been reported to deposit their urine and faeces at sites and in patterns of communicative significance (*Johnson, 1973; Macdonald, 1985*). Deitz (1981) studied the defecation patterns of maned wolves and found an accumulation of faeces in the vicinity of resting sites and on conspicious objects along main trails. Trap (1978) found that grey foxes defecated at good feeding sites, but he also observed marking of inedible food items with faeces. Red and arctic foxes have been observed to leave their faeces on visually conspicious objects along their trails. An accumulation of faeces is seldom found and, if so, only around large carcasses (*Hersteinson and Macdonald, 1982; Macdonald, 1979; Macdonald, 1985*). The conclusion from several of these studies has been that faeces and urine are used as scent-signals for making an area familiar to the inhabitor and for warning conspecifics about occupied territory and it may contain information about the age, sex and social status of the animal (*Gorman and Trowbridge, 1989; Johnson, 1973*).

Farmed foxes live in a territory of limited size adjoined neighbouring foxes. Often the feed and water are placed at fixed sites year round. Most foxes are kept in barren cages; some have a shelf or a shelter mounted at a fixed place in the cage. During routine management practices, the foxes are usually moved to several different cages during the course of the year. In Denmark, it usually occurs when the vixen is mated, when she is brought to her breeding cage, when her cubs are weaned, and if she is selected for another year of breeding. If defecation of farmed foxes follows the same patterns as those found for wild foxes, one would expect the vixens to defecate close to neighbouring foxes, close to positions in the cage where the caretakers or observer would frequently pass, and close to the feeding site. If the deposition of faeces is used to familarize the foxes to their surroundings, one would expect that the amount of faeces left in or on shelters would be high when the shelters are new, because of novelty, but then it would diminish because of the obtained familiar odour.

The defecation patterns of farmed foxes, kept in a stable environment, was studied from autumn 1987 to March 1989. The aim of the study was to examine the deposition of faeces in the cage and different shelters among farmed silver fox and blue fox vixens and to examine the influence of different parameters on the choice of defecation site. The results of the study were considered important for the decisions concerning provision of whole-year shelters to foxes on farms, since the main argument for not providing the foxes with whole-year shelters is that the foxes will defecate in them and dirty their pelt. The results were also considered useful for the possibility of controlling the choice of defecation site in order to develop methods to faciliate the farm cleaning procedures.

Method/materials

Subjects and housing

Fifty silver fox vixens and 45 blue fox vixens born in the spring of 1986 and 1987 were distributed in the middle row of two four-row fox houses, so that each species occupied 1 fox house and each individual was kept in a double fox cage which measured 1.95 m x 1.20 m x 0.95 m. Each individual was provided with three different types of wooden nest boxes and a wooden shelf, all mounted in the left-hand section of the cage (Photo 1, Fig. 1). A detailed description of the nest boxes can be found in Pedersen and Jeppesen (1992). A plate divided in 8 equally sized squares was mounted under each cage (Fig. 1). The open box was placed above square no. 1 of the plate, so it was not possible for the fox to defecate above square no. 1 when the box was in the cage. The foxes were fed once a day by machine. For silver foxes, feed was placed in the right-hand, empty section of the cage from November 1987 to September 1988, and then they were fed in the left-hand section (with shelters) until the end of the study. For blue foxes, the feed was placed in the right-hand, empty section of the cage from November 1987 to November 1988 and then the feed was placed in the left-hand section (with shelters) until the end of the registrations. Water was available ad libitum in both sections of the cage.

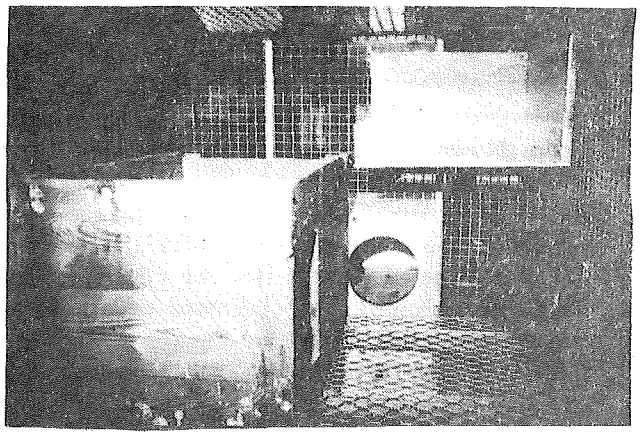
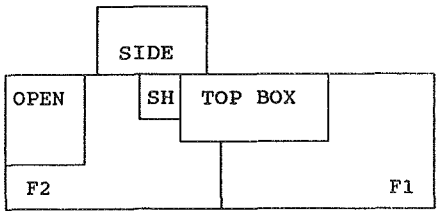
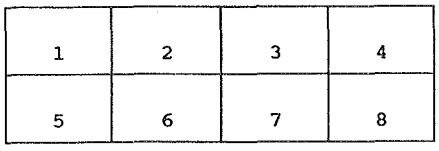


Photo 1. Illustration of the left-hand section of the cage equiped with shelters. The silver fox vixen is coming from the right-hand, empty section of the cage.

View of cage from above:



The plate beneath the cage viewed from above:



View of cage from the front:

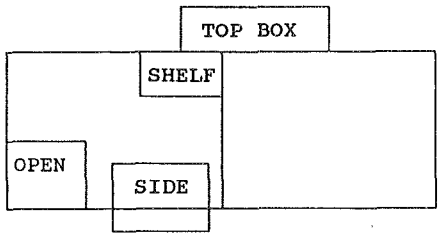


Fig. 1. Plans of the cage with boxes, shelf and feeding sites seen from above (top drawing) and from the front (bottom drawing). The plate beneath the cage (middle drawing) is divided in 8 equally sized squares numbered from the hind most left to the foremost right corner.

Observations

The defecation pattern of the silver fox vixens was registered from November 1987 until medio January 1988 (observation period 2 to 5), and from August 1988 to February 1989 (observation period 10 to 22). The registration of blue foxes took place from November 1987 to Februar 1988 (observation period 2-9) and then again from September 1988 until March 1989 (observation period 10-22). The registrations paused during the mating and whelping season in observation period 5-10 for silver foxes and observation period 9 and 10 for blue foxes. The 1st registration took place 14 days after the vixens were allowed access to the shelters. Faeces in the 4 types of shelters were collected and weighed every second week, and on the same day the distribution of faeces beneath the cage was estimated in per cent. For blue foxes one registration (observation period 7) was not accomplished.

In autumn 1989, a marking experiment was performed which included the removal of the open box and the insertion of additional objects to mark/defecate on. Two x 14 days after the removal of the open box a wooden plate was placed above square no. 1, the former site of the open box. The wooden plate was replaced by a ball after 2 x 14 days, and this ball was moved to square no. 4 after 4 x 14 days. Here the ball stayed the last 4 x 14 days of the experiment. Faeces on the plate were weighed and faeces in the square beneath the ball were estimated in per cent of total amount in all 8 squares every second week. Faeces in all the shelters were collected and weighed at the same time.

Statistics:

All observations were registrered in a SAS dataset and analysed by appropiate parametric or non-parametric statistics from the Statistical Analysis System version 6 (SAS Institute Inc. 1987).

Results

Silver foxes:

The number of silver foxes defecating in the 4 types of whole-year shelters is illustrated in Fig.

2 (top). A high number of silver foxes defecated in the open box during the 22 periods, but a significant decrease took place in the last 2.5 months of the study ($p < 0.0001$, χ^2 test). The number of animals defecating in the side box, in the top box, and on the shelf was below 10 during all the periods of registrations and less animals were defecating in these 3 shelters at the end of the study compared with the beginning ($p < 0.011$, side box, $p < 0.042$, top box, $p < 0.008$, shelf, χ^2 test).

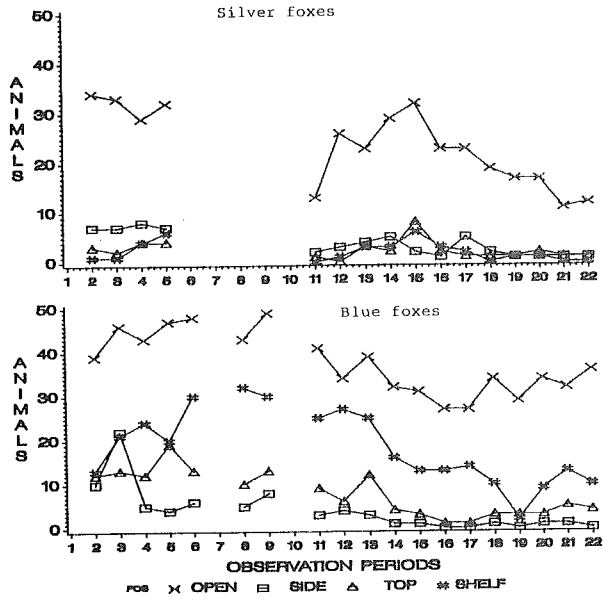


Fig. 2. Number of silver fox vixens (TOP) defecating in the 4 shelters during the 22 periods of observation. Number of blue fox vixens defecating in the 4 different shelters are illustrated at the bottom. See text for further details.

The highest amount of faeces was found in the open box for all periods (Fig. 3, top). In the beginning of the study, the amount of faeces left in the open box increased (observation period 1-5). After weaning, a smaller amount was left in the open box but it increased during the autumn and then decreased during the last 2 months of study ($p < 0.0001$, Kruskal Wallis-test). Between 0 and 5 grams of faeces per individual per 14 days were found in the other types of shelters and was a maximum in the beginning of the study ($p < 0.0138$, side box, $p < 0.0573$, top box, $p < 0.0101$, shelf, Kruskal Wallis-test).

From November 1987 to September 1988, feed was placed in the right side of the cage above square no. 8 and in this square the highest amount of faeces was found (Fig 4, top). The silver foxes defecated the least in square no. 2. From November 1988, feed was placed in the left side of the cage above square no. 5 (Fig 4, bottom). A significant increase of faeces was observed in this square, ($p < 0.0001$, Wilcoxon/-Mann-whitney U-test) after the change of feeding site. A significant increase of amount of faeces was also found in square no. 6 ($p < 0.0001$, Wilcoxon/Mann Whitney U-test) whereas significant decreases were observed in square no. 4, 7 and 8, ($p < 0.0561$, $p < 0.0002$, $p < 0.0003$, respectively, Wilcoxon/Mann Whitney U-test). Even though a decrease of faeces was seen in square no. 8 after changing the feeding site, this square still contained the highest amount of faeces.

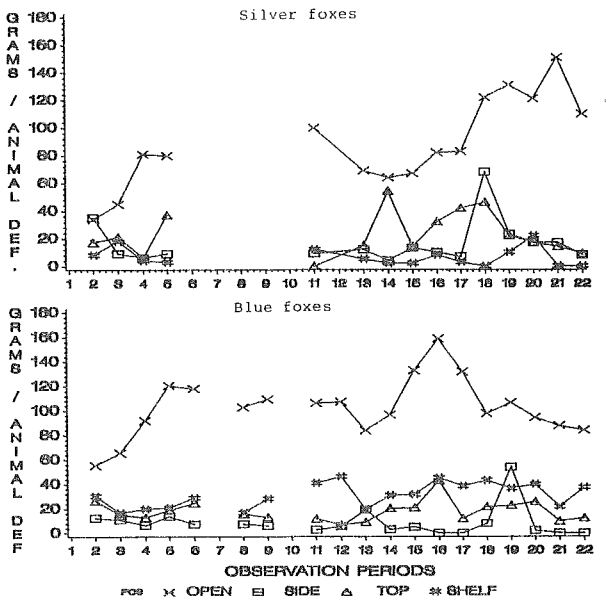


Fig. 3. Amount of faeces depositied in the 4 different shelters for 50 silver foxes (TOP) and 45 blue foxes (BOTTOM) during the 22 periods of observation.

In Fig. 5 (top) the distribution of faeces in 4 of the 8 different squares is illustrated for the 22 periods of registrations. Curves for squares with no or the least significant changes were deleted from the graph for a better survey. During the first 4 observation periods, the amount of faeces in square no. 5, 6 and 8 increased, whereas it decreased in square no. 4. Change of feeding site from above square no. 8 to above square no. 5

took place in observation period 11. After this change the amount of faeces in square nos. 8 + 4 decreased, whereas it increased in square nos. 5 + 6. The differences described above were significant ($0.0001 < p < 0.0342$, Kruskal Wallis t-test).

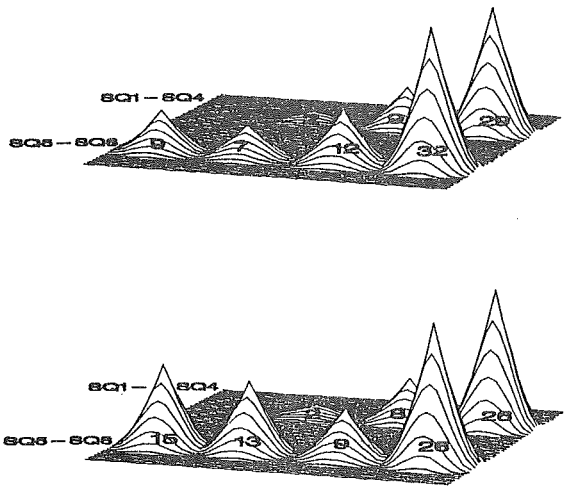


Fig. 4. Amount of faeces in percent deposited by 50 silver fox vixens beneath the cage when feed was placed in the right-hand section of the cage (SQ8, top-drawing) and when feed was placed in the left-hand section (SQ5, bottom-drawing) of the cage.

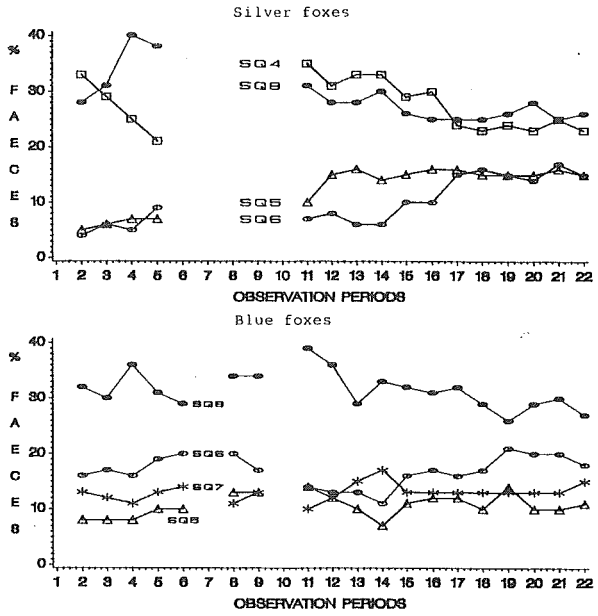


Fig. 5. Distribution of faeces deposited beneath the cage in percent for 50 silver fox vixens (TOP) and 45 blue fox vixens (BOTTOM) during the 22 periods of observations. Square numbers 4, 5, 6 and 8 for silver foxes, and square numbers 5, 6, 7, and 8 for blue foxes. See text for further details.

Table 1. The mean distribution of faeces deposited in 14 days in 4 types of shelters and on the wire-mesh. Means in grams and percentage for 50 silver fox vixens and 45 blue fox vixens, January 1989. Differences in means between species are tested with Wilcoxon / Mann-Whitney U-test.

	SILVER FOXES		BLUE FOXES		
SITE	GRAMS	PERCENT	GRAMS	PERCENT	P <
OPEN BOX	26.42	3.40	71.48	6.93	0.0001
SIDE BOX	0.16	0.02	1.20	0.12	0.3042
TOP BOX	0.18	0.02	1.71	0.17	0.2518
SHELF	0.00	0.00	7.96	0.77	0.0010
TOTAL IN NEST BOX	26.76	3.44	82.35	7.99	
TOTAL ON WIRE-MESH	750.69	96.56	948.80	92.01	
TOTAL IN CAGE	777.45	100.00	1031.15	100.00	0.0001

In January 1989, the silver foxes left a total of 777.45 g faeces in the cage and shelters for a period of 14 days (Table 1). Of this total amount of faeces 0 to 3.4 % was found in the shelters, with the highest amount deposited in the open box. The highest amounts of faeces left on the wire-mesh were observed in square no. 8 (198.50 g.) and no. 4 (174.78 g.).

In the marking experiment the removal of the open box did not cause any significant changes in amount of faeces in the other shelters during the 6.5 months of study ($0.58 > p > 0.10$, GLM, Table 2). A significant increase in amount of faeces was observed in square no. 1 and 2 during the experiment, and in nos. 6, when the plate and ball was positioned above square no. 1 ($p < 0.001$, GLM). The foxes defecated less on the wooden plate compared to defecation in the open box (means for open box was 21.4 grams, and for the plate 15.8 grams, $p < 0.0035$, GLM).

Table 2. Mean distribution of gram faeces in the open box/on the plate above square no. 1. For square no. 1 the total amount deposited on the wire-mesh is calculated from table 1. Mean distribution of faeces in percent in square nos. 1 to 8 for 50 silver fox vixens from Nov. 89 to Apr. 1990 with different marking objects in the cage. Statistical analysis performed with, GLM, sig = $p < 0.001$, ns = $p > 0.05$).

		POSITION								
SET-UP	BOX/ PLATE (g)	SQ 1 (g) CALC	SQ 1 %	SQ 2 %	SQ 3 %	SQ 4 %	SQ 5 %	SQ 6 %	SQ 7 %	SQ 8 %
NORMAL REGISTRATION	21.4	--	--	1.4	8.3	24.3	17.7	12.4	6.7	29.2
OPEN BOX REMOVED (2*14 DAYS)	--	53.3	7.1	2.7	7.9	21.2	22.3	7.8	7.2	23.9
WOODEN PLATE (2*14 DAYS)	15.8	--	--	4.8	8.2	20.4	18.7	12.6	8.3	27.1
FLOATER IN 1 (4*14 DAYS)	--	29.3	3.9	4.3	6.5	18.4	23.5	12.1	7.4	24.0
FLOATER IN 4 (4*14 DAYS)	--	75.8	10.1	4.3	9.4	17.6	20.2	6.9	7.4	23.9
Statistics:	sig	sig	sig	sig	ns	ns	ns	sig	ns	ns

Blue foxes:

Most of the blue foxes defecated in the open box (Fig. 2, bottom), and an increase in numbers of vixens defecating in this box was found during the first observation periods. After the start of observations in September 1988 (observation period 11) the numbers of vixens defecating in the open box fluctutated and then decreased, but started to increase again during the last 4 observation periods. Changes observed were significant ($p < 0.0001$, χ^2 test). A high number of blue foxes was defecating on the shelf as well, following the pattern observed for the open box ($p < 0.0001$, χ^2 test). For the side box, an increase in number of vixens defecating was observed from the first to the second observation period, but then it decreased and in the end of the study the number had fallen to between 0 to 2 individuals ($p < 0.0001$, χ^2 test). More individuals were defecating in the top box in period 2 to 9 (with a maximum of 19 animals in

observation period 5) compared to the rest of the periods ($p < 0.0001$, χ^2 test).

The highest amount of faeces was found in the open box and it increased from the 1st to the 5th observation (Fig. 3, bottom). From here it fluctuated until it started to increase again in observation periods 14 to 16. Then it decreased until observation period 18. From observation period 19 and to the end of the study the amount of faeces in the open box slowly went down ($p < 0.0011$, Kruskal Wallis-test). From observation periods 2 to 9 the amount of faeces found on the shelf fluctuated. In observation period 12 the highest amount on the shelf was found. The amount of faeces left on the shelf went down in observation period 13 and increased to observation period 16. From here it fluctuated around 40 grams except for period 21 where it went down to 25 grams. Changes observed for the amount of faeces left on the shelf were significant ($p < 0.0001$, Kruskal Wallis-test). Only a small amount of faeces was found in the side and top box with some fluctuations during the 22 periods of observation. The highest amount of faeces was found in the side box in observation period 19 and in the top box in observation period 16. Changes observed were significant ($p < 0.0001$, both shelters, Kruskal Wallis-test).

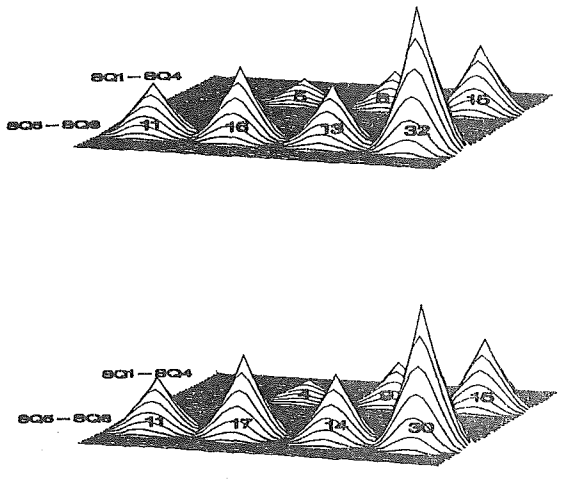


Fig. 6. Amount of faeces in percent deposited by 45 blue fox vixens beneath the cage when feed was placed in the right-hand section of the cage (SQ8, top-drawing) and when feed was placed in the left-hand section of the cage (SQ5, bottom-drawing).

When the feeding site was changed from the right-hand section to the left-hand section of the cage (Fig. 6) a small but significant increase in defecation was observed in square nos. 3 and 7 ($p < 0.0181$ and $p < 0.0018$, respectively, Wilcoxon/Mann Whitney U-test) and a small but significant decrease of defecation was observed in square nos. 2 and 8 ($p < 0.0001$ and $p < 0.0099$, respectively, Wilcoxon/Mann Whitney U-test). The highest amount of faeces was found in square no. 8, both before and after the change of feeding site, and the least amount of faeces was found in square no. 2.

Distribution of faeces in percent in 4 of the 8 different squares during the 22 observation periods is shown in Fig. 5 (bottom). Squares with the least significant changes or no significant changes were deleted. Fluctuations observed in square no. 8 were found significant ($p < 0.0003$, Kruskal Wallis test). In square no. 6 significant changes were found in the amount of faeces during the 22 periods with the least amount in observation period 14 and the highest in observation period 19. For square no. 5 significant differences were observed with the least amount of faeces in observation period 14 and the highest in observation periods 11 and 19. For square no. 7 the amount of faeces was at maximum in observation period 14 and then it stabilized at 13 percent, until the last observation period, when it increased to 15 percent ($p < 0.0012$, Kruskal Wallis t-test).

In January 1989, the blue fox vixens left a total of 1031.15 grams of faeces in the cage and shelters for a period of 14 days (Table 1). Of this total amount of faeces 0 to 6.93 % was found in the shelters, with the highest amount found in the open box. The highest amount of faeces left on the wire-mesh was left above square no. 8 (276.40 g.) and no. 6 (186.10 g.).

In the marking experiment (Table 3) the removal of the open box did not cause any significant changes in the amount of faeces deposited in the top box or side box during the experiment, but a significant decrease was found for the shelf ($p < 0.0001$, GLM). The foxes defecated less on the wooden plate compared to defecation in the open box (means for open box was 90.1 grams, and for the plate 67.9 grams, $p < 0.0001$, GLM).

Table 3. Mean distribution of gram faeces in the open box/on the plate above square no. 1. For square no. 1 the total amount deposited in the wire-mesh is calculated from table 1. Mean distribution of faeces in per cent in squares nos. 1 to 8 for 45 blue fox vixens from Nov. 89 to Apr. 1990 with different marking objects in the cage. Statistical analysis performed with GLM, (sig = 0.0369 > p > 0.0001, ns = p > 0.050).

		POSITION								
SET-UP	BOX/ PLATE (g)	SQ 1 (g) CALC	SQ 1 %	SQ 2 %	SQ 3 %	SQ 4 %	SQ 5 %	SQ 6 %	SQ 7 %	SQ 8 %
NORMAL REG.	90.1	--	--	4.0	7.5	13.7	15.9	18.2	12.4	28.2
OPEN BOX REMOVED (2*14 DAYS)	--	121.4	12.8	3.9	4.1	10.0	25.3	11.4	8.8	23.6
WOODEN PLATE (2*14 DAYS)	67.9	--	--	9.4	5.1	11.3	23.0	20.7	8.9	21.7
FLOATER IN 1 (4*14 DAYS)	--	37.0	7.5	6.9	5.5	11.9	21.7	13.7	9.7	23.1
FLOATER IN 4 (4*14 DAYS)	--	95.8	12.9	6.6	7.0	11.3	17.8	9.9	10.6	24.1
Statistics:	sig	sig	sig	sig	sig	ns	sig	sig	sig	ns

Significantly less faeces were observed in square no. 1 when the ball was placed above it ($p < 0.0001$, GLM). A significant increase in the amount of faeces was found in square no. 2, when the plate was placed above square 1 ($p < 0.0001$, GLM) and in square no. 3, when the ball was placed above square no. 4 ($p < 0.0001$, GLM). A significant decrease was found in square 5 and 6, when the ball was placed above square no. 4 ($p < 0.0001$, GLM). Less faeces were deposited above square no. 7 when the ball was placed above square 1 ($p < 0.0369$, GLM). Above squares 4 and 8 no changes in deposition of faeces occured.

Comparison of species

Blue fox vixens deposited a higher amount of faeces in the open box compared to silver foxes ($p < 0.0001$, GLM) during the 22 periods of observations. An analysis of variance revealed that blue foxes also defecated more in the top box compared to silver foxes ($p < 0.0026$, GLM,) and that it was caused by a higher degree of defecation in the beginning of the study ($p < 0.0013$, GLM). Blue foxes differed from silver foxes both with respect to the total amount of faeces left on the shelf ($p < 0.0001$, GLM, blue foxes a higher amount) and the amount left on the shelf each period ($p < 0.0003$, GLM).
In square nos. 2, 6, 7 and 8 blue foxes left more faeces than silver foxes ($0.0138 > p > 0.0001$, GLM), whereas silver foxes deposited more faeces above square nos. 4 and 5 compared to blue foxes ($p < 0.0001$, $p < 0.0002$, GLM, respectively).

Discussion

In the present study both silver foxes and blue foxes preferentially defecated close to the first feeding site, which also was close to the feed

gangway and close to a neighbouring fox. The feeding site did not seem to be the one and only parameter to affect the choice of defecation site, since the changing of the feeding site did not cause the foxes to defecate most at the new site, although a significant increase was revealed. However, the foxes may have needed more time to become accustomed to the shift than 3-4 months, as examined in this study. At the end of the study, it was still at the first feeding site that the highest amount of faeces was found for both species.

The high amount of faeces at the first feeding site could be due to its position farthest away from the entrances to the shelters. The literature on faecal depositions of wild canids describes that faeces are left close to, on and in the entrances of dens (*Frafjord, 1986; Egosque, 1962*). Thus, the behaviour of wild canids does not reveal any trend to keep defecation away from their den entrances. On the contrary, observations of the kit fox (*Egoscue, 1962*) revealed that scats of faeces close to the den entrance made it possible for the researchers to conclude if the den was inhabited or not. Frafjord (1986) observed arctic foxes leaving faeces on top of their dens and just inside the den entrance. A study of marking behaviour of captive african dwarf mongooses revealed that entrances and exits of nestboxes were marked several times a day (*Rasa, 1973*). In this and other studies it is mentioned that a high degree of marking or an accumulation of faeces is found close to preferred daytime resting places (*Deitz, 1981; Rasa, 1973*).

The positions of square nos. 4 and 8 in the right-hand section of the cage were adjoining a neighbouring fox, but this was also true for square nos. 1 (with the open box) and 5 in the left hand section of the cage. The fact that the caretaker during feeding, and the observer, in the parallel study of use of whole-year shelters (*Pedersen and Jeppesen, 1992*), always would approach the cage from the right side may explain the preference for defecating at these sites. Most studies of foxes in the wild revealed that faeces would be most abundant in the vicinity of territorial borders and at the main trails (*Johnson, 1973; MacDonald, 1979, 1985*). If the vixens are using their faeces to signal about their territory borders one should expect an accumulation of faeces at sites frequently encountered by conspecifics or other species.

The fluctuations in degree of defecation observed in the 8 different squares during the 1.5 year study could be an effect of the hormonal cycle of the foxes, so that different seasons of the year cause different patterns of defecation due to different functions of the scent marking. It cannot be confirmed in the present study without a control group with no changes of their cage environment or farm routines. With this control group it would have been more evident if the change of feeding site in itself caused the changes in the defecation pattern.

Both silver foxes and blue foxes defecated most in the open box. The marking experiment revealed that defecation on the site of the open box (when the open box was removed) took place to the same degree as defecation in the open box, and defecation on the plate, which replaced the open box, was lower than in the open box. This indicates that the solid floor may not have been the "attractive" part of the open box. This hypothesis is supported by the results showing that defecation in the other types of shelters did not increase with the removal of the open box. Thus, the position of the open box seemed to be more important for defecation to occur than the existence of a solid floor. The foxes kept the other types of shelters almost clean from faeces during the experiment. In a study of the ecology of the kit fox (*Egoques, 1962*) the author stated that the defecation patterns of this species were different from other canid species because of its habit of living in dens all year round. The kit fox used one or more tunnels of the den as a day-time latrine, but kept the rest of the den clean. It has not been possible to find literature concerning depositions of faeces inside dens of red or artic foxes. The farmed foxes in the present study may have perceived the shelter and cage system as one big den, and they chose the open box as a latrine. Farmed raccoon dogs, which use latrines, have been observed to defecate inside their nest boxes (*Korhonen et al., 1991*).

In the beginning of the study, the defecation in all shelters was higher than in the end of the study. Maybe the novel shelters represented an expansion of the foxes' territory and this new territory was marked in order to achieve a familiar scent. Since no other foxes or intruders visited the shelters the need for constantly marking decreased. Wild foxes would defecate on novel

objects and in novel surroundings (*Johnson, 1973*) and in the wild the need of marking the territory is more or less continuous because of visiting foxes and overlap of hunting grounds (Johnson, 1973). If this hypothesis holds true for farmed foxes one should expect that a stable environment is important for keeping the whole-year shelters clean and dry, but it needs further examination.

Conclusion

The results of the present study indicate that several factors influence the defecation patterns of farmed foxes. In comparison with known defecation patterns of wild foxes, farmed foxes showed the same patterns by defecating near territory boundaries, close to the feeding site and sites frequently encountered by other species (man). These factors should be considered in any attempt to control the site of defecation, for instance for the purpose of easy farm cleaning. It was suggested that a stable environment could be a major factor in keeping the foxes from defecating on and in whole-year shelters.

Acknowledgements

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Original Report

Some peculiarities in reproduction in silver fox males under domestication

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Summary

The role of social contacts in the regulation of endocrine testicular function induced by the presence of females has been studied in silver fox males respectively selected and not selected for domestic behaviour. The presence of anoestral females for an hour did not affect plasma testosterone levels at the period of sexual inactivity but, in the reproductive season, the presence of receptive females increased testosterone plasma levels only in domesticated males, though their background testosterone level in this period was lower than in undomesticated foxes. In social contacts within male-female pairs, the domesticated males show higher aggressiveness towards nonreceptive females and less sexual activity with receptive females in comparison with undomesticated males. It is assumed that domestication can change social interactions between opposite sexes through its influence on the testicular hormone function.

Introduction

It was shown in the previous communication that selection of silver foxes for lack of aggression towards humans (domestic behaviour), was accompanied by genetic changes in some variables of the hormonal control of reproduction (*Osadchuk, 1992*). It appears that selection for behavioural characteristics can change the sensitivity of the endocrine systems to social stimuli. Among various kinds of social interactions, sexual behaviour is important since it has a significant effect on reproduction, depriving a part of the population of the chance of reproduction. In the present paper, we attempt to evaluate the role played by social contacts between males and females in the regulation of endocrine testicular function.

Materials and methods

The animals used were sexually mature male silver foxes (*Vulpes fulvus Desm.*), raised on the experimental animal farm of the Institute of Cytology & Genetics, Siberian Branch of the Academy of Sciences of Russia. The silver foxes employed in this study comprised 6 undomesticated males and 19 domesticated ones. Silver foxes have seasonal reproduction, the mating lasting from mid-January to mid-March in this country. As a rule, the males are active throughout the season, and a female in oestrus is introduced to the male's cage for 2-3 hr. in the morning. It was observed that pairing is accompanied by aggressive interactions, which most cha-

racteristic expression is where the male and female, 30-40 cm apart, lower their heads to the floor of the cage and growl at each other. This is called by us "conflict posture". Another sign of aggression may be the posture known in rats and mice as "boxing" - reminiscent of a boxer in the ring - in which the animals stand on their hind paws while grappling with their front paws and baring their teeth. Besides the ritual expressions of aggression, silver foxes actually attack each-other, the attacker trying to bite the opponent at the throat, snout or shoulder-blades. However, these attacks are rare, almost never accompanied by trauma, and to a considerable degree ritualised.

Results and discussion

Figure 1 shows the components of aggressive and sexual behaviour in social contacts when females are introduced to males in different parts of the reproductive cycle. One can see that aggressive behaviour depends to a considerable degree on the stage of the reproductive cycle. Thus, there is significantly ($p<0.05$) more ritual and actual aggression when females are introduced to males out of the breeding season than when females in oestrus are used. It is of interest that during the breeding period (February), direct attacks practically disappear. It is possible that in silver foxes, like in other species, pheromone signals from the female in oestrus are able to suppress the male's aggression (*Mugford and Nowell, 1971; Lee and Brake, 1972; Johnston and Bronson, 1982*). On the contrary, the male's sexual activity, as measured by the number of mountings, is markedly higher when females in oestrus are introduced than when anoestral females are used. In our view, this demonstrates the pheromonal initiation of male sexual behaviour, and is in accordance with the results of other workers (*Dunbar, 1977; Goodwin et al., 1979; Marchlewska-Koj, 1984; Signer et al., 1984*). If social behaviour between males and females is considered in relation to domestication, on the whole, the absence of aggression towards humans in domesticated males is not accompanied by any decrease of intraspecific aggression, as may be judged by the number of boxing postures or actual attacks (fig. 1). It is possible that the introduction of the other fox (even a female) represents a stressful factor. These data suggest that social behaviour changes its structure and expression during domestication and this may be reflected in the hormonal balance in view of the complex interrelations between social behaviour and reproductive hormones.

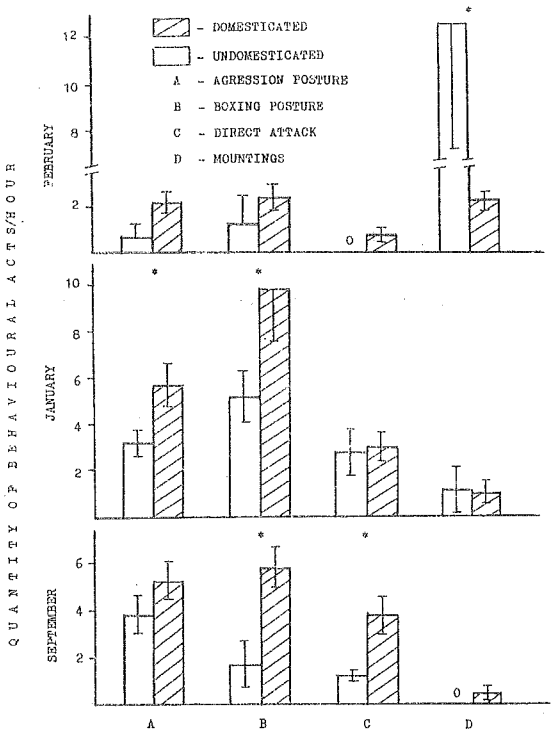

Fig. 1. Social and sexual behaviour of silver fox males. The significance of differences between domesticated and undomesticated males is marked by an asterisk in all pictures. Level of significance * - $p<0.05$.

It is now accepted that relationships between animals in a population play an important role in the regulation of reproduction in the majority of species. It is interesting to note that relations between males and females stimulate the hormonal activity of the testis (*Macrides et al., 1975; Kamel et al., 1978*). In males of several species, in the presence of a receptive female, even when there is no direct contact, there is an activation of the hypophysis-testis axis, expressed in an increased level of luteinising hormone and testosterone in the blood (*Younglai et al., 1976; Liptrap and Raeside, 1978; Coquelin and Bronson, 1980; Bronson and Desjardings, 1982*). These hormonal reactions are induced principally by female pheromones and their effects are mediated through the males' sense of smell (*Wysocki et al., 1982, 1983*).

In the model of social interactions used by us,

females were presented to males in three physiological states - in anoestrus, in the period preceding the mating (early hormonal activation of the gonads), and in oestrus. Outside the breeding season, the presence of females had no effect on testis hormone activity of either group of animals. During the breeding season (February), introducing females to domesticated males resulted in a significant increase in blood testosterone, an effect not seen in undomesticated males (fig. 2). It should be noted, however, that the background testosterone level, i.e. during "physiological" quiescence, is different in the two groups, being significantly lower in the domesticated foxes. This difference is eliminated during sexual activation (fig. 2). The lower testosterone level in domesticated males during "physiologial" quiescence is evidently responsible for the lower number of mountings in this group than in undomesticated males (fig. 1.).

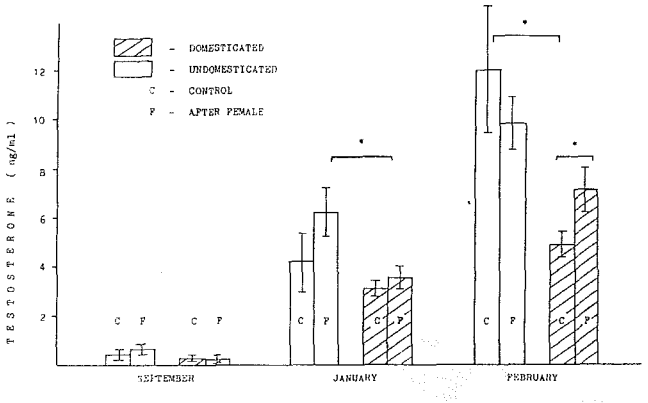

Fig. 2. Plasma testosterone concentrations in silver fox males after introduction of females.

We propose the following explanation for the difference observed between the two lines. In the commercial rearing of foxes, in which the animals are crowded together in a small space, evidently the pheromone concentration from females in oestrus during the breeding season reaches levels sufficient for stimulating a hormonal reaction. It is possible that the pheromone alone, with no direct contacts between males and females, is enough to stimulate the male's reproductive system, including maximum activation of the androgenic function of the testis in undomesticated males, but is insufficient for the domesticated ones. Thus in the latter, direct contacts provoke an additional activation of testosterone secretion.

It should be noted that the short-time contacts with infertile females at the beginning of the breeding season (January) have a weak stimulating effect on blood testosterone level in both groups (fig. 2). In this period of "physiological" quiescence, the males' testosterone level is significantly lower than in the middle of the breeding season (February) and this suggests the leading role of social factors, particulary pheromonal ones, in the further activation of the hypophysis-testis system in silver foxes during the mating season. Thus, the impression is gained that, apart from such environmental factors as photoperiod controlling seasonality in silver fox reproduction (*Muise et al., 1988; Osadchuk and Trut, 1988; Christiansen, 1989; Forsberg et al., 1989*), social contacts between males and females through pheromones may be another important mechanism controlling the hormonal activity of gonads. Our results also suggest that a reduction of pheromonal control of sexual arousal takes place in silver fox males under the domesticative process.

Thus, data from this study show that domestication has an effect on social mechanisms regulating the testicular endocrine function in silver foxes.

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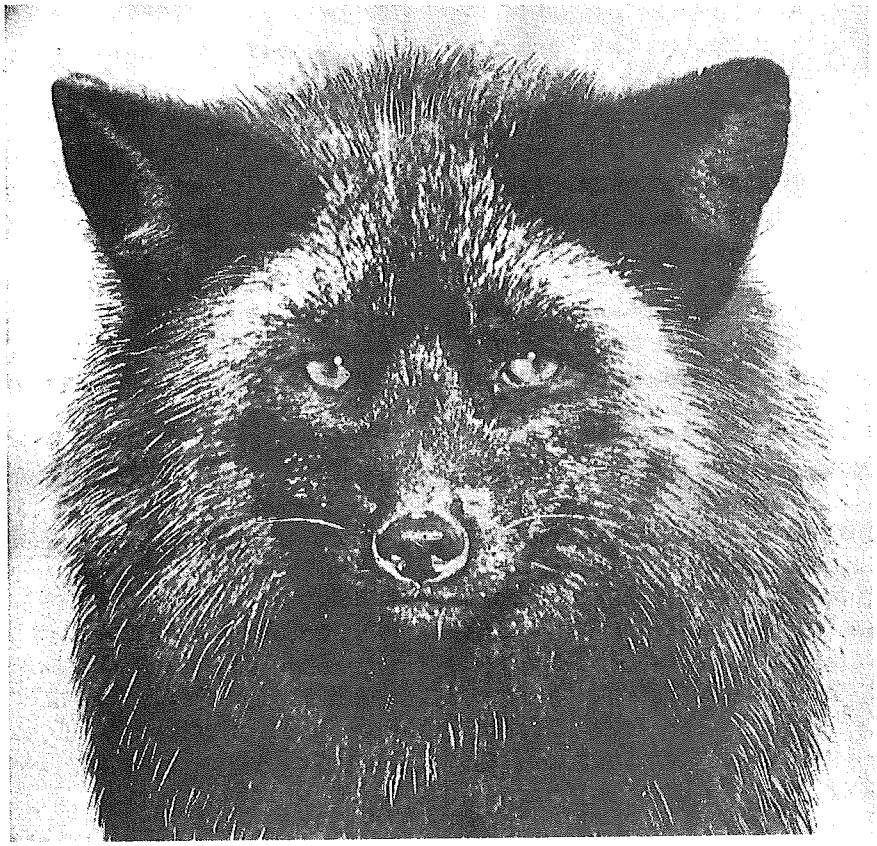

Original Report

Change of the enzyme spectrum of the digestive tract in mink during postnatal ontogeny

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Abstract

Investigations were performed to determine the activity of amylase, lipase and total proteolytic (TPA) in pancreatic tissue and amylase, lipase, dipeptidase, invertase, lactase and TPA in the intestine mucosa of mink kits at 1,2,3,5,7,10,-15,20,25,30,35,40,50,75 and 180 days after birth. A considerable level of TPA and lipase activity was detected in the pancreas at birth, but that of amylase was low. Afterwards, the activity of all three enzymes increased. A powerful rise of lipase activity took place at mixed feeding. In the small intestine there was an increase of the activity of amylase, lipase, invertase and TPA. The lactase activity declined during postnatal ontogeny. The dipeptidase activity was high during all of the experiment. The activity of the protein and fat-hydrolizing enzymes developed in the mink intestine at an earlier age than the carbohydrate-hydrolizing ones.

Introduction

The organism's nutrient needs substantially change with age. Adaptive changes of the enzyme spectrum in the digestive tract take place according to the age, too (*Zaks & Nikitin, 1975*).

The dynamics of age changes of the digestive enzyme activity in predatory animals is scantily explored as yet. The obtained data mainly concern elder age groups (*Berestov & Oleinik, 1984; Elnif et al., 1988; Barabasz & Oleinik, 1991*). The aim of the present work was to study the activity of digestive hydrolases in the pancreas and small intestine in mink during ontogeny with emphasis on the early period of postnatal ontogeny.

Materials and methods

Mink kits of a standard genotype were investigated at 1,2,3,5,7,10,15,20,25,30,35,40,50,75 and 180 days after birth. In each age group 5 individuals were investigated. The female to male mink ratio was 2:3 or 3:2. The mink got the usual feed used on fur farms (*Pereldik et al., 1981*). They were slaughtered in the morning at the same time. The fed animals were under examination from the lactation period to mixed feeding up to the time when they were set apart (2 hours after they were fed). Beginning from the age of 50 days the mink were investigated after night fasting. With the purpose of controlling both fed and fasted 40 day-old mink were examined. The enzyme activity in 40 180-day old mink kit was determined in a homogenate of the intestine mucosa, and in 1 30-day old one's in a homogenate of the entire intestine. In 35 day-old mink the activity was determined in a homogenate of the intestine mucosa as well as the

entire intestine.
The small intestine was bathed with distilled water. The samples of tissue were frozen and kept at -25°C up to the time of the experiment.

The activities of alpha-amylase (EC 3.2.1.1), lipase (EC 3.1.1.3) and total proteolytic activity (TPA) (EC 3.4.21) were determined in the pancreas. The activities of lactase (EC 3.2.1.23), glicil-DL-leucin dipeptidase (EC 3.4.13.2), monoglyceridlipase (EC 3.1.1.23), invertase (EC 3.2.1.48), alpha-amylase and TPA were determined in the small intestine. More detailed descriptions of the methods of enzyme activity determination have been given earlier (*Oleinik & Svetchkina, 1992*).

Results

Average enzyme activity (on 3 enzymes) in the pancreas in fed 40 day-old mink made up 108% of the level in hungry animals. In the small intestine (an average of 6 enzymes) correspondent values were 105%. In 35 day-old mink the enzyme activity in the homogenate of the intestine mucosa (on 6 enzymes) was 13% higher that in the homogenate of the entire intestine.

The activity of enzymes in the pancreas in mink kits of different ages is demonstrated in fig. 1. Activity values are given in percentage of the activity levels in 180 day-old mink. Average activity values in 40 day-old mink kits are shown in fed and fasted animals (on 10 animals).

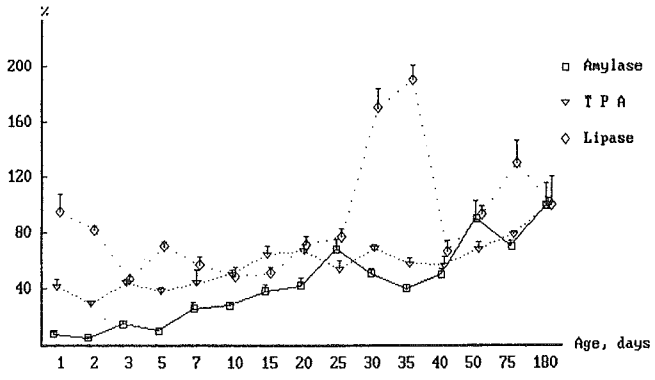

Fig. 1. Digestive enzyme activities in the pancreas in mink of different ages (in % of the adult level).

The enzyme activity variously declined in the pancreas in the kits on the first days after birth in comparison with the level of immature born animals. Further on, the activity of amylase and TPA slightly increased. As to the activity of lipase, it varied during the 2-25 days of life. Peak lipase activity was observed on the 30th and 35th days. It declined abruptly by the 40th day and uniformly increased by 75th day. A substantial increase of the amylase activity took place on the 25th day of life. After some drop in amylase, proteases activity increased more evenly in the course of the whole period of the experiment.

The enzyme activity in the small intestine in mink kits of different ages is shown in fig. 2. Activity values are given in percentages of the activity level of 180 day-old animals, except lactase (its correspondent activity is given in percents of the level of immature born animals).

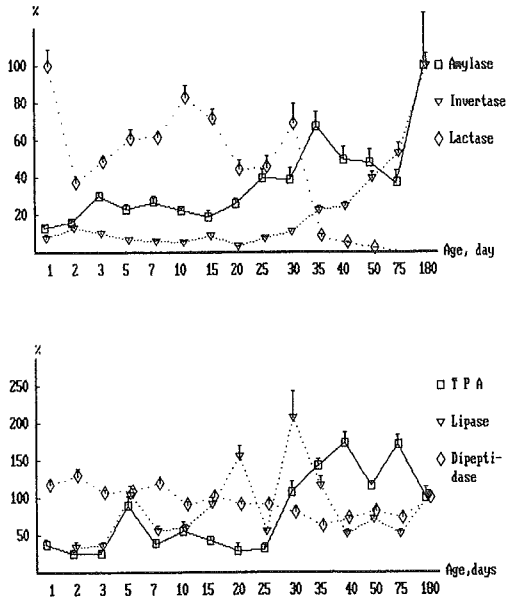

Fig. 2. Digestive enzyme activities in the small intestine in mink of different ages in % of adult level; for lactase - in % of newborn level.

For each individual mink average values of the enzyme activity were taken in 3 equal parts of the small intestine, including the duodenum. In 35 day-old kits the average value of the activity is illustrated in homogenates of the intestine mucosa and the entire intestine as well as that in fasted and fed 40 day-old kits (from 10 animals).

The increased enzyme activity in the intestine

was concomitant to the age, except dipeptidase and lactase. The latter declined greatly on the 2nd day, then increased, reaching the local maximum on the 10th day, then dropping to nothing by the 50th day of life. As to dipeptidase, its activity was rather stable during the whole period of the experiment.

The activity of invertase was rather low at the early age until a transition to a definitive type of feeding. Approximately at that time a considerable increase in the activity of lipase, amylase and TPA was observed.

The activity of amylase and invertase reached its maximum in adult animals. As to the peak of the other enzymes, it was fixed at more early age.

Discussion

The obtained data testify that the enzyme spectrum in the digestive tract in mink undergoes substantial changes in the period of postnatal ontogeny.

Dynamics of enzyme status formation in the pancreas in mink is similar to that in rats and other animals, correcting the period of ontogenic development of the mink's organism (*Robberecht et al., 1971; Corring et al., 1978; Saraux & Girad-Globa, 1982*), i.e. a reduction in the activity of most of the enzymes from birth and then a gradual increase. The local maximum of the enzyme activity is usually at the transition to solid feed.

In mink, local peak amylase activity has been observed at the age of 25 days, i.e. at the transition to mixed feeding; that of lipase - a bit later, at the age of 35 days.

As to TPA, no strongly pronounced local maximum in mink has been noticed in the period of mixed feeding. Probably, this may be explained by the peculiarities of the nutrition of predatory animals. The activity of protein-hydrolizing enzymes in them is genetically programmed, in contrast to omnivorous rats, for whom there is no strict programme of enzymes formation and all is determined by the ratio of substrata for enzymes in the definitive feeding (*Snook, 1974; Henning & Guerin, 1981*).

The obtained dynamics in TPA formation in the pancreas has been generally similar to the dynamics of trypsinogen/trypsin changes in mink observed earlier (*Elnif et al., 1988*). Some distinctions in the formation dynamics of alpha-amylase activity in the obtained results and those of the above-mentioned researchers, especially in late ontogeny, could be the result of a different diet. Carbohydrate content in the mink kit feed increased with age in our experiments, according to recommendations in the feeding of growing mink (*Pereldik et al., 1981*). This fact could have caused the increase in the activity of amylase in adult animals. This result has been showed in our early research (*Berestov & Oleinik, 1984*).

A very high level of lipase in the pancreas as well as in the small intestine in mink, having been observed during mixed feeding, is not clear just now. It is to be solved later on whether it is really a typical feature of postnatal development of the digestive system in mink. As to rats, increase in the activity of lipase, though not so considerable, has also been observed in the period of transition to solid feed (*Robberecht et al., 1971*).

In the small intestine in mink kits, dynamics of enzyme activity was of three types. The activity of lactase, as in other animals (*Henning, 1987*), was not observed after the end of lactation, in accordance with the decrease of lactose in the food. The activity of dipeptidase was high from birth and changed very slightly. This enzyme takes part in membrane hydrolysis of peptides and apparently, during the entire period of postnatal ontogeny there are enough substrata for it there: first - milk peptides, then those of solid feed. The activity of the other enzymes increased with age.

Dynamics of enzyme activities of pancreatic origin in the small intestine in early ontogeny coincided with those in the pancreas but, at the transition to mixed feeding, the increase in activity of these enzymes in the small intestine occured at an earlier age. For instance, substantial increase in the activity of amylase in the small intestine was observed in 35 day-old mink, and in the pancreas in 50 day-old mink. TPA in the small intestine was not reduced below the finite level after the 30th day of age, whereas in the pancreas of 75 day-old mink it was still lower than in adult animals. We have observed similar regularity in mink and polar foxes earlier (*Berestov & Oleinik, 1984*).

Peak lipolitic activity occured a bit earlier in the small intestine than in pancreas. The activity of invertase became more or less high only by the 50th day of life. Very likely before that time there was not enough substrata for it. It is interesting to note that the activity of protein and fat hydrolizing enzymes in the small intestine of mink at the age of 50 days did not substantially differ from the level of adult mink ($P>0.05$), whereas the activity of amylase and invertase were much lower even in 75 day-old kits. This must be explained by the fact that predatory animals specialize in animal origin diets with high protein and low carbohydrate levels.

Thus, mink as well as other animals (*Robberecht et al., 1971; Henning, 1987; Rakhimov, 1986*), as a result of ontogenetic changes of the enzyme spectrum of the digestive tract, are able to digest nutrients independently of their polymerization level. The final formation of the enzymes hydrolyzing proteins and lipids in mink actually take place by the end of the second month of life; whereas this process for carbohydrates comes to an end much later.

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Original Report

Effects of dietary calcium-phosphorus ratio on growth, skin length and quality in mink (Mustela vison)

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Abstract

Effects of different dietary calcium-phosphorus ratios (0.9, 1.3 & 1.9) on skin length and quality were studied in pastel mink kits in the growth period from July to pelting. Each group consisted of 48 male kits and the animals were fed ad lib. and caged according to normal practice. The animals were weighed every second week throughout the experimental period, and after pelting and drying the length of the skins was measured and grading regarding density of guard hair, clarity of colour and the overall quality was carried out. The animals from the higher calcium-phosphorus ratio group (1.9) had reduced weight gain and the skins were significantly shorter compared to the low (0.9) and medium (1.3) groups. The density of the guard hair was improved with increasing calcium-phosphorus ratio but the overall quality was not influenced. It was concluded that the generally accepted maximum dietary calcium-phosphorus ratio of 2:1 is too high for mink in the growing-furring period.

Introduction

Recent literature describing the reaction of mink to a varying calcium-phosphorus ratio is very limited, and the available reports primarily deal with the deficiency disease 'rickets' (*Bassett et al., 1951; Helgebostad, 1960*). These investigations concentrated on the early part of the growth period and were based on extensive use of soft slaughter-house offal, which resulted in a low calcium content and a markedly inverse calcium-phosphorus ratio. In the growth period an experiment was carried out with young ferrets (*Mustela putorius furo*) on dietary calcium-phosphorus ratios of 1.3:1 and 1:1.3 without any adverse effects on growth or development (*Edfors et al., 1990*).

When practical feeding changed and larger amounts of fish offal was included a considerable increase both in mineral contents and in calcium-phosphorus ratio was the result owing to the content of fish bones in the feed. The more recent use of whole fish resulted in de-

creasing, but still rather high, contents of the two minerals with regard to covering the requirements of the animals (*NRC, 1982*).

Since the influence of varying calcium-phosphorus ratio on growth and skin parameters in mink has not previously been subject to a proper investigation, the present experiment was carried out to elucidate this important aspect of the calcium and phosphorus supply.

Materials and methods

The study comprised three groups of male kits of pastel mink during the period from 1 July to pelting in November. Each group involved 48 male kits and the planned calcium-phosphorus ratios were 0.9:1 (Group I), 1.7:1 (Group II), and 2.5:1 (Group III). The experimental animals were caged together with a female kit according to common practice, and they were fed ad lib. The animals were weighed at the start of the experiment and then every second or third week throughout the experimental period. The composition of the diets is shown in Table 1. From 15 August, some minor changes had to be made in the composition of the diet for technical reasons, because the three groups were concurrently acting as control groups in a larger experiment which also involved fish preserved with sulphuric acid (*Enggaard Hansen et al., 1986*).

Table 1. Dietary composition in per cent.

Ingredient, per cent	Until 15 August	After 15 August
Cod offal	33.0	29.5
Slaughterhouse offal	4.6	5.5
Industrial fish	19.0	23.0
Fish meal	2.0	1.8
Blood meal	1.6	1.4
Potato protein	1.5	1.4
Soya meal, TF 100	1.8	1.7
Barley, heat-treated	10.4	12.7
Wheat bran	1.8	1.8
Lard	1.8	0.9
Soya oil	1.7	0.9
Vitamin-mineral mixture[1)]	0.3	0.4
Water	20.5	19.0

[1)] Minerals added: Group I: 15 g phosphorus mixture/kg diet; Group II: 2 g phosphorus mixture/kg diet; Group III: 11 g calcium carbonate/kg diet.

Vitamins, content per gram: Vitamin A, 6,000 I.U.; Vitamin D_3, 600 I.U.; Vitamin B_1, 1,000 µg; Vitamin B_2, 2,200 µg; Niacin, 12,000 µg; D-pantothenic acid, 4,000 µg; Vitamin B_6, 1,000 µg; Vitamin B_{12}, 16 µg; Biotin 5 µg; Folic acid, 240 µg; p-Aminobenzoic acid, 2,500 µg; Choline chloride, 10,000 µg; Vitamin E, 8,000 µg.

The calcium-phosphorus ratio in the diets was adjusted by the addition of minerals. For Groups I and II, the minerals were equal parts of monosodium phosphate and monoammonium phosphate, and Group III was given calcium carbonate. The mineral salts used had been chosen because of their fairly good solubility, and the extra sodium added to the diet through the phosphorus mixture was compensated for by the addition of sodium chloride, so that the sodium concentration in the diet was the same for all three groups. The quantities of phosphorus mixture and calcium carbonate added to the diets are shown in Table 1.

The diets were mixed daily. Feed analyses, including dry matter, crude protein, crude fat, calcium and phosphorus, were carried out on samples of equal volume collected in connection with the feed preparation. Samples were pooled for a two-week period and the analyses were performed according to previously described

methods (*Stoldt, 1957; Weidner & Jakobsen, 1962; Enggaard Hansen, 1973, 1974*), and the digestibility of the diets was determined in parallel experiments.

After pelting and drying, the length of the skins was measured as the distance from the tip of the nose to the root of the tail. Furthermore, the skins were graded regarding the density of their guard hairs (scale 1-3) and their quality (scale 1-5), clarity of the colour (scale 1-10), as well as the overall quality of the skins (scale 1-10).

The statistical treatment of the data included analysis of variance for evaluation of the main effect of calcium-phosphorus ratio, and differences between the groups were calculated by means of Tukey's test ($P < 0.05$). A possible correlation between skin length and the individual parameters was tested by calculation of correlation coefficients. The statistical calculations were made by means of the SAS programme (*SAS Institute Inc., 1982*).

Results

During the experimental period, one kit died in Group I, but the cause of death could not be explained by the experimental treatment.

Table 2. Chemical composition, and calculated contents of metabolizable energy and digestible protein in the diets (Mean ± SEM).

	Until 15 August			After 15 August		
	Group I	Group II	Group III	Group I	Group II	Group III
No. of pooled samples	3	3	3	6	6	6
Dry Matter, %	35.0±0.8	34.7±0.7	34.5±0.2	35.2±0.7	34.8±0.7	35.5±1.0
Contents in dry matter:						
Crude protein, %	42.4±0.3	41.4±0.1	40.7±0.3	43.2±0.5	42.8±0.8	41.4±0.6
Crude fat, %	20.3±0.3	20.9±0.1	20.5±0.5	16.6±0.7	17.0±0.9	16.8±0.7
Crude carbohydrate, %	26.5±0.2	27.7±0.2	27.9±0.1	29.5±0.3	30.5±0.5	30.7±0.7
Ash, %	10.7±0.6	10.0±0.1	11.0±0.7	10.8±0.1	9.6±0.1	11.2±0.1
Calcium, g/kg	20.1±0.4	21.8±1.5	26.3±4.2	17.9±0.4	18.4±0.3	25.9±0.5
Phosphorus, g/kg	21.8±1.6	15.3±0.8	14.5±0.5	22.3±0.5	15.2±0.2	13.3±0.3
Ca-P ratio	0.92±0.06	1.42±0.17	1.81±0.34	0.80±0.02	1.21±0.03	1.95±0.03
Content in diets:						
ME, kJ/100 g	589±11	607±11	611±4	562±16	577±17	594±21
Digestible crude protein, g/100 g	12.1±0.3	12.1±0.2	12.2±0.1	12.4±0.1	12.6±0.2	12.7±0.2

The chemical composition of the feed and the calculated contents of metabolizable energy and digestible crude protein per 100 g feed are shown in Table 2. The change made in mid-August only resulted in minor differences in the contents of energy and nutrients. In the calcium-phosphorus ratios there were also minor differences between the periods before and after 15 August, but the three levels were maintained. On the basis of the results in table 2, the overall calcium-phosphorus ratio was calculated for the total period from July to pelting as follows: Group I: 0.85 ± 0.03, Group II: 1.28 ± 0.06, and Group III: 1.91 ± 0.10. The growth performance of the animals during the experimental period is shown in Fig. 1, from which it also appears that the development of the animals could be regarded as normal in both Group I and Group II. At the last weighing (4 November) before pelting, the following average weights were found for the individual groups (Mean ± SEM): Group I: 2,009 ± 262 g, Group II: 1,969 ± 242 g and Group III: 1,789 ± 241 g.

Table 3. Skin length and quality (Mean ± SEM).

	Number of skins	Skin length, cm	Clarity	Guard hairs		Overall quality
				Density	Quality	
Group I	47	71.9 ± 0.5[a]	6.2 ± 0.4	1.8 ± 0.1[a]	2.7 ± 0.1	5.8 ± 0.3
Group II	48	71.8 ± 0.5[a]	6.2 ± 0.4	2.0 ± 0.1[ab]	2.7 ± 0.1	6.1 ± 0.3
Group III	48	69.0 ± 0.5[b]	5.6 ± 0.3	2.2 ± 0.1[b]	2.7 ± 0.2	5.9 ± 0.4

[a & b)] Values within columns with different superscripts are significantly different (P < 0,05).

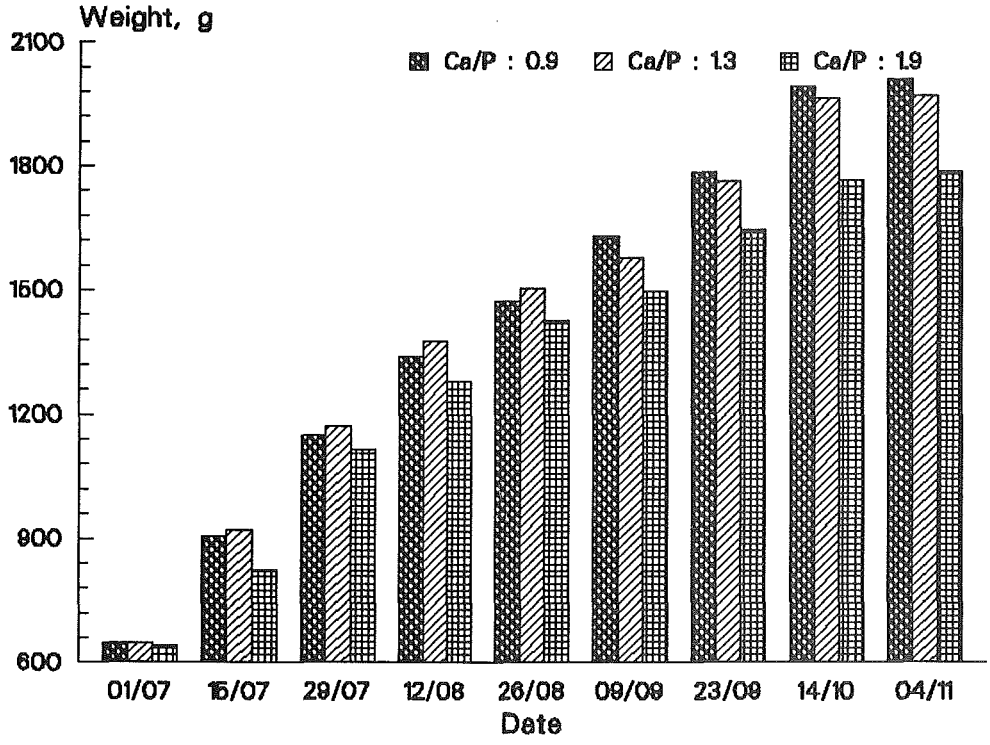

Fig. 1. Effect of calcium-phosphorus ratio on growth performance of male mink kits.

Table 3 shows the results found relating to length and quality of the skins for the three groups (Mean ± SEM). Calculated on the basis of the total experimental material, the calcium-phosphorus ratio was found to have a highly significant influence on skin length (P < 0.001). It is evident from Table 3 that the influence was negative at the high calcium-phosphorus ratio (Group III), while there was no difference between Group I and Group II, where the ratios were 0.9:1 and 1.3:1, respectively (P > 0.05).

The calcium-phosphorus ratio also had a significant influence on the density of the guard hairs (P < 0.008), and Table 3 shows that the density was improved with increasing calcium-phosphorus ratio. The results for Group I and Group III differed significantly (P < 0,05), whereas neither of these groups differ significantly from Group II.

Calculations were made to establish whether there was any correlation between the length of the skins and the density of guard hairs. The results showed, however, that the two parameters varied independently. The other skin parameters used in the experiment: quality of guard hairs, clarity of colour, and the overall quality of the skins, were not influenced by the different calcium-phosphorus levels in the diets.

Discussion

The diets must be considered adequate for covering the animals' requirements of energy and nutrients during the growth and fur development period (*NRC, 1982*), but there is an obvious discrepancy between a previously reported maximum acceptable calcium-phosphorus ratio of 2:1 (*NRC, 1982*) and the results found in the present study.

The planned calcium-phosphorus ratios were not quite obtained, especially regarding the high levels. The principal cause was probably a lower content of the minerals than expected in some of the feedstuffs. There is reason to suppose that the fish products in particular may have varied in mineral contents, because previous investigations of Danish fish products have shown that considerable differences may occur (*Enggaard Hansen, 1974; Just et al., 1983*).

The results found relating to the level of calcium-phosphorus ratio are consistent with the levels required to avoid rickets and locomotory disturbances in the early growth period (*Bassett et al., 1951; Helgebostad, 1960*). Skeletal bones were not examined in the present experiment, but no inhibition or disturbance of movement was observed in the three experimental groups.

It is not possible to draw a distinct line between the two highest levels of calcium-phosphorus ratio, but it is quite clear that a calcium-phosphorus ratio as high as 1.9:1 had an adverse effect on skin length, whereas the density of the guard hairs was improved.

In monogastric animals, a calcium-phosphorus ratio of 1.3:1 is generally regarded as optimum, and there is hardly any reason to assume that the ratio should be much different for mink. If monogastric animals differ in this respect, then - in the light of its natural food habits - mink would tend to show greater tolerance to a lower calcium-phosphorus ratio than species with which it is naturally compared, because mink mainly eat the soft parts of the prey, i.e. the parts with the relatively lowest calcium level. This theory was, in fact, supported by the results of the present study in that no difference was found in skin length between Groups I and II, whereas the skins of Group III were slightly shorter.

Conclusion

The present study shows that, provided that the supply of vitamin D is sufficient and the feed does not contain other ingredients which affect the calcium and phosphorus metabolism, the optimum dietary calcium-phosphorus ratio in mink evaluated on the basis of skin length and quality at pelting time are consistent with the optimum ratio previously determined for prevention of defective bone development.

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Original Report

How do coypu and rabbit digest the same feedstuffs?

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Abstract

The authors wanted to know whether rabbit digestibility coefficients can be used in coypu ration formulation. Indirect digestibility studies were carried out using 5 adult female New Zealand White rabbits and 5 adult female coypus. Five typical feedstuffs (corn, wheat, wheat bran, extracted sunflower meal and alfalfa meal) were tested, the nutrients digestibility measured and the digestible energy content calculated. In feedstuffs poor in fiber (corn and wheat), or containing fiber in an easily degradable form (wheat bran), the digestibility coefficients of the two species did not differ. The high-fiber feedstuff (alfalfa meal) was digested less efficiently by the coypus. In conclusion, the authors state that despite the great similarities in the digestive anatomy and functions, rabbit digestibility coefficients cannot be used in coypu nutrition, especially in the case of high-fiber feedstuffs. It is supposed that the significance of coypu cecotrophy is less important than with rabbits.

Introduction

Owing to the relatively short history of breeding (NRC, 1991), only a few digestibility trials have been carried out with coypus (*Myocastor coypus*). These experiments are rather difficult, because of the coypu's nutritional behavior, such as the high selectivity in feed intake and the consecutive great wastage. For these reasons, one has not estimated values in the literature concerning the digestibility coefficients of the most important coypu's feedstuffs. A further difficulty arises during comparison of the few existing data gained by different methods (*Olson, 1982*).

The question has not only practical, but also theoretical importance, because the morphological features of the coypu and rabbit digestive tract are very similar. The well-justified question arises, whether can we use the rabbit digestibility coefficients during the coypu's ration formulation. At the same time, the adaptation of the coypu to the originally half-aqueous way of life made its basal metabolism (the maintenance of the body temperature in the water) and its feeding behavior (the preferene for the intake of low fiber aqueous plants in natural circumstances) are in some respects different from those of the rabbit. The comparison of the fiber digestion of the two species seems to be especially interesting, because notwithstanding the mentioned similarity of the digestive tracts, there are different opinions concerning the coypu's cecotrophy (*Scheelje, 1979; Hörnicke et al., 1985; Pereldik et al., 1987*).

During the design of this experiment we took

into consideration some practical points of view and tried to learn the digestibility of nutrients of some important coypu feedstuffs, to make possible the proper ration formulation in the practice.

Materials and methods

The experiment was carried out in the animal facility of the department of Poultry and Rabbit Nutrition of the Research Center for Animal Breeding and Nutrition, using the method of Fekete and Gippert (1986). Experimental animals: 5 adult, female coypus and 5 adult, female New Zealand White rabbits. The test feeds represented not only different fiber levels, but also a characteristic group of feedstuffs. The corn and wheat stood for the cereals (feed grains), wheat bran represented the middlings, sunflower the extracted meals and alfalfa meal the hays. The results of the approximate analyses of the tested feedstuffs are shown in table 1.
For the associated (indirect) metabolic trial (*Schneider and Flatt, 1975*) we used two basal diets. The first contained less protein and more fiber (17.3 % crude protein and 15.3 % crude fiber) and gave 40 % of the mixtures, made by this first basal diet and corn or wheat or wheat bran. The second basal diet had a higher protein and lower fiber level (21.5 % crude protein and 12.4 % crude fiber) and gave 60 % of the mixtures, made by this second basal diet and extracted sunflower meal or alfalfa meal. The composition of the two basal diets was the following: corn 0 or 27, barley 0 or 10, oats 53 or 10, alfalfa meal 0 or 26, soybean meal (solv. extracted) 0 or 10, sunflower meal (solv. extracted) 30 or 10, wheat straw 15 or 4, tallow 0 or 1, salt 0.5 or 0.5 and mineral-vitamin premix 1.5 or 1.5, first and second basal diet, respectively. The animals were fed with the basal diets and the experimental mixtures ad libitum in form of a pellet of 5x12 mm, both for the 5 coypus and 5 rabbits.
The approximate analysis of the feeds and feces has been carried out by the methods described by the A.O.A.C. (1975).
The statistical analyses were performed as described by Pearce (1985). The digestible energy content was calculated on the basis of equation of Schiemann et al. (1972).

Table 1. Approximate chemical composition of the tested feedstuffs, %.

Feedstuff	DM	CP	EE	CF	NFE
Corn	92.2	9.4	3.8	2.1	74.5
Wheat	88.8	13.1	1.8	2.6	71.5
Wheat bran	88.8	14.5	3.9	10.4	53.6
Sunflower meal	89.6	36.9	1.5	12.7	31.5
Alfalfa meal	91.6	19.2	2.47	23.9	37.0

Legend: DM = dry matter;

Results

The nutrients' digestibility coefficients of the tested feedstuffs for rabbits and coypus are summarized in figures 1 and 2 and in table 2.

Fig. 1.

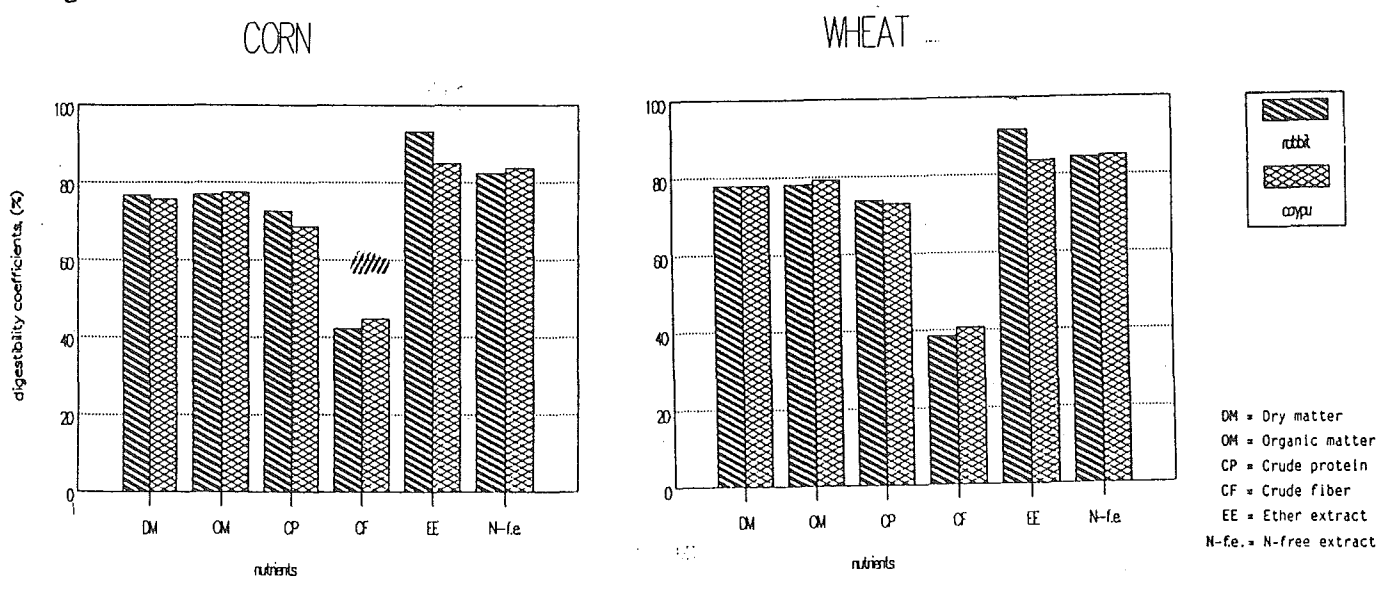

Fig. 2.

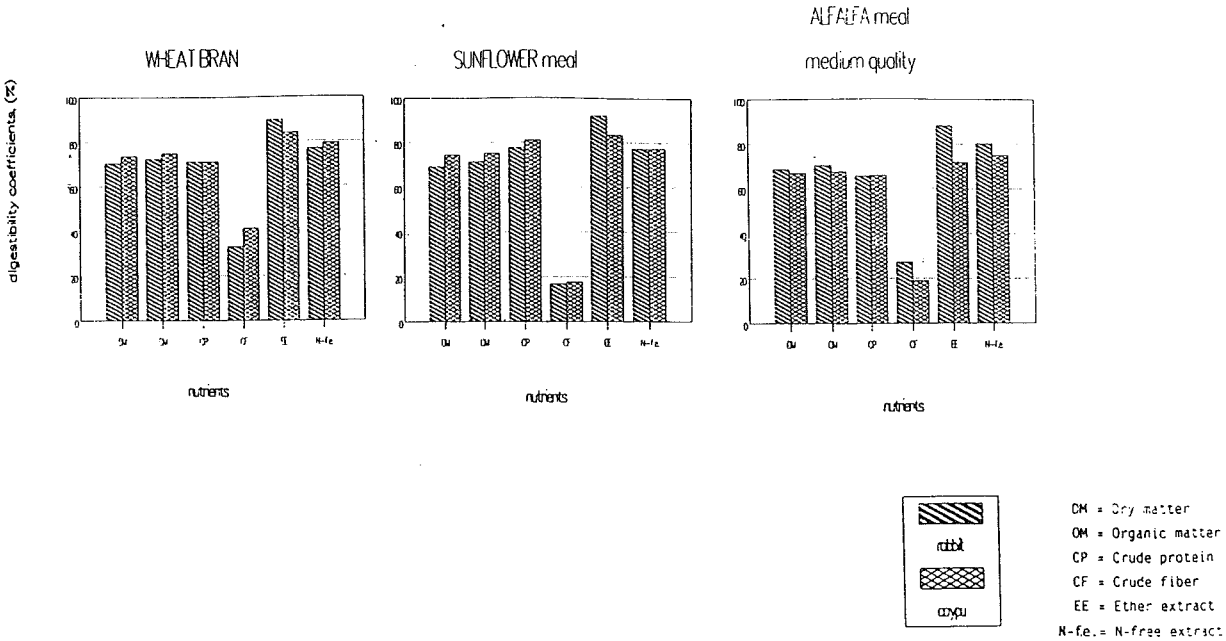

Table 2. Comparison of rabbit and coypu digestibility coefficients (%), N = 5.

Nutrient	Species	Corn	Wheat	Wheat bran	Sunflower meal, extr. solvent	Alfalfa meal medium
Dry matter (DM)	rabbit	76.63 ± 0.89	77.85 ± 0.97	70.51 ± 1.64[a]	69.22 ± 1.11[c]	68.83 ± 1.75
	coypu	76.53 ± 1.78	77.86 ± 1.20	73.53 ± 1.65[a]	74.48 ± 1.64[c]	66.97 ± 1.47
Organic matter (OM)	rabbit	76.85 ± 0.92	78.12 ± 1.11	72.32 ± 1.72	71.37 ± 0.89[b]	70.43 ± 1.67[a]
	coypu	77.49 ± 1.72	79.12 ± 1.20	74.77 ± 1.60	75.09 ± 1.57[b]	67.55 ± 1.43[a]
Crude protein (CP)	rabbit	72.57 ± 1.25[b]	73.79 ± 1.03	71.05 ± 0.73	77.67 ± 1.23[c]	65.63 ± 1.71
	coypu	68.54 ± 2.14[b]	72.98 ± 1.65	70.97 ± 2.28	80.92 ± 1.37[c]	65.69 ± 1.54
Crude fiber (CF)	rabbit	42.36 ± 2.61	38.47 ± 2.72	33.17 ± 2.24[c]	16.82 ± 1.81	27.17 ± 2.14[c]
	coypu	44.86 ± 3.02	40.63 ± 2.50	41.20 ± 2.59[c]	17.73 ± 1.74	18.85 ± 1.86[c]
Ether extract (EE)	rabbit	93.18 ± 1.17[c]	91.62 ± 1.18[c]	89.72 ± 1.39[c]	92.10 ± 1.08[c]	88.12 ± 1.29[c]
	coypu	84.86 ± 0.93[c]	83.54 ± 1.23[c]	83.90 ± 1.65[c]	83.45 ± 1.17[c]	71.88 ± 1.19[c]
N-free extract (N-f.e.)	rabbit	82.33 ± 1.03	84.39 ± 0.72	76.78 ± 1.25[a]	77.34 ± 1.54	80.39 ± 1.44[c]
	coypu	83.63 ± 1.47	84.85 ± 0.59	79.10 ± 1.31[a]	77.34 ± 1.53	74.94 ± 1.66[c]

The digestibility coefficients differ between the two species at a level of
a: $p<0.05$; b: $p<0.01$; c: $p<0.001$

The dry matter digestibility of the low-fiber grains (corn and wheat) does not differ between the two species. The dry matter of the medium-fiber wheat bran and extracted sunflower meal is better digested by the coypus; that of the high-fiber alfalfa meal best by the rabbits. There is the same tendency concerning the digestion of the organic matter.

The protein digestibility coefficients of corn, wheat and wheat bran are higher in the rabbits, and that of the extracted sunflower meal higher in the coypus. In the case of the alfalfa meal there is practically no difference.

As concerns the crude fiber digestibility, there are no differences between the two species in the case of the corn, wheat and extracted sunflower meal; the crude fiber of wheat bran was significantly ($p<0.001$) better digested by the coypus and that of alfalfa meal by the rabbits. The rabbits digested the fat (ether extract) of each tested feedstuff better.

The digestibility of the corn, wheat and extracted sunflower meal N-free-extract did not differ in the two species. The coypus digested the N-free extract of the wheat bran better as the rabbits did in the case of the alfalfa meal. Comparing the calculated digestible energy content of the different feedstuffs (table 3), one can state that it is only the alfalfa meal where there is a significant difference ($p<0.05$) between the two species. The rabbit energy value is higher by 9 %.

Table 3. The calculated digestible energy values, DE, kcal/kg (mean ± standard deviation)

Feedstuff	DE, rabbit	DE, coypu
Corn	3383 ± 50	3357 ± 95
Wheat	3290 ± 69	3312 ± 79
Wheat corn	2781 ± 100	2848 ± 86
Sunflower meal	2952 ± 121	3007 ± 148
Alfalfa meal	2421 ± 133	2212 ± 145 *

*: $p < .05$ after the Student t-test

Discussion

While the rabbit nutrient requirements are well-known (NRC, 1977; Blum 1984), those of the coypus remained unclear. Considering the large cecum, one could hypothese a great fiber need, like that of the rabbit. Nevertheless, as Holdas (1982) pointed out, the coypu fiber requirement has been overestimated. Pereldik et al. (1987) suggest a fiber need for coypus of only approximately 50 % of that of rabbits.

In the present experiment, the digestibility of dry matter, organic matter, crude fiber and N-free extract, corn and wheat (poor in fiber) are practically the same in the two species. The high-fiber alfalfa meal was less digested by the coypus, compared to the rabbits. It was only with the wheat bran and the extracted sunflower meal, that the digestibility of the dry matter, organic matter, crude protein and fiber (sunflower meal only) were higher in coypus and not in rabbits. One can suppose that the coypu fiber requirement is at that level, i.e. between 10 and 13 % of the air-dry feed. This is less by 15-19 % than the rabbit recommendations (*Fekete and Gippert, 1985*).

The protein digestibility of the corn, wheat and wheat bran are higher in rabbits. The explanation of that may lead to the field of cecotrophy. It is well-known that by means of the intake of soft feces pellets the rabbits "save" an important amount of protein (*Fekete and Bokori, 1985*). Hörnicke et al. (1985) report about the cecotrophy of coypu, too. The average daily feces consumption of an adult individual was 30 feces pieces. This activity lasted 7 hours a day. They state that the quality of feed influences the amount and duration of cecotrophy.

On the contrary, Pereldik et al. (1987) say that there is no cecotrophy in the coypus. Babtist and Mensah (1988) described that the cane rat (*Thryonomys swinderiamus*), a species both taxonomically and behaviorly very close to the coypu, practises cecotrophy, but the form of the two feces types does not differ.
During the present experiment, we sporadically could detect some intake of soft feces pellets, formally very like to the normal feces. Based on the described observation and the protein digestibility data we suppose that the significance of cecotrophy in the coypu is smaller than that in the rabbit.

The coypu fat requirement is low (2%) and above 3-4 % even the fur quality worsens (*Pereldik et al., 1987*). On the contrary, the rabbit fat digestion is excellent (*Fekete et al., 1989*), so it was not surprising that the coypus fat (ether extract) digestibility coefficients were lower than that of the rabbits. The physiological explanation of this phenomenon (differences in the bile, lipase proudction?) remained unclear. The coypu covers its energy requirement mostly from easily degradable carbohydrates, such as sugar and starch. In agreement with that - except the alfalfa and sunflower meal - the coypu digestibility coefficients of the N-free extract were slightly higher than those of rabbits.

The digestibility of the alfalfa nutrients - except the crude protin, which was the same - were lower for the coypus. This is added up in the digestible energy value: 2421 kcal for rabbit and 2212 kcal for coypu. This fact demonstrates that the coypu can compensate/tolerate the high fiber content of the feed only to a certain limit and presumably do not require a lot. This latter can be proved by the practical observations; after that the coypus do not eat even the older, high-fiber green alfalfa. In our opinion, the low fiber digestibility in the coypu can be explained by the simpler structure of the colon and, presumably, by the lack of a separation mechanism in the hind gut. On the other hand, it is worth mentioning that the fiber digestion of the beaver is higher - about 34 % (*Hoover and Clarke, 1970*).

Conclusions

1. In spite of the great similarities of the anatomy and function of the digestive system, the rabbit digestibility coefficents - especially of the high-fiber feedstuffs - cannot be used during the coypu ration formulation.
2. Presumably owing to the half-aqueous way of life (continous possibility for the intake of low-fiber parts of aqueous plants), the significance of cecotrophy is not so high in the coypu.

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Proceedings from the Vth International Scientific Congress in Fur Animal Production

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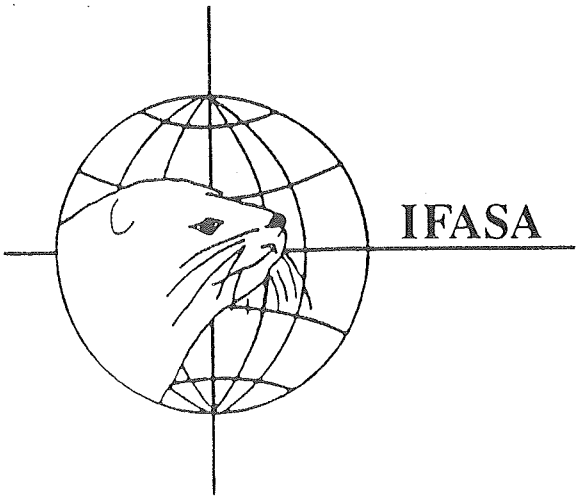

Preface

EINAR J. EINARSSON & ANDERS SKREDE
Department of Animal Science, Agricultural University of Norway
P.O. Box 5025, N-1432 Ås, Norway

The International Fur Animal Scientific Association (IFASA) was established in 1989, following a proposal made by the Fur Animal Division of the Scandinavian Association of Agricultural Scientists at the IVth International Scientific Congress in Fur Animal Production in Canada in 1988.

The objective of IFASA is to promote knowledge of all aspects of fur animal science and the fur industry by encouraging the exchange of information among scientists with an interest in fur animals. An important function of the IFASA is therefore to organize international cooperation in fur animal science and to coordinate and arrange international scientific meetings and congresses. This congress is the Vth International Scientific Congress in Fur Animal Production, the first having been held in Helsinki in 1976. However, it is the first international congress to be arranged by IFASA.

These Proceedings from the Vth International Scientific Congress in Fur Animal Production contain the full text of contributions accepted for oral presentation or as posters. A total of 90 papers are published in this volume, and this reflects the large body of information resulting from research in the area of fur animal science. The papers cover a wide range of topics relating to the five working groups of IFASA: (1) Breeding, reproduction and genetics, (2) nutrition, (3) pathology and diseases, (4) ethology and welfare and (5) fur properties. The members of the Scientific Committee which is responsible for the scientific programme and the Proceedings are:

Prof. Dr. Anders Skrede (Chairman)
Dr. Bjarne O. Braastad
Prof. Dr. Einar J. Einarsson
Dr. Jan A. Fougner
M.Sc. Kai-Rune Johannessen
Prof. Dr. Adrian Smith
M.Sc. Morten Bakken (Secretary)

We thank all authors who submitted manuscripts. Unfortunately some manuscripts could not be accepted mainly because of late submission, and a large number of editorial changes have been made. We trust that this will be accepted by authors and readers.

We take this opportunity to thank the Norwegian Agricultural Advisory Service for financial support and excellent cooperation during the preparation of the proceedings. In particular, we thank the managing editor of the Norwegian Journal of Agricultural Sciences, Jan A. Breian, for his enthusiasm and great flexibility. Thanks are also extended to George Drennan for language corrections.

At the congress there were oral presentations of 60 reports and presentation of 30 posters. Abstracts from all presentations are given in this issue of SCIENTIFUR. The Proceedings: PROGRESS IN FUR ANIMAL SCIENCE were printed as a 636 page Supplement (No. 9, 1992) of the Norwegian Journal of Agricultural Sciences. Additional copies of the mammoth proceedings (ISSN 0801-5341) can be obtained at the Norwegian Agricultural Advisory Service, Moerveien 12, N-1430 Ås, Norway (Tel.: +47 9 94 13 65) at a price of NOK 300.- + postage.

Norwegian Journal of Agricultural Sciences

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Breeding, reproduction and genetics

Progress and challenges in the physiology of reproduction in furbearing carnivores

Bruce D. Murphy

There has been substantial progress in the understanding of the reproductive biology of furbearing carnivores in recent years. However, much of the physiology remains unknown and information in a number of areas could be used in strategy to improve production. It has been determined that melatonin is the endocrine message which regulates seasonal breeding, but it is not known on which tissues it acts in furbearers, nor by what mechanisms its effects are mediated. The dynamics of follicle development are not well understood in any species of carnivore and these are of particular interest in mink, as these animals appear to be able to ovulate on almost any day of the breeding season. The processes of embryonic diapause, embryo attachment and invasion of the uterus at implantation require investigation. This article describes these problems in further detail and discusses potential approaches to aid in their resolution.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 17-29. 59 refs.

History, progress and challenges in the breeding and genetics of mink and foxes

Einar J. Einarsson

For many years the genetics of mink and foxes was concentrated on colour genetics and the breeding work was based on phenotype selection, mainly for fur characters. The mutants and combinations have been well described and the colour genetics explained by Mendel's law of inheritance. However, a more detailed and better explanation is discussed, based on the theory of homology of colour loci between species and using new biotechniques for gene-mapping. For quantative genetics it is important to have well-defined breeding goals, using modern methods of breeding value estimation and developing an optimum breeding programme. It is necessary to search for objective and representative fur characteristics. The importance of international cooperation and cooperation be-tween scientific fields is underlined.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 30-38. 30 refs.

Selection for fertility, body size and pelt quality in mink and effects of crossing

Gabrielle Lagerkvist

In 1984, a five generation selection experiment with standard mink was initiated. The lines were selected for fertility (F-line - litter size at three weeks of age), body size (BS-line - September weight), pelt quality (P-line - underfur density) and combined selection for fertility and body size. A control group with random mating was established. Each line comprised 80 females but the combined line 160 females. In 1987 and 1988 reciprocal crossings between two-year-old animals from the F- and BS-lines were performed. In 1990, the experiment was extended to include corresponding crossings in yearlings and two-year-old animals in order to evaluate the effects of age and heterosis. Litter size at three weeks was in the last generation 5.3 in the F-line and 3.7 in the control ($p<0.01$), yearling females. Male September weight was in the BS-line 2254 g and in the control 1989 ($p<0.001$). Underfur density scores (5-point score) were 4.1 in the P-line and 2.9 in the control ($p<0.001$). Heritabilities and breeding values were estimated by using an animal model; h^2±S.E was 0.05±0.03 for litter size at three weeks , 0.54 ±0.09 for male September weight and 0.21±0.06 for underfur density. Crossing between F-females and BS-males gave the best reproductive results, 6.2 (1987) and 7.2 (1988) kits per litter at three weeks of age. Crossing between yearling F-females and BS-males (1990) gave 1.2 kits more than the average of the single lines while the reciprocal crossing gave 0.8 kits below the average. The effect of crossing in two-year-old females was +0.6 and -0.1 kits, respectively. The project will be extended to include field experiments on backcrossing of F X BS females to BS males, in order to take advantage of maternal heterosis.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 39-48. 6 tables, 2 figs., 17 refs.

Development of an animal model for multi-trait analysis in mink

R. Neal Westwood, Brian W. Kennedy, Robert L. Park, Don Bartholemew & Lawrence R. Schaeffer

Genetic analysis using the Animal Model is becoming widely used in the cattle and swine industries. Adaptation of current swine models is a natural starting point for utilization with mink and other litter-bearing animals. A single trait model was adapted from the work carried out at the University of Guelph. This was implemented using data from over 15 fur farms. This early model included ranking and indexing of analyzed traits. In 1991 a multi-trait analysis which supports adjusting, indexing and ranking of traits was completed. Modifications were made for speed and efficiency so that up to six traits can be analyzed simultaneously. Indexing and ranking on up to nine traits can be performed. An efficient, fast, practical working model has been developed and is now in use.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 49-53. 1 table, 13 refs.

An adviser based databank for support of commercial breeding programs

Michael Sønderup, Ejner Børsting & Janne Hansen

The extensive use of personal computers in Danish mink breeding has made it possible to develop a data bank system run by the local advisory service. The users of the DanMink system send a copy of their files to the local adviser twice a year. The adviser transfers the data to SAS data sets and runs a set of statistics on the data. A report is then issued and given to the farmer. It gives the farmer an overview of the breeding work and estimates of the latest genetic progress. The normal genetic parameters are also estimated. The adviser helps the farmer to use the report for improvements in his breeding program and the adviser's own know-how is enhanced by the system. New statistics are developed every year, and calculation of inbreeding in each line will be one of the future tools in the system.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 54-60. 5 tables, 3 figs.

Reliability of subjective grading in foxes

Hilkka Kenttämies

The association between repeatedly scored body size and fur characteristics evaluated by several judges was studied in silver foxes (*Vulpes vulpes*) and blue foxes (*Alopex lagopus*). The grading in different environments was studied for blue foxes. Differences between various colour types of the fox were compared. There were obvious differences between the various viewpoints of the judges in repeatabilities. In blue foxes, differences between judges appeared to be greater than differences between environments. Grading outside the cages, particularly in daylight, was found to be more reliable than grading inside the cages, while colour tended to be easier to evaluate than the other traits. In the comparative gradings, caged gradings produced higher repeatabilities for colour in silver foxes than in blue foxes. The most uniform repeatabilities were obtained for assessment of body size, the most varying ones were those for clarity. The "silver type" mutants seemed to be easier to judge for general appearance than the "golden type" animals. The most reliable results were achieved when the same judge evaluated the animals in the same environmental conditions.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 61-66. 3 tables, 12 refs.

The comparison of two exterior evaluation methods of foxes

Janusz Maciejowski, Grażyna Jeżewska, Stanisław Socha & Jerzy Sławoń

The results of exterior evaluation of red and pastel foxes conducted according to two different methods were compared. The authors have put forward a modified evaluation system, whose essence is the reduction of the number of evaluated traits as well as the narrowing of the assessment scale. The proposed system contributes to better underlining of animal variability, and what this involves, but it should contribute to an easier and more effective selection for utility traits in carnivorous fur animals.

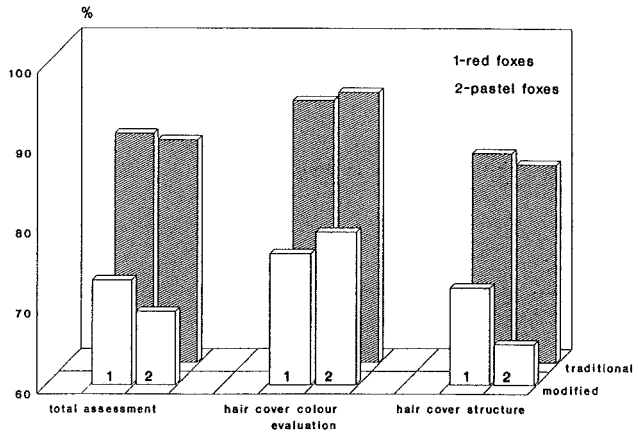


Fig. 1. Average assessments of evaluated traits expressed as deviations from the max. assessments of 100.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 67-72. 2 tables, 2 figs., 6 refs.

On-farm animal model estimation of breeding values

Peer Berg

An algorithm for animal model evaluations for a typical fur animal population is described. This algorithm iterates on data so that mixed model equations are not set up explicitly. It is reasonable to assume that at maximum, one observation is recorded on fur animals with no offspring. This allows for an efficient way of "absorbing" non-parent breeding values. This gives an efficient algorithm for large-scale animal model evaluations on small to moderate computing capacities (e.g. PC's). This makes it useful for on-farm evaluations of breeding values using an animal model. A small numerical example is given.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 73-80. 2 tables, 8 refs.

Norwegian breeding programme for mink and foxes

Einar J. Einarsson & Kai-Rune Johannessen

The national breeding programme for mink and foxes was established in Norway in 1983, based on a national breeding plan. The breeding goals and strategies are presented here together with an evaluation of the results up until 1992. The most important strategy is the field recording system (Pelsdyrkontrollen). About 25% of farmers are participating in the field control, representing 17.8%, 26.4% and 26.6% of the mink, silver fox and blue fox populations, respectively. The results of the breeding strategies are discussed and related to the assumptions that were put forward. The practical adaptations of the programme are also discussed and alterations to the breeding programme proposed.

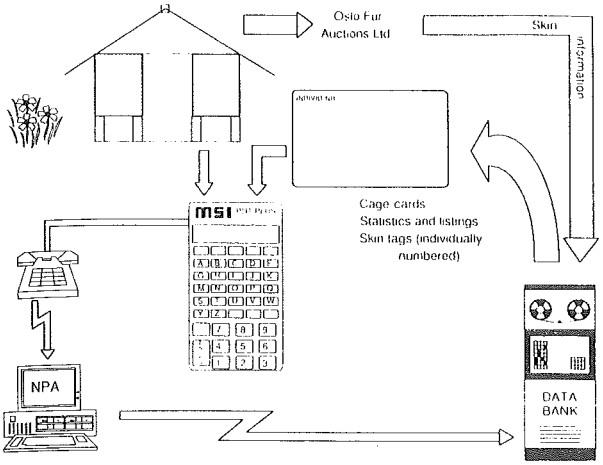


Fig. 1. Data flow and the units involved in the Norwegian field record system (Pelsdyrkontrollen)

Norw. J. of Anim. Sci., Suppl. 9, 1992, 81-86. 4 tables, 1 fig., 7 refs.

Correlation between the development of mink kits in the lactation and growth periods, correlations to fur properties and heritability estimations

Bente Krogh Hansen, Outi Lohi & Peer Berg

At birth distinct differences between sexes are found in both body weight and body length of mink kits. During the lactation period the body weight and body length at four weeks of age provide the best estimates of skin size. Much higher correlations are, however, found in September, October and at pelting. From the age of six weeks male kits show negative correlation between high body weight and fur quality of dried pelts. This correlation is increased from September onwards. The most pronounced negative correlation with fur quality is reflected in the condition at pelting, e.g. the relation between body weight and body length. For female kits the negative correlation is found only in

December. At two and four weeks of age heritability for length is higher than that for weight. Maternal effects for both length and weight increase from two to four weeks of age.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 87-92. 6 tables, 1 ref.

Enhancing mink breeding in Holland

Louise Boekhorst, Ejner Børsting

The NFE introduced two new services to their members in the late 1980s: A technical economical administration program called TEAP to improve the production efficiency on the farms and the DanMink system to improve the selection work. The TEAP program was started in 1987 as a central system run at the NFE office, and it is used by 25-30 % of the mink farms in Holland. The DanMink system, which was introduced in 1989, was the English version of the Danish PC system for mink breeding. The system is used by 25 farmers, that is, 10% of the Dutch mink farms.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 93-98. 8 tables, 2 refs.

Genetic variation in arctic foxes and in silver foxes from different farms

T. Niini, V. Simonsen, B. Larsen & O. Lohi

Blood samples from 725 arctic foxes (*Alopex lagopus*) from eight farms, 698 silver foxes (*Vulpes vulpes*) from ten farms and 32 crossbreeds (*Alopex lagopus* x *Vulpes vulpes*) have been studied by means of agarose gelelectrophoresis, starch gelelectrophoresis, isoelectric focusing and two-dimensional electrophoresis. Seventeen electrophoretic markers have been revealed, nine of them being polymorphic in arctic foxes and nine in silver foxes, but five of them were mutual to both species. The observed genetic variations, among the farms for both species are pronounced and this might be due to different breeding regimes at the different farms and/or to random genetic drift. Allelic frequencies of the loci investigated are presented as well as the level of heterozygosity within the farms and species. Genetic divergence among the farms and between the species is also shown.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 99-104. 3 tables, 12 refs.

Transponders used for identification in mink

Niels Therkildsen, Ejner Børsting & Ulla Lund Nielsen

In May 1991, 15 mink kits were subcutaneously and aseptically implanted with transponders. The transponders were easy to read and gave reliable imformation. In two cases the transponders were unreadable. X-ray pictures revealed that the transponders had disappeared from the animals, most likely because of incorrect implantation. At pelting time in December all 13 transponders were found subcutaneously where implanted. At that time it was found that the transponders were surrounded by some connective tissue, but neither the mink nor the skin were injured by the transponder.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 105-107. 3 tables, 12 refs.

Embryonal development and embryo losses during the preimplantation period in the silver fox

Liisa Jalkanen

The preimplantation period of 18 yearling silver fox females was studied on different days after artificial insemination. The mean number of corpora lutea was 5.9 per female and the number of eggs was 4.9 per female, ranging from 1 to 7. During the first two days only oviductal oocytes were present. After day 3 different stages of development from 2-cell (day 3) to hatched large blastocyst (day 14) could be seen. The oviductal passage took 4 - 6 days and the embryos entered the uterus at 4 - 8 cell or early morula stage. Degenerative changes occured in 27% of ova or embryos. The proportion of embryo degeneration was extremely high (54%) in three females inseminated with blue fox sperm compared to pure silver fox combination (29%). The relatively high preimplantational degeneration rate probably contributes to the low litter size of the silver fox.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 108-114. 2 tables, 14 refs.

Species differences in fertility after artificial insemination with frozen semen in fox pure breeding

Wenche K. Farstad, Jan A. Fougner & Kjell Andersen Berg

Field trials with frozen silver fox semen using a programmable freezer and a new automatic freezing programme were initiated in 1988. A conception rate of 80% and a mean litter size of 8 cubs resulted when frozen silver fox semen was used to inseminate blue fox vixens. The vixens were inseminated twice (24-h interval) and 100-150 million spermatozoa were deposited intrauterinely at each insemination. Also, silver fox females were artificially inseminated intrauterinely with frozen silver fox semen (double insemination, 100 million spermatozoa per insemination) yielding an 81% conception rate and 3.6 cubs per litter at whelping (n = 21, 1991). These results are comparable with those obtained for artificial insemination with fresh semen. A gene bank has been established by freezing silver fox semen obtained from superior males, i.e., rare or otherwise valuable mutants. It was assumed that cryopreservation of blue fox semen would benefit from the improvement in post-thaw semen quality obtained by the new freezing technique developed for silver fox semen. However, artificial intrautrine insemination of 70 (1990) and 52 (1991) blue fox vixens with frozen blue fox semen (2 x 100 million spermatozoa) resulted in low (33%, 1990 and 48%, 1991) conception rates and mean litter sizes of only 2.3 and 5.8 cubs born per litter, respectively. Electron microscopical studies of post-thaw acrosome integrity of spermatozoa from blue and silver foxes did not reveal any differences between the two species in the severity of prevalence of acrosomal damage. Conclusively, differences are observed between the two fox species in fertility of semen frozen by the same freezing method, but studies of post-thaw acrosome integrity of the spermatozoa or other semen parameters studied by means of light- or electron microscopy could not explain the differences in fertility results.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 115-121. 1 table, 10 refs.

Duration of spermatogenesis and spermatozoan transport in the mink (*Mustela vison*)

Holly R. Franz & LeGrande C. Ellis

The primary objective of this research was to determine the time required for development of spermatozoa from the primary spermatocyte to the differentiated spermatozoa and the epididymal transit time using ^{3}H- thymidine and autoradiographic techniques. Thirty-five days were required for the labeled sperm to appear in the head of the epididymides. Six additional days were required for the sperm to transit the epididymis and appear in the proximal end of the vas deferens. The time required for development of mature sperm from type A spermatogonia to the appearance of sperm in the proximal vas deferens was calculated as 58 days. Thus sperm used for inseminating females on 1 March would be type A spermatogonia on 31 December or 1 January (leap years) and mink with poor testicular development at this time would be infertile.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 122-127. 1 table, 2 figs., 8 refs.

The effect of management system on the developmental changes in the testes and testosterone level in the blood sera of blue foxes (*Alopex lagopus* L.)

Olga Szeleszczuk

Experiments on the effects of management systems on the morphotic and developmental changes occurring in the gonads of young and mature blue fox males were carried out on a total of 24 individuals under two management systems: (a) group light in detached cages with permanent access to light; and (b) group darkness - in roofed pavilions. The following parameters were determined histologically in the testes spermatogenic stages, presence and value of PAS (+) substance as well as the activities of Δ-5 3-β steroid dehydrogenase and diaphoresis. Changes in the spermatogenic activities of the experimental animals were observed in September and they indicated an accelerated spermatogenesis in group darkness. The highest activities of both enzymes (2.5-3.5) were observed in Jan-

uary-March. An increase in testosterone level from 0.7 to 2.0 mmol/l was observed in September in the blood sera of the darkness group males and those differences (statistically significant - $p < 0,05$) were observed throughout the experiment.

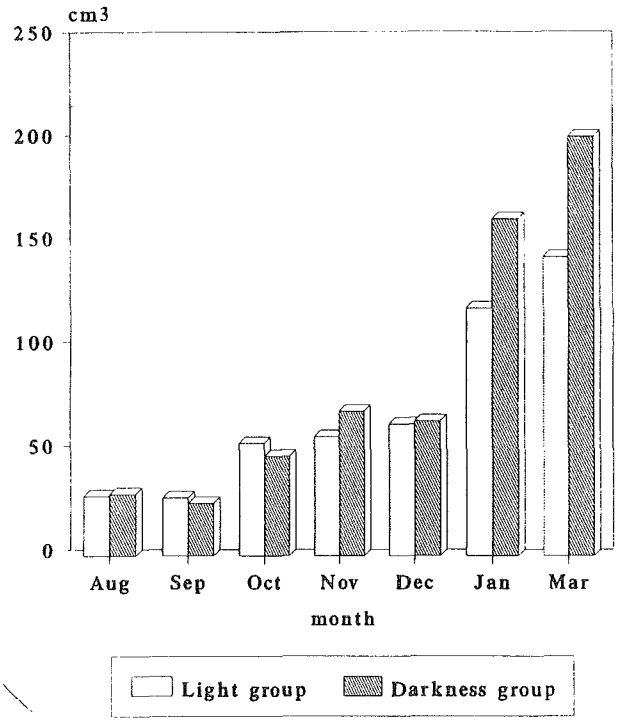


Fig. 2. Seasonal changes in volume of testes in experimental male blue fox.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 128-136. 5 figs., 1 table, 15 refs.

The biological efficacy of pregnant mare serum gonadotropin (PMSG) to stimulate reproductive function in anestrous mink

William B. Wehrenberg, Lois C. Stagg, Donald M. Voltz, LeGrande C. Ellis & Reinhold J. Hutz

The number of viable offspring raised per breeding female is critical to the economic success of mink farming.A recurring problem during the breeding season is that 2 to 5% of the herd does not breed, due to persistent anestrus. Our objective was to investigate the biological efficacy of PMSG to stimulate reproductive function in anestrous mink. Anestrous mink (n=298) were identified by ranch management on nine different commercial mink ranches in Wisconsin and Utah between 15 and 22 March. On the day of identification and two days later each anestrous female was injected with 50 IU of PMSG or placebo. Treatment was administered in a blind research design fashion. Standard breeding practices were resumed four days after the second injection. There was a significant ($p<0.05$) treatment effect of PMSG on the breeding success of these anestrous animals. PMSG-treated mink bred at a rate of 51.0%, compared with only 18.1% for the placebo-treated mink. The efficacy of treatment was further reflected in the number of breeding attempts following treatment. The PMSG-treated group averaged 3.23*0.11 attempts while in the placebo group they averaged 3.82*0.09. This significant decrease reflected the fact that PMSG-treated mink successfully bred.

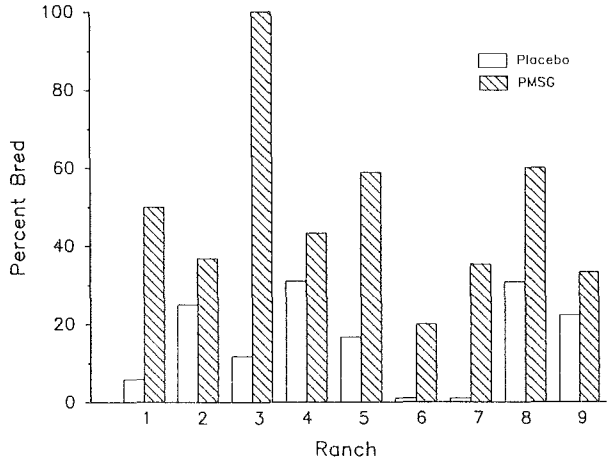


Fig. 1. The percentage of anestrous mink which bred following PMSG or placebo treatment at nine individual farms where anestrous or non-breeding mink were selected successfully at the end of the breeding season.

There was no difference in length of gestation between the two groups. The percentage of mink whelping was significantly higher in mink treated with PMSG (36.6%) versus those treated with the placebo (14.6%). Litter sizes in whelping females were similar in the two treatment groups but when averaged for all females in the study, the number of kits born was significantly higher in PMSG-treated animals (1.88*0.26) versus placebo-treated animals (0.68*0.16). These results demonstrate the efficacy of PMSG to induce estrus and successful breeding in non-

breeding mink. The ability to induce over 50% of these females to breed will directly benefit the rancher economically.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 137-144. 2 tables, 1 fig., 15 refs.

Effects of GnRH-analogue on fertility in mink

Motoaki Umezu & Shichiro Sugawara

Field trials were carried out over a three-year period to examine the effects of GnRH-analogue (fertirelin acetate) on fertility in female mink at a ranch (Zao Mink). In the first oestrus, all females were routinely mated and most mink with a second or third oestrus were later injected i.m. with 5 μg of the analogue immediately after mating. When all data were combined for the three-year period, the conception rate and mean litter size per female were 90.8% and 4.61% for the analogue group and 85.3% and 4.24% for the control group.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 145-149. 3 tables, 6 refs.

Constantly pregnant... well almost. Reproductive hormone levels of the fisher (*Martes pennanti*), a delayed implanter

R.B. Cherepak & M.L. Connor

Female fisher exhibit an obligatory delayed implantation, with a total gestation length of 327-358 days. The cues which terminate the delay, and the length of active gestation are unknown. Breeding occurs in spring one to two weeks postpartum and ovulation is believed to be induced. Blood samples were collected from 14 females over a two-year period with progesterone and oestrogen levels determined by radio immunoassay (RIA). Progesterone profiles suggest that the lengthening days following the winter solstice stimulate corpora lutea activity capable of producing progesterone levels of over 40 ng/ml. Active gestation is approximately 50 days and spontaneous ovulations are likely to occur. Oestrogen profiles suggest that seasonal follicular activity begins in early January (annual range of 17ß-oestradiol: 5-80 pg/ml).

Norw. J. of Anim. Sci., Suppl. 9, 1992, 150-154. 2 figs., 13 refs.

Fertility in mink unilaterally ovariectomized or ovariohysterectomized

Niels Therkildsen

In order to obtain information on the potential fertility in female mink, 10 and 11 mink respectively were unilaterally ovariectomized and unilaterally ovariohysterectomized and compared to laparotomized mink in the control groups. The surgery took place in the period December-January. With the limited number of females, the results in the ovariectomized mink revealed no evident difference in fertility rate and number of kits per fertile female compared to the control group. In the ovariohysterectomized mink the number of kits per fertile female was 2.6 compared with 6.7 in the control group. With a modified ELISA technique the plasma progesterone levels were measured in the gestation period in the ovariohysterectomized mink and the control group and showed equal levels with a peak at approx. 56 ng/ml just before whelping time. The remaining ovary displayed a compensatory hypertrophy.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 155-160. 4 tables, 7 refs.

Genetic and endocrine aspects in the regulation of the reproductive function in silver fox

Ludmila V. Osadchuk

Selection for domestic behaviour is accompanied by a change in the endocrine regulation of the reproductive function. Domesticated females have a lower plasma progesterone level at anoestrus than undomesticated ones, which is due to lower adrenal progesterone production. The increased plasma progesterone level in domesticated females in comparison with that of undomesticated ones at oestrus and the preimplantation period of pregnancy coincides with the higher ovulation rate in the former than in the latter. The plasma testosterone level in domesticated males is lower than that in undomesticated males in the breeding season, but this difference is eliminated during sexual activation.

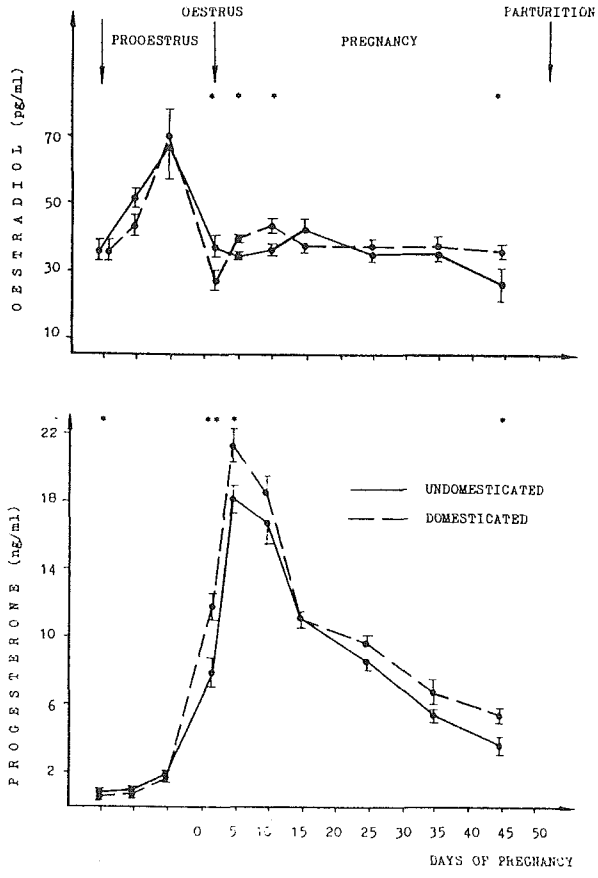


Fig. 2. Oestradiol and progesterone concentrations in the blood plasma of silver fox females during the prooestrus, oestrus and pregnancy.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 161-166. 3 tables, 2 figs., 1 refs.

Influence of exogenic Gn-RH applications on reproduction performance of standard mink females

Horst Hattenhauer, Ronald Krieg, Ute Schnurrbusch, Jens Ebert & Heinz Pingel

Once-mating systems involving ovulation induction (OI) and ovulation stimulation (OS) with single i.m. injections of 10 µg Gn-RH or 2 respective 3 µg Gonavet (D-Phe^6-LHRH) from the firm Berlin Chemie/Veyx, Germany, have been tested under commercial management conditions with regard to their action on the reproduction performances of standard mink females. The suitability of the OI and OS-sustained once-mating systems depends upon the age of the females. The best reproductive potencies were found with the OI+1 system in young females and OI+1 or 1+OS systems in old females. The reproduction performances were thereby enhanced up to or above the level of twice-mated females. The 1+OS mating systems in young females and the OI+8-9 system in young and old females were found to result in smaller litter sizes or mating rates and are therefore less suitable. A first experiment with mating ratios rising from 1 : 4 to 1 : 9 on the basis of OI-sustained once-mating, led to encouraging results with the number of born kits per male increasing to 2.6 without lowering the individual female performances. Also, the effectiveness of twice-mating systems could be elevated by exogenic Gonavet applications. Females 1+1+OS-mated showed higher litter sizes and number of corpora lutea than 1+1-mated females. The rate of oocyte degeneration and embryonic mortality remained unaffected by OS. In total, the emphasized once- and twice-mating systems with hormonal support are suitable to intensify the breeding process in mink. However, the scientific and ethical questions involved will have to be discussed before a general application can take place.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 167-173. 6 tables, 6 refs.

Collection of ungelatinizable semen from nutria (*Myocastor coypus*)

Stanislaw Jarosz & Olga Szeleszczuk

Studies on the semen collection by the ee method were conducted using: (a) deep anaesthesia (halothane or ether) or (b) premedication, using, initially, rompum (rometar 2% leciva praha) + atropine sulphate, combelen (biowet) + atropine sulphate and, later, combelen alone, which gave the same effect. Combelen was given intramuscularly at a dose of 1-2 ml depending on body weight. Both methods provided stimulation of males with an electric current of 15-25 ma and a constant voltage of 4 mv. The semen obtained from all males subjected to deep anaesthesia (halothane, ether) became gelatinized after a few seconds, whereas the semen obtained from the males subjected only to premedication (combelen) did not gelatinize even after 24-48 h storage at room temperature and at +4°c. The ability to collect ungelatinizable semen makes its direct assessment and utilization of ai possible.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 174-179. 2 tables, 9 refs.

Mouse monoclonal antibodies detect epitopes of immunoglobulin γ-, κ-, and λ-chains common to several fur animal species

V.V. Peremislov, I.V. Mechetina, I.V. Bovkun & A.V. Taranin

Diagnostics and investigation of diseases in fur animals calls for highly specific and standardized reagents to the Ig molecules of the various isotypes. A panel of 26 monoclonal antibodies specific to mink IgG was produced. Eleven antibodies reacted with the Fc-fragment of γ-heavy chains, 4 with conformational epitopes of Fab-fragment, 3 with λ-light chains and 4 with κ-light chains. In a double immunodiffusion, 23 of the 26 antibodies formed precipitin lines in the presence of polyethylene glycol. Antibodies against κ- and λ-chains, and a part of those against γ-chains cross reacted with IgG of other Mustelidae species as well as some other fur animal species remote from mink (fox, arctic fox).

Norw. J. of Anim. Sci., Suppl. 9, 1992, 180-184. 1 table, 3 figs., 7 refs.

Hypothalamic immunocytochemical localization of proGnRH and GnRH and pituitary and testicular pathology in type I and type II, primary infertile, dark male mink

Baha M. Alak, Oline K. Ronnekleiv, Jeff E. Edwards & LeGrande C. Ellis

Attempts have been made to ascertain the cause of primary male infertility using immunocytochemical localization of proGnRH and GnRH, *in situ* hybridization of mRNA for GnRH and pituitary and testicular histopathology. ProGnRH and GnRH immunoreactive neurons were observed in the preoptic basal hypothalamic to the caudal basal hypothalamic areas. Adjacent sections through the preoptic basal hypothalamus, when reacted with proGnRH and GnRH antisera, showed the same distribution indicating that the same cell reacted for both antisera. Two forms of infertility were observed: Type I had an apparently normal hypothalamic function, hypoplastic testes and microcytic degeneration of the pituitaries while Type II had degenerative testicular lesions and normal pituitaries, but insufficient GnRH secretion due either to a lack of stimulation or excessive inhibition of GnRH secretion.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 185-189. 1 fig., 7 refs.

Blood protein polymorphism in Polish foxes

A. Madeyska-Lewandowska, Christian Magnac & T. Zdunkiewicz

We have studied the polymorphism of prealbumin, α_1B-glycoprotein, transferrin, two regions of postalbumin, two systems of activity of the protease inhibitor and four regions of pretransferrin - using the methods PAGE and 2D-PAGE. These results suggest that the protein polymorphism could be used for genetic control in fox families. These examinations offer high possibilities of conforming or excluding fatherhood which may improve the results of breeding.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 190-195. 1 table, 2 figs., 14 refs.

Molecular cloning of mink immunoglobulin λ, κ and γ-chain cDNA

A.M. Nayakshin, E.S. Belousov, Yu.B. Alabjev, L.A. Bovkun, V.V. Peremislov, B. Aasted & A.V. Taranin

Immunoglobulins are encoded by a gene complex comprised of three gene families for λ-light, κ-light and heavy chains. We cloned a number of cDNAs encoding mink immunoglobulin λ,κ, and γ-heavy chains. The sequences of two λ, one κ, and one γ cDNA clones were determined and analysed. Genomic blot hybridization revealed that the mink λ-locus contains multiple V- and C-gene segments. The isolated mink genes can be used as specific probes in further studies on the organization of Ig gene families and their expression in healthy and affected minks and related *Carnivora* species.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 196-200. 3 figs., 10 refs.

Random amplified polymorphic DNA (RAPD) markers for paternity identification in multiple-sired mink litters

Shuhui Xiong, Robert L. Park, Ralph W. Andersen, R. Paul Evans & Daniel J. Fairbanks

An experiment was conducted to identify parentage in multiple-sired mink litters using random amplified polymorphic DNA (RAPD) analysis. Genomic DNAs were prepared from ear tissue collected from individuals in six multiple-sired mink litters. Several 10-mer arbitrary primers were screened for polymorphisms. RAPD pro-

ducts were separated and visualized through 1.5% agarose gels. Selected primers amplified reproducible polymorphic DNA markers that could be used to identify litters if the marker was present in one sire and absent in the dam and the other sire. The parentage of all progeny in multiple-sired litters was identified using these primers. In addition, a male-specific RAPD marker was found. Analysis of two or three RAPD markers can accurately and efficiently identify parentage in a multiple-sired litter in mink.

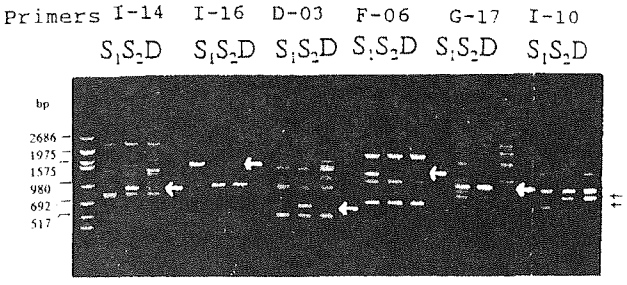


Fig. 1. Primer screening with mink DNAs. The polymorphic markers (arrow) were stably reproducible. PrimerG-17 amplified a male-specific marker (arrow).

Norw. J. of Anim. Sci., Suppl. 9, 1992, 201-205. 3 figs., 9 refs.

Immunohistochemical study of GH and PRL cells in the mink (*Mustela vison*) during its growth

S. Vidal, P. Sánchez, A. Román & L. Moya

No detailed studies have been performed on the histomorphological changes in GH and PRL cell populations during the growth of mink. We sought to determine these changes by means of immunohistochemistry Avidin-Biotin Complex (ABC). In our study we used 24 farm mink of the wild variety, including six 3-week-old mink (beginning of lactation), six 2-month-old (end of lactation), six 6-month-old (pre-puberty) and six 8-month-old mink (puberty), with 50% male and 50% female in each group. The hypophyses of these animals were perfused and fixed with 2% paraformaldehyde-0.5% glutaraldehyde in 0.1M cacodylate buffer (pH 7.4-7.6) and then removed and postfixed by immersion in the same fixative, for two hours at 4°C. Only the right hemihypophysis was used, and this was embedded in para-plastin and then serially cut at 3μm. The sections obtained were labelled with either human anti-GH raised in rabbit (NIDDK-AFP-1613102481) 1:500 or human anti-PRL raised in rabbit (NIDDK-AFP-55781789) 1:1000. Pronounced age-related changes were observed for these morphometric parameters studied. The results of this study reveal the strong correlation between the observed changes and the growth and the onset of puberty.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 206-212. 6 figs., 18 refs.

Immunogold identification of the GH and PRL cells in the suckling mink (*Mustela vison*)

S. Vidal, A. Ruíz-Navarro, F. Gracia-Navarro & L. Moya

PRL and GH cell types have been identified ultrastructurally in the adenohypophysis of many species on the basis of the size and shape of the secretory granules. However, more definitive identification of these cell types is required. Accordingly, we used an immunogold method. In our study 12 farm minks of the Wild variety (50% male and 50% female) were used, of which six were 3-week-old kits (beginning of lactation) and six were 2-month-old kits (end of lactation). The hypophyses of these animals were perfused and fixed with 2% paraformaldehyde-0.5 % glutaraldehyde in 0.1 M cacodylate buffer (pH 7.4-7.6) and then removed and refixed in the same fixative, for two hours at 4°C. Only the left hemihypophyses were used and these were postfixed in O_4Os 1 h. at 4°C. The samples were embedded in Epon. The ultra-thin sections were labelled by means of the immunogold method with human anti-rabbit GH (NIDDK-AFP-1613102481) and human anti-rabbit PRL (NIDDK-AFP-55781789). Our study demonstrated that the immunocytochemical localization of the different adenohypophysis hormones seemed the best way to make an accurate identification of the adenohypophyseal cells.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 213-217. 3 figs., 12 refs.

Nutrition

Recent advances in the nutrition of fur animals

Niels Enggaard Hansen

During the ca. 100 years of fur animal domestication, there has been a line of continuity from the preliminary task of composing a usable feed ration via examination and description of the individual feedstuffs to the determination of standards for energy and nutrient supplies in the different stages of the production cycle of the animals. Research on the more basic subjects was not initiated until recently, which is reflected in the present limited knowledge compared with results available regarding other species of domestic animals. With reference to the nutritional subjects discussed at the IVth International Congress in Fur Animal Production held in Toronto (Murphy & Hunter 1988) and more recent publications, the aim of this paper is to give an overview of the ongoing research work and to suggest potential future experimental areas. The literature review should be seen in that light. A conventional approach to the subject is maintained by discussing separately the topics digestibility of nutrients, energy and nutrient supply and specific effects of amino acids, minerals and vitamins. The conventional division of the subjects into digestibility of the nutrients, their contribution to the energy requirement of the animals, and the specific effect they may also have, including being an amino acid source, is maintained. Finally, an attempt will be made to identify future trends and areas within nutrient research which require further study.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 221-231. 1 table, 1 fig., 46 refs.

Use of ferret kits in the assessment of the biological value of protein in dehydrated mink feedstuffs

W. L. Leoschke

Practical mink ranch diets in North America provide the animals with about 32% of total metabolizable energy (M.E.) as digestible protein. Studies on the biological evaluation of protein quality in dehydrated mink feedstuffs with mink kits have used experimental diets with digestible protein quantity limited to 28% M.E. Research studies designed to employ ferret kits for the evaluation of protein quality in dehydrated mink feedstuffs indicate that digestible protein levels should be limited to 20% M.E.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 232-234. 2 tables, 2 refs.

Effect of flushing on LH release in mink

Anne-Helene Tauson & Mats Forsberg

LH release, oestradiol-17β, and number of corpora lutea (CL) were studied in two groups of 10 standard mink females after a single mating on 10 March and after the second of two matings on 9 and 17 March. The control group was kept in energy equilibrium, while in the flushing group, a two week period of 20% energy restriction was followed by *ad libitum* feeding from 5 March. Blood samplings, twice daily (07.00 h and 15.00 h), were started one day before and lasted until 3 days after matings. Generally, LH peaks were more distinct and more synchronized in the flush-fed females than in controls. Elevated concentrations of LH tended to be recorded later after the second matings than after the single matings. For females with distinct peaks, elevated LH concentrations were recorded during approximately 24 h.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 235-241. 3 tables, 1 fig., 12 refs.

Different dietary fat:carbohydrate ratios for blue fox in the reproduction period. Effects on reproduction, kit growth, milk composition and blood parameters

Øystein Ahlstrøm

The aim of this study was to examine the effect of different dietary fat:carbohydrate ratios on blue fox in the reproduction period. The fat: carbohydrate ratios in the experimental diets on a metabolizable energy basis were 55:1, 43:13 and 35:25. In an experiment, which included 39 blue fox females, blood analyses were carried out at eight stages from *ca.* 25 days prepartum to *ca.* 42 days postpartum. Plasma concentrations of

triacylglycerols, free fatty acids, cholesterol, acetoacetate, glucose, albumin, total protein, urea, alanine aminotransferase, aspartate aminotransferase, calcium and phosphate revealed characteristic changes due to pregnancy and parturition. A high fat:carbohydrate ratio in the diet promoted a significantly higher plasma content of cholesterol and acetoacetate. The milk fat content tended to increase with increasing fat:carbohydrate ratio in the feed. The number of kits born was not affected by diet. The kit mortality was highest in the group receiving the highest fat:carbohydrate ratio. On the other hand, kit growth was reduced on the lowest dietary fat:carbohydrate ratio.

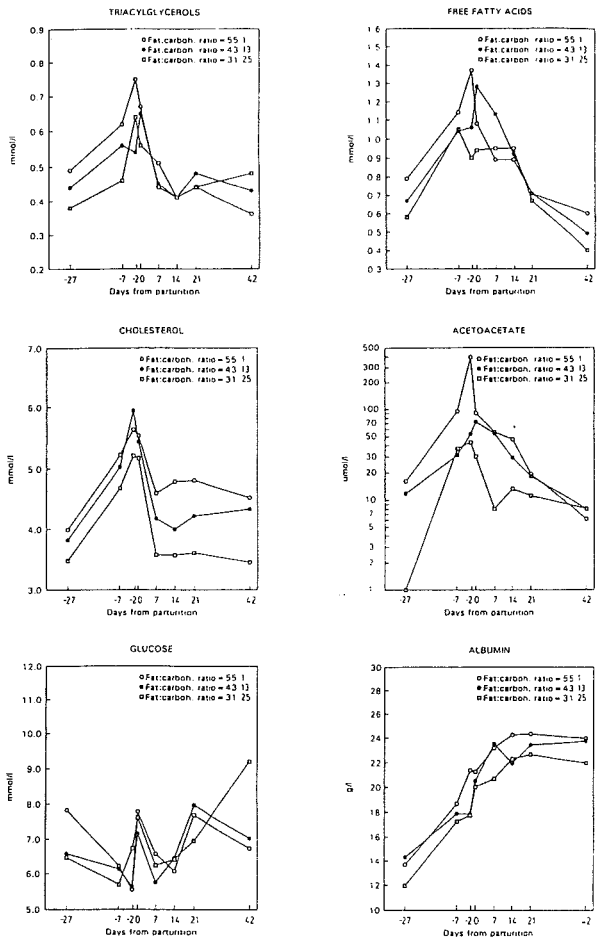


Fig. 1. Average plasma concentrations of triacylglycerols, FFA, cholesterol, acetoacetate, glucose and albumin in blue foxes fed different dietary fat:carbohydrate ratios.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 242-248. 1 table, 2 figs., 6 refs.

Effects of fish fat feeding on body fat composition of foxes

Kirsti Rouvinen

Ranched blue and silver foxes were fed saturated fat (SF) and fish fat (FF) diets from weaning to pelting in order to clarify the effects of accumulation of omega-3 fatty acid in the body. Five males from each dietary group were sampled. The dietary background significantly influenced the fatty acid composition of all body fat depots in both fox species. The animals from the FF group had considerably more eicosapentaenoic (EPA), docosahexaenoic (DHA) and cetoleic acids in their tissues than the animals of the SF group. Moreover, silver foxes in the FF group had significantly higher levels of DHA in the liver (21.7%) compared to blue foxes (17.0%). In the SF diets, fat accumulated in the liver in large droplets, while in the FF diets it was present in small droplets. Furthermore, according to the histopathological evaluation, degenerative changes were more numerous and severe in the FF dietary group.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 249-253. 2 tables, 10 refs.

Accuracy of nitrogen balance measurements in adult mink

Jan Elnif

When comparing nitrogen balances measured in traditional balance trials with balances measured by slaughter techniques it is found that, the balance trials tend to overestimate the N retention. Some reasons for these differences might be an inappropriate collection of nitrogen excreted in the feces and urine and loss of nitrogen in the form of volatile ammonia. In 36 balance studies carried out in respiration chambers, the amount of ammonia released in 24 h accounted for 1.7-2.9% of the nitrogen found in urine. Data from method studies, in which mink urine with a known N concentration was used, showed that by applying different collecting and washing routines, 62 to 71% of the nitrogen excreted could be accounted for. Therefore, when performing nitrogen balance trials, it is recommended that the retrieval percentage of nitrogen for the routine applied be estimated.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 254-260. 3 tables, 9 refs.

Energy metabolism and foetal growth in the pregnant mink (*Mustela vison*)

Anne-Helene Tauson, J. Elnif & N. E. Hansen

Energy metabolism, weight of uteri, and selected blood parameters were studied in three groups of mink females, each comprising six animals, before mating, at the estimated time of completed implantation and close to estimated time of parturition. One-week balance periods included a 24 h measurement of heat production (HE) by means of indirect calorimetry in open-air circuit respiration chambers. At the end of each balance period, blood samples were taken and the animals were killed for collection of uteri. HE was not significantly affected by stage of gestation. Weight of uteri averaged 1.11 ± 0.16 g before mating, 3.29 ± 1.68 g in females that had recently become implanted, and 88.7 ± 53.1 g in pregnant females with 4-11 foetuses, indicating that the major part of energy retention in foetal tissues occurs close to parturition. Late gestation values for plasma protein, albumin, cholesterol, and creatinine differed significantly from preceding periods.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 261-267. 3 tables, 17 refs.

Apparent and true digestibility of dry matter, crude protein and amino acids in diets for mature silver foxes

W.L. Faulkner, l.A. Egan & D.M. Anderson

The availability of amino acids to mature silver foxes and the influence of gut microbes on digestibility of nutrients are relatively unknown. Twelve adult male silver foxes were used to examine the utilization of dry matter (DM), crude protein (CP) and amino acids in a meat-type basal diet (A) when 15% was replaced by soybean meal (S), fishmeal (F) or meatmeal (M), or 25% replaced by wheat (W) or hulless oats (O). Half of the animals received weekly oral doses of the antibiotic Furazoladone (1 ml/5kg body weight) to estimate the effect of gut microbes on the availability of nutrients. True digestibility coefficients of CP and individual amino acids were found to be 3-8% units higher than those of apparent digestibility. Administration of antibiotics significantly improved the apparent digestibility of CP and ten individual amino acids by approximately 2% units. However, antibiotics significantly reduced the true digestibility of CP. It was concluded that the endogenous fraction in silver fox feces appears considerable; hence, true digestibility coefficients may be more valuable than those of apparent digestibility. The microbial population in the gut of silver foxes seems substantial and may be capable of reducing nutrient digestibility.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 268-274. 3 tables, 9 refs.

The effect of protein source on digesta passage and nutrient digestibility in polar foxes

Roman Szymeczko, Gunnar Jørgensen, Henryk Bieguszewski, Christian Børsting

A digestibility experiment with six male polar foxes was conducted with three different sources of dietary protein, which were supplied by cod fish, cod fish and fishmeal, or fishmeal, respectively. A significant effect of the source of protein on ileal and total digestibilities was found. The highest values for the apparent digestibility of nutrients (dry matter, nitrogen, and amino acids) were found in the experimental animals fed on the diet with cod fish. An increase in fishmeal content in the investigated diets caused faster digesta passage and a decrease in nutrient digestibilities. No statistically significant differences ($p > 0.05$) in apparent fat digestibility were noted.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 275-281. 7 tables, 15 refs.

Microbiological and proteolytic spoilage of fur animal feed

H.A.P. Urlings, C.H.C. Van Oostrom & P.G.H. Bijker

A laboratory trial was conducted to investigate spoilage of fur animal feed on the wire of the pens. Three types of mink-feed formulae were tested: (1) broiler by-products (pasteurized and fermented) mixed with raw fish; (2) broiler by-products (pasteurized and fermented); and (3) control feed (raw broiler by-products mixed with raw fish). The feed was stored in portions of 200 g at 20°C for 20 h. A rapid bacterial growth was observed in the control feed resulting in a pH drop from 6.2 to 4.9 during the 20 h of storage. During storage the TVN/total N in-

creased from 1.3% to 1.9%. In feeds 1 and 2 no changes were observed in the number of bacteria, pH (5.2 and 4.4, respectively) and TVN/total N. It is concluded that fur animal feed without any preservative agent is spoiled within 20 h at ambient temperatures of 20°C or more. Consequently, unless fur animals are fed at least twice a day, their feed should include an effective preservative against both microbial and enzymatic spoilage.

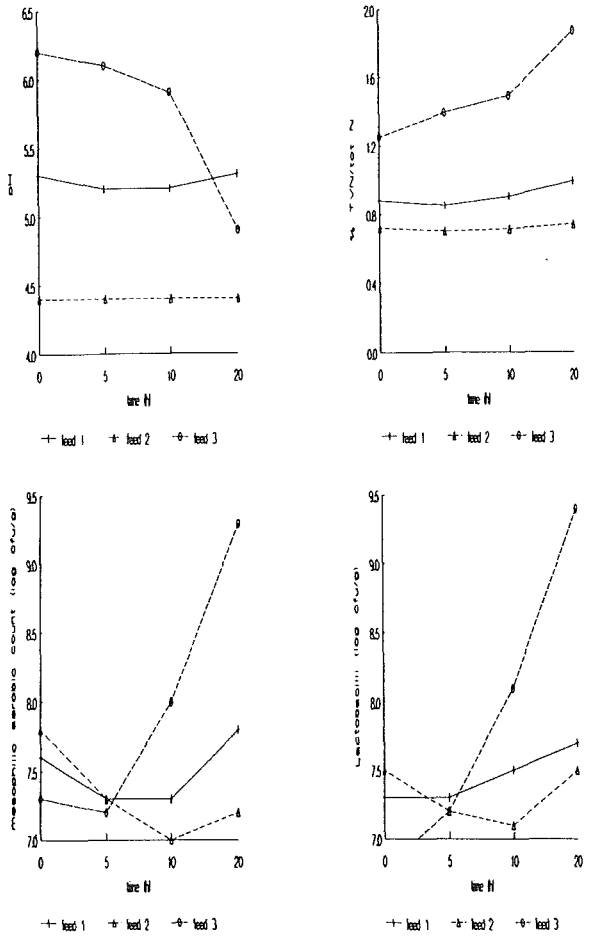


Fig. 1. pH, TVN/total N, mesophilic aerobic count and *Lactobacili* count (in $\log N.g^{-1}$) in feed formulae 1, 2 and 3 during 20 h of storage at 20°C (see table 1 for feed composition).

Norw. J. of Anim. Sci., Suppl. 9, 1992, 282-288. 1 table, 2 figs., 15 refs.

The effects on some physiological and performance indices of adding formic acid-preserved feed to the meat ration of ferrets

Beata Glowinska & Henryk Bieguszewski

Forty young ferrets divided into two groups of 20 were used in the study. The control group was fed a diet containing 40% fresh meat offal, 10% fish offal, 25% cooked pearl barley, 10% wheat bran, 8% green forage and vegetable and 7% sour milk. The meat ration of the experimental group (E) consisted of 15% fresh meat offal and 25% meat offal preserved with formic acid (1.5 kg formic acid was added to 100 kg meat feed), the other ingredients of the diet were the same as those in the control group. The supplementation of ferret feed with formic acid-preserved feed had no effect on the acid-base parameters, the body weight and grading of live animals, but a decrease was observed in the digestibility of crude protein.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 289-292. 4 tables, 7 refs.

Morphological and biochemical indices of blood of mink fed with chemically preserved feed additives

Henryk Bieguszewski & Beata Glowinska

The experiment was carried out in two series with standard mink. In experimental group 1 of the first series, 50% of the frozen meat-fish fodder was replaced with feed preserved with formic acid. In experimental group 2, 33% of the meat-fish was replaced by slaughter blood preserved with sulphuric acid and sodium benzoate. The meal ration of experimental group 1 in the second series was the same as that in the control group in the first series but 5 ml formic acid was added to 1 kg fodder each day. Mink of the second experimental group received the same diet as that in the second experimental group in the first series but only slaughter blood was preserved with sulphuric acid. No significant differences in the morphological and biochemical indices, acid-base balance parameters

or the iron level and TIBC in mink fed the diet with formic acid were found. The addition of slaughter blood preserved with sulphuric acid and sodium benzoate or with sulphuric acid only to the meal ration of mink, had a slight effect on some indices of the red blood cell system. In experimental group 2, no change occurred in the biochemical indices, acid-base parameters, iron level of blood plasma or TIBC.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 293-297. 3 tables, 9 refs.

Taste appeal trials with poultry offal for mink

Bente Lyngs

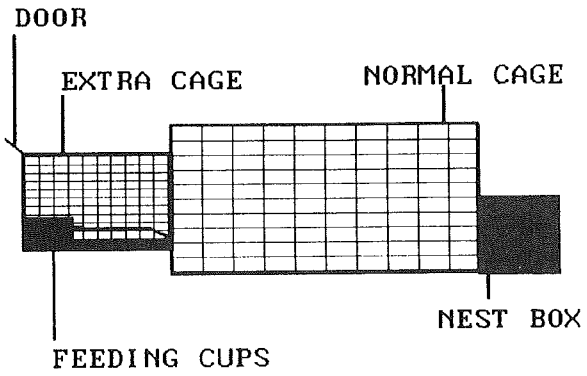


Fig. 1. Cage used for taste appeal trials with mink - seen from the side.

The purpose of taste appeal trials is to achieve an expression of the effect of ingredients and feed composition on the feed consumption of the animals, primarily as a response to smell and taste. Trials are carried out either with lactating females or with growing kits. Each experiment lasts four weeks, and two groups of 10 females or two groups of 10 male kits and 10 female kits are used. In weeks 1 and 4 all the animals have the opportunity of choosing their feed, in weeks 2 and 3 the two groups are only offered one of two kinds of feed. Feed consumption and weight gain are registered. Trials where poultry offal is added to the feed have shown that lactating females, kits in the early growth period and kits in the late growth period all prefer feed containing poultry offal ($p < 0.0001$ in all trials).

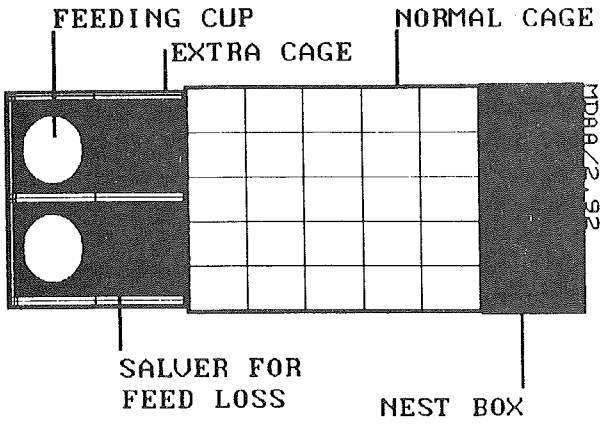


Fig. 2. Cage used for taste appeal trials with mink - seen from above.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 298-307. 2 tables, 9 figs., 4 refs.

Compositional changes in mink (*Mustela vison*) milk during lactation

Carsten Riis Olesen, Tove N. Clausen & Søren Wamberg

Preliminary longitudinal studies on changes in mink milk composition were carried out. Milk samples were obtained in 34 apparently healthy Pastel mink throughout the normal six-week lactation period. A parallel and significant increase in milk fat and dry matter (DM) was observed during the entire lactation period. The protein content of mink milk varied within 8-10%, whereas lactose decreased significantly from the initial value of 2.5%. Moderate changes were observed in mink milk osmolality but significant changes were observed in several major electrolytes. Mean concentrations of calcium and phosphorus increased during lactation (from 22 to 40 mmol/l and from 35 to 48 mmol/l, respectively). Sodium and chloride varied considerably (range: 35-60 mmol/l). Magnesium remained fairly constant at 3 mmol/l, while potassium decreased from 33 to 26 mmol/l. A large individual variation was encountered in all variables tested. The results are discussed with respect to

species differences and in relation to the estimated nutritional requirements of nursing kits.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 308-314. 3 tables, 22 refs.

Effects of dietary fluoride on growth, reproductive performance, and tissue fluoride levels of the fox (*Alopex lagopus*)

Daniel G. Chausow, Arnold B. Clay & John W. Suttie

The effects of dietary F on fox growth, reproduction, and tissue F accumulation were evaluated by feeding a commercial pelleted diet (104 mg F/kg) supplemented with 0, 50, 150, or 250 mg/kg F (as NaF). Body weight gain of three-month-old blue fox pups was not affected by dietary F addition and plasma, urine, and femoral F concentrations increased linearly with increasing dietary F. No treatment effects were observed on fur density, color, or texture. Females from each group were maintained on their respective diets through three successive breeding cycles. Addition of 250 mg F/kg to the diet had no effect on litter size or pup body weight at four weeks of age. Pup survival rate at four weeks was adversely influenced by 250 mg F/kg only during the third litter. Growth rates of pups maintained on their dam's experimental diet were not affected by dietary F level. Skeletal or dental signs of F toxicosis were not observed at any time during these studies. During the third breeding season, vixens were switched from 50 mg/kg supplemental F to 600 mg/kg F. Pups whelped to these females had reduced survival rates, but litter size and lactation performance were not affected. Based on the results of these studies, fox are relatively tolerant of dietary F.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 315-320. 2 tables, 8 refs.

The influence of zinc supplementation on growth and reproduction of mink

Heinz Pingel, Manfred Anke & Elke Salchert

During a three-year period an investigation was carried out on the effects of zinc supplementation on growth and litter size in standard mink. The mean content of zinc in the analysed feed exceeded the recommended level, but the lower zinc intake was reflected in the zinc of hairs of growing mink. It was found that the daily zinc intake of less than 6 mg by female mink before and during the breeding season compared with an intake of more than 10 mg zinc tended to reduce the litter size. The high Ca-concentration of mink feed (C as a Zn antagonist) has to be considered in further investigations.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 321-325. 6 tables, 7 refs.

The effect of dietary acidifiers in diets of mature ranched foxes with a history of chronic urolithiasis

M.B. White, L.A. Egan & D.M. Anderson

In an eight weeks' trial 24 adult male silver foxes were studied, in a complete randomized block with fixed effects, in order to evaluate the effect of dietary acidifiers. The animals were fed a dry diet at 190 g/day or the same diet supplemented with acidifiers; ammonium chloride (0.99%), phosphoric acid (2.68%) or Alimet, a methionine hydroxy analogue (1.68%). Biweekly, three days' voided urine, sterile urine and blood were collected. Blood packed cell volume (PCV), blood creatinine, blood urea nitrogen (BUN), urine pH, urine culture and urine specific gravity were measured. No significant differences ($p<0.05$) were observed among treatments for PCV (44.6-45.8 ml/100ml), BUN (6.11-6.81 mM/l), blood creatinine (74.2-84.7 mM/l) and urine specific gravity (1.036-1.043). However, a significant difference ($p<0.05$) was evident for urinary pH between the control diet (7.5) and the treatment containing phosphoric acid (6.2), with the other acidifiers producing median values.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 326-331. 2 tables, 12 refs.

Feeding devices reduce waste in mink feeding

Kirsti Rouvinen, Derek M. Anderson & Steven Alward

Wet feeding devices for mink were compared to the conventional feeding on cage wire. The treatments were: 1) dry pellet feeder, 2) control, wet feed on wire, 3) spill tray, 4) slant tray, and 5) cup feeder. The first experiment was performed during the suckling period using five fe-

males with litters per group. The second experiment was run during the growing-furring period with two males and three females in each group. The feed consumption and the amount of feed wasted were measured on a dry matter (DM) basis. The influence of dietary DM on the amount of feed wasted was also clarified. During the last two weeks of the suckling period, the feeder groups wasted significantly less feed (week 1; 7-10 %, week 2; 5-12%) than than the control group (17%, 21%), respectively. During the growing-furring period, the average amount wasted in the feeder groups (1-3%) was also significantly lower than the control (6.5%). One percent decrease in the dietary DM increased the feed waste by 3.8%, when the DM of the diet declined from 33-25%.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 332-335. 1 table, 3 refs.

Effect of storage time on the stability of ALAT, ASAT, CK, urea and creatinine in mink plasma

Birthe M. Damgaard

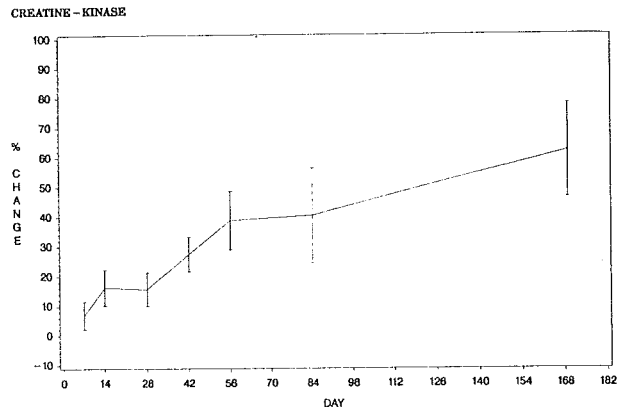


Fig. 1. Changes (%) in initial activity of creatinine kinase (CK) in plasma during storage at -20°C. Mean values and standard deviation (±SD).

In physiological investigations of mink blood it is often desirable to store plasma samples for some time prior to carrying out an analysis. The purpose of this study was to examine the stability of alanine aminotransferase (ALAT), aspartate aminotransferase (ASAT), creatine kinase (CK), urea, and creatinine in mink plasma stored at -20°C. Blood samples were collected from 10 male mink. The plasma samples were immediately aliquoted and frozen at -20°C. One aliquot of each sample was analysed after 7, 14, 28, 42, 56, 86, and 168 days. Storage time had a strong effect on the stability of the enzymes CK, ALAT and ASAT. The effect was most pronounced for CK, less so for ALAT and least of all for ASAT. The stability was high for urea, and creatinine was stable.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 336-341. 2 tables, 3 figs., 6 refs.

Feeding breeding fitches with diets at various levels of energy from fat and carbohydrates

Boguslaw Barabasz & Stanislaw Jarosz

The aim of these studies was to attempt to define the optimal fat:carbohydrate energy ratio in diets for fitches. Experiments were carried out in the years 1986-89 on a total of 120 mature females and 50 males as well as on 200-280 young fitches. The animals were divided into three experimental groups and fed diets with the same level of protein (30% of dietary ME) and various levels of fat (30-60% ME) to carbohydrate (10-40% ME) energy ratio. The results included reproduction indices for females and males, and growth rate and quality of winter fur coat in kits.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 342-347. 4 tables, 9 refs.

Effect of feeding intensity prior to parturition on postnatal growth in blue foxes (*Alopex lagopus*)

Maria Rusanen & Ilpo Pölönen

The objective of this experiment was to investigate whether feeding intensity during gestation affects lactation rate and, hence, cub growth in blue fox. Ninety-three nulliparous blue fox females were divided into low (LE) and high energy (HE) groups which received 14.6 and 19.5 MJ of ME/kg dry matter, respectively, from gestation day 35 onwards. From day 3 postpartum both groups were fed HE diets. Energy change at the beginning of the third trimester resulted in more rapid growth of cubs during lactation. Cub weights at 14 and 21 days of age were 231 and 361 g with the LE diet and 189 and 336 g with the HE diet, respectively. Differences were significant at both stages. Preparing females for lactation during the third trimester proved to be beneficial and resulted in

higher growth rates of cubs.

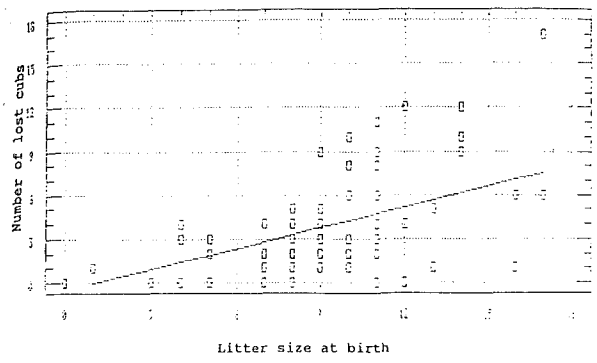


Fig.1. Number of cubs lost during the first three weeks of life as a regression on litter size at birth (cubs lost = 0.58*litter size at birth - 1.58. $p>0.001$, $R^2=24.1\%$).

Norw. J. of Anim. Sci., Suppl. 9, 1992, 348-354. 3 tables, 2 figs., 10 refs.

Pathology and diseases

Fur animal health: current status

Knut Nordstoga

A survey is given of the most common traditional diseases in fur-bearing animals, together with a brief presentation of some recently described ailments. Most of the more or less specific contagious conditions for fur animals can be controlled by vaccination or hygienic measures in countries and areas in which a high standard is maintained in the raising of fur-bearing animals; an important exception is plasmacytosis in mink which still causes considerable losses despite the good results achieved with eradication programs, based on the counterimmunoelectrophoresis test. Feed-borne infections can be prevented or considerably limited by hygienic precautions or by boiling of suspect components in the feed. Some previously unrecognized conditions relating to nourishment have appeared during recent years; some of these conditions occur in rapidly growing individuals that are given special growth-promoting diets. It is suggested that these groups of conditions will be on the increase when fur animals are raised under otherwise optimal conditions. Genetically determined disorders may be excluded by selection, although there seem to be situations in which genetic factors play a contributory role in the development of diseases not considered as hereditary. Such multifactorial diseases are frequently difficult to explain fully, and their existence will probably represent a challenge to research on fur animal diseases in the future.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 363-377. 44 refs.

Energy demand of the coypu from weaning to maturity

S. Kuosmanen-Postila & M. Harri

Weight gain, feed intake and efficiency of gain were measured for five silver (S-group) and four beige (B-group) coypus from weaning until the age of 50 weeks. Both groups gained weight steadily until the age of 38 weeks, after which they began to lose weight. A plot of the average feed intake (y, g/day) on age (x, weeks) yielded the equations: $y = 33.84\ x^{0.50}$ ($r=0.96$) and $y = 25.83\ x^{0.49}$ ($r=0.78$) for the S- and B-groups, respectively. From the weights 1 kg to 4 kg the total gross energy (GE) demand was 231 MJ/animal for the B-group and 275 MJ/animal for the S-group. To reach 5 kg, an additional 154 and 142 MJ/animal, respectively, were needed. Low temperature resulted in increased feed intake, and slowed down weight gain. GE digestibilities in the S- and B-groups were 71.4 ± 5.8% (±sd) and 69.6 ± 5.7%, respectively. N digestibility was significantly better in the S-group (77.2 ± 4.8%) as compared with that in the B-group (74.4 ± 4.8%) ($p<0.001$).

Norw. J. of Anim. Sci., Suppl. 9, 1992, 355-360. 4 figs., 15 refs.

Towards a more specific serological diagnosis of Aleutian disease

Åse Uttenthal & Mogens Hansen

Counterimmunoelectrophoresis (CIEP) is used worldwide to test mink blood for the presence of antibodies against the parvovirus infection ADV. This serological method is fast, inexpensive, sensitive and easy to perform, with a limited number of manipulations required. Currently more than 80% of the Danish mink farms have been tested and 67% of the farms are free from Aleutian disease. Since we sometimes test animals that are diagnosed as weakly positive, the need for a more specific serological diagnostic method arises. CIEP is still our method for routine diagnostics, but when occasional positive reactors appear in an otherwise negative population, we have several methods for re-evaluating the samples. The positive mink are killed and serum collected by heart puncture. Liver and kidney are formalin fixed. Our routine re-examination is by CIEP and Rocket line immuneelectrophoresis (RLIE), but an additive CIEP has been developed that can distinguish false positive reactions from a faint but true precipitin line. We have tried to use Western blotting and peroxidase labelling of virus in cells by means of the patient serum, but up until now it seems that this method is of rather low sensitivity.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 378-382. 1 fig., 6 refs.

Early detection of Aleutian disease virus in mink by polymerase chain reaction

M. Keven Jackson, LeGrande C. Ellis, John D. Morrey & Dale Barnard

Comparisons were made of counter-immuno-electrophoresis (CIEP) of serum samples with polymerase chain reaction (PCR) amplification of DNA extracted from peripheral blood cells for the diagnosis of Aleutian disease virus infection. Mink were infected with an intraperitoneal inoculation of 100 µl of a 10% spleen homogenate from an infected mink. At day 0 all mink were tested negative by PCR and CIEP. On day 3, two mink were positive by PCR. One of the mink was also tested positive by CIEP by day 3, but not by PCR. Seven days after inoculation, one mink was positive by PCR, but all five were tested negative by CIEP. At ten days, four mink were positive by PCR and all five were positive by CIEP. PCR was combined with Southern blot to increase the sensitivity of detection. This method was found to be too sensitive, in that nine out of ten mink found to be negative by CIEP were positive by PCR combined with Southern blot. Although the reagents used for the assay were not contaminated, the high numbers of false positives was probably due to contamination of samples. PCR may be combined with the CIEP test to allow a more sensitive detection of Aleutian disease virus in valuable breeding stock, but Southern blotting should not be combined with PCR because of the high number of false positive results.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 383-387. 1 table, 5 refs.

Enzyme immunoassay of antibodies against Aleutian disease virus

S.M. Miroshnichenko, V.V. Peremislov & A.V. Taranin

Two highly specific and sensitive procedures of enzyme immunoassay were developed for detection of antibodies against Aleutian disease virus. The ELISA procedure on 96-well microplates was used for screening of mouse hybridomas; dot immunoassay was used for testing mink sera applied onto nitrocellulose. The ELISA and dot assay were shown to be 1000 and 100 times, more sensitive, respectively, than countercurrent electrophoresis. Dot assay revealed 19% more positive samples than counterimmunoelectrophoresis in comparative analysis of 1250 mink from farms affected by Aleutian disease. Dot immunoassay was found to be comparatively less time- and labor-consuming and may be regarded as a useful diagnostic test.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 388-392. 7 refs.

Hereditary spongy degeneration of white matter in silver foxes

Gunnar Hagen & Inge Bjerkås

Hereditary spongy degeneration of white matter in silver foxes is a rare genetic disorder of the central nervous system. We report on continued breeding studies of the disease and correlate

pathomorphologic lesions in the CNS with clinical signs at different stages of the disease process. Fifty-three silver fox cubs were born in 14 litters, and 29 of these developed spongy degeneration of white matter. The distribution of affected cubs within litters strengthens our previous assumption of an autosomal recessive mode of transmission. Twelve affected cubs were allowed to live beyond the period of maximal disability, and they all showed marked clinical improvement after five months of age. Vacuolation of the myelin-forming oligodendrocyte is an important early lesion in this disease. The onset of clinical signs can be correlated with the development of marked vacuolation of myelin sheaths, expansion of extracellular spaces and demyelination, while the clinical improvement in older foxes coincided with resolution of the vacuolation and remyelination. In conclusion, the present condition in silver foxes provides a model for detailed investigation of a naturally occurring myelin disease.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 393-397. 3 tables, 4 refs.

Distemper in mink in the NW of Spain

J.M. Nieto, I. Quiroga, M. López, R.F. Antonio

An episode of distemper was diagnosed between July and December in a group of mink farms near one another in NW of Spain. The farms have a high level of Aleutian disease infection. Thirteen animals died, Wild and Standard varities, with a clinical history of acute distress, thickening of the foot pads and hyperkeratosis. The mink were autopsied, and samples from different tissues were collected according to the routine for histopathological studies. Interstitial pneumonia, hyperkeratosis and inclusion bodies in the epithelia and nervous tissue were the most important findings. An indirect immunoperoxidase technique using a monoclonal antibody against the nucleocapside of the distemper virus demonstrated the presence of a viric antigen, as described for the systemic phase of the disease. All animals were positive to the Aleutian disease CEIP test and two animals had lesions of progressive Aleutian disease.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 398-404. 2 figs., 24 refs.

Maternal immunity in mink kits to mink virus enteritis and distemper

J. Keith Hulsebos

Studies were carried out to investigate mink kits from females which were revaccinated with a distemper and MEV-containing vaccine just prior to breeding and/or experienced a mink virus entritis (MEV) field exposure. Animals from two different farms were tested. The focus on the first was MEV and on the second, distemper. Serological data were collected in addition to challenge data. For both agents, based on challenge data, a successful vaccination could be given when the kits were 10 weeks of age. One hundred percent of the unvaccinated kits were susceptible to distemper infection at 16 weeks and to MEV infection at 12 weeks of age.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 405-412. 5 tables, 11 figs., 7 refs.

Parvovirus infection and reproduction in blue fox vixens in Norway. Field studies and experimental infections

Astrid Indrebø & Bjørn Hyllseth

Field studies: The antibody titre against parvovirus using the haemagglutination inhibition test (HIT) was studied in blood samples from 585 blue fox vixens in 37 farms in 9 counties in Norway. Seropositive animals were found in 15 farms. There was no statistical significant difference in litter size in seronegative and seropositive farms. Experimental infections: 16 seronegative vixens were inoculated with cell culture grown blue fox parvovirus on day 17 or 18 after the last mating. A similar group received harvest from non-infected cell culture, and a third group received no inoculum. The uterus was examined for placenta zones at the time of pelting. Clinical, reproductive or serological data did not indicate an association between parvovirus infection and foetal losses in blue fox vixens. Based on these studies vaccination of blue foxes against parvovirus is not recommended in Norway.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 413-419. 2 tables, 10 refs.

Fleas and farmed mink

Kim Søholt Larsen

Several flea species are present on farmed mink. The squirrel fleas *Monopsyllus sciurorum* and *M. vison* are the most common. When present in large numbers, fleas seem able to cause anaemia and poor growth of the mink. Furthermore, the fur may be damaged. The fleas are also potential vectors of the Aleutian disease virus. Severe flea control problems are reported, probably due to insecticide resistance. Fleas can be very detrimental to the health of mink and control failures are a serious problem at present. More information is needed on the biology of the important flea species and on the efficacy of insecticides used to obtain a more efficient control.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 420-425. 1 table, 24 refs.

Nitrosamine-induced vascular and carcinogenic changes in mink (*Mustela vison*)

Nils Koppang & Arne Helgebostad

In a lifetime experiment, 48 mink were given herring meal containing NDMA equivalent to a daily dose of 0.4 - 0.025 mg NDMA/kg bw. At a dose level of 0.2 mg NDMA/kg bw/day, liver cell necrosis was unusual. However, occlusive changes in the efferent hepatic vein, promoting distended blood-filled sinusoids, and precancerous liver changes developing into liver haemangioendothelioma, were common features. Daily exposure to 0.2 mg NDMA caused liver tumours in 100% of the mink. At reduced NDMA levels some mink succumbed to intercurrent diseases before the additive NDMA level for tumour development had been reached, no synergistic effects of the three different nitros-amines were observed. However, this was not unexpected since the NDMA levels were 200 - 1000 times higher than the NDPA and NPYR levels.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 426-433. 1 table, 34 refs.

N-nitrosodimethylamine (NDMA) induced toxic-, vascular- and carcinogenic changes in mink (*Mustela vison*)

Nils Koppang & Arne Helgebostad

Treating 31 standard mink with single doses of 6-13 mg NDMA/kg bw resulted in a LD_{50} of 7 mg/kg bw. Forty-seven adult mink were repeatedly exposed to NDMA, daily or at longer intervals. In all mink exposed to NDMA, changes were seen in the efferent hepatic vein system. With daily exposure of less than 0.15 mg NDMA/kg bw, liver necrosis did not usually occur and the first changes observed were in the hepatic vein system after a total uptake of about two times the LD_{50}. The clinical and pathomorphological changes revealed in these NDMA experiments were found to be the same as those observed in malignant liver disease in mink caused by nitrosamines in the fish meal.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 434-443. 2 tables, 34 refs.

An ultrastructural study of inclusion bodies in a systemic distemper virus infection in foxes (*Vulpes vulpes*)

M. López, F. Guerrero, L. Moya, M.I. Quiroga, R.F. Antonio & J.M. Nieto

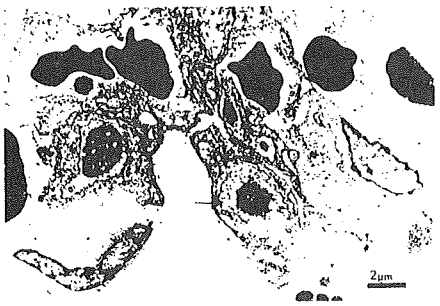


Fig. 3. Intracytoplasmic inclusion (→) in an alveolar cell.

A systemic distemper infection was diagnosed in a farm of fur foxes (*Vulpes vulpes*) by histopa-thological, ultrastructural and immunohistochemical examinations. Samples from eight farmed foxes were taken in 10% buffered formalin and processed, and 25-30 µm thick sections cut according to the paraffin routine methods were deparaffinated and processed for an electron microscopy study following the Reynold's met-

hod. Cytoplasmic and nuclear inclusions were identified by light microscopy and immunolabelling methods. Ultrastructurally, inclusions were characterized as a dense mass of tubular aggregates. This procedure is presented as a system for providing differential identification between inclusions due to distemper and other infections or artefacts.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 444-450. 1 table, 4 figs., 17 refs.

Nursing sickness in female mink (*Mustela vison*)

Tove Nørgaard Clausen, Carsten Riis Olesen, Søren Wamberg, Otto Hansen

Epidemiological and pathophysiological studies on nursing sickness in mink were carried out at Fur Research Farm West. During the breeding seasons of 1989-90 the mean overall incidence rate of nursing sickness amounted to 12.8% with a 7.2% mortality loss. Sick dams raised significantly larger litters and suffered heavier weight losses than apparently healthy females. Postmortem severe dehydration and emaciation were found. Blood sampling in severely affected females disclosed: azotemic acidosis, low base excess, aldosteronism, hyperglycemia and hyperinsulinemia. Plasma concentrations of sodium and chloride were extremely low, while those of potassium, magnesium and phosphate were high. Urinary osmolality and solute concentrations were remarkably low due to impairment of the concentrating ability of the kidneys. In summary, nursing sickness is characterized by severe electrolyte and volume depletion, metabolic derangements and malfunction of several organs, presumably caused by the combined effects of genetic predisposition, inadequate or ceased dietary nutrient supplies during heavy lactation, and environment stress.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 451-455. 4 tables, 8 refs.

Metabolic and karyologic analysis of mink lymphocytes

Ján Rafay & Vladimír Parkányi

Samples of total blood from eight standard mink females were used in this experiment. These animals were specifically tested for plasmacytosis. Three of them were found to be negative and antibodies were detected in the other five. The animals were 18 months old, and their weight was 910 ± 125 g at the time of sampling. The aim of this work was to investigate the changes that occurred in oxygen consumption and in the karyotypes of mink infected with the plasmacytosis virus. It was found that the curve of maximum O_2 consumption of one cell cycle *in vitro* in standard cultivation conditions peaked within 46 - 50 h after the start of cultivation. The significantly higher values of O_2 in the group of animals with a diagnosis of virus plasmacytosis can be linked with the existence of reactive forms of the lymphocytes which are created as a reaction of the immunity system to the infection and which presumably represent transition cells developing into plasmacytes. The observed lymphocytes did not have any visual structural anomalies of chromosomes in their karyotypes and from this point of view they can be characterized as normal.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 456-458. 2 tables, 1 fig.

Different pathogenicities of two Aleutian disease virus (ADV) strains in Norway

B. Hyllseth, K. Nordstoga, G. Loftsgaard, C.W. Leathers & J.R. Gorham

Pathogenic variation of Aleutian disease virus (ADV) was suspected in Norwegian (N) mink farms on clinical and epidemiological grounds. An experiment was carried out in standard (St) and sapphire (Sa) (Aleutian) mink (M) to elucidate this suspicion. Virus material from one typical high-virulence farm (NADV1) and from one typical low-virulence farm (NADV2) were passaged once in StM before being inoculated into groups of StM and SaM in a 12-week experiment. Sequential blood samples were analyzed for concentrations of γ-globulin (%) and antibody measured in a counter immuno-electrophoresis (CIEP) test. In both StM and SaM there were significant differences (Student's t-test) in γ-globulins at weeks 4, 6, 8, 10 and 12; NADV1 had the highest values throughout. In SaM, γ-globulin concentrations were higher than those in StM for both NADV1 and NADV2 and the differences were less marked. There were significant differences between NADV1 and NADV2 CIEP titers for StM at weeks 1, 2, 10 and 12; for SaM at weeks 2, 3, 10 and 12. There were significant differences (analysis of varian-

ce) between NADV1 and NADV2 in body weight changes, kidney weight and platelet counts at euthanasia in week 12. It was concluded that NADV1 is a high-virulence strain and NADV2 is a low-virulence strain. The standard mink appears to be a better type than the sapphire mink for differentiating pathogenicities of ADV strains.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 459-468. 1 table, 1 fig., 31 refs.

Marginal effects of levamisole and isoprinosine on pathogenesis of Aleutian disease virus infection in sapphire mink

B. Hyllseth, H.J.S Larsen, C.W. Leathers & J.R. Gorham

Levamisole and isoprinosine have been reported as having an influence on the pathogenesis of some virus infections in animals. An experiment lasting 12 weeks was carried out to examine whether these two drugs (two dosage levels each) separately or in combination could influence the pathogenesis of infection with Aleutian disease virus (ADV) in sapphire (Aleutian-*aa*) mink. With few exceptions, there were no significant differences at the various counter immunoelectrophores testing points (CIEP) in antibody titers, g-globulin concentrations and lymphocyte proliferations (Con-A) when both infected and non-infected drug-treated groups were compared with corresponding untreated groups. Isoprinosine and combination groups had lower CIEP and γ-globulin values at some early and late testing points. At six weeks levamisole appeared partly to restore suppressed Con-A-induced proliferation of lymphocytes caused by ADV infection. At euthanasia, no major differences in blood and organ values were found within infected or non-infected groups. The high dose levamisole treated group in each of these categories had significantly higher platelet counts than the corresponding untreated groups. Levamisole, isoprinosine or a combination of the two, had only a marginal influence on the pathogenesis of highly virulent Aleutian disease virus infection in sapphire mink.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 469-481. 2 tables, 2 figs., 36 refs.

Mink breeding hygiene in hot climatic conditions

V.Z. Gazizov, E.Yo. Musina & E. Muratova

There are some difficulties in breeding mink in hot climatic conditions (Central Asia), because of high temperatures and low humidity in summer, the long light period in spring and autumn, and high sun activity. However, by means of special hygienic breeding procedures it is possible to obtain normal mink reproductivity (4-6 kits per female) and a high quality of fur. We recommend that animals be kept in two-rowed sheds, where the distance between the roof and the top of the cage is 120-150 cm. The air temperature in sheds of this kind is lower than that in the standard shed (by 7°C). The ordinary procedure for feed preparation and distribution must be changed. It was established that it is better to feed the animals twice a day - at 07.00 h and 20.00 h and the feed must be cooled. This procedure ensures that there is a decrease in the amount of bacteria and an increase in the amount of eaten feed by 5-11%. In addition, there must be a plentiful supply of fresh water. It was established that a high resistance to infection and high reproductivity of mink are possible under such conditions (certainly lower than that in the northern animals).

Norw. J. of Anim. Sci., Suppl. 9, 1992, 482-484.

Behaviour and welfare

Progress in the ethology of foxes and mink

Bjarne O. Braastad

This is a review of the progress that has been made in the behavioural biology of farmed foxes and mink during 1988-92. This scientific area has undergone rapid growth, which is evidenced by the 71 reviewed publications of 52 different authors in seven countries. The review covers the effects of selection for domestication on behavioural ontogeny, hormonal aspects of

behavioural ontogeny, early handling of cubs, rearing conditions and management related to behaviour, circannual and circadian rhythms of behaviour, stereotypes and stress, maternal behaviour, social behaviour, and behaviour related to resting platforms and nest boxes. Some ideas for further research are given.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 487-504. 78 refs.

Correlation between levels of cortisol, behaviour and nest box use in silver fox vixens

Leif Lau Jeppesen & Vivi Pedersen

A study was carried out on the correlation between levels of cortisol, behaviour and nest box use in 49 silver fox vixens kept for a period of two years in cages provided with different types of nest boxes. The results indicated that nest box use was a rather stable individual character. Base levels of cortisol were shown to correlate positively with defensiveness, exploration, and levels of cortisol following 20 min acute stress. Base levels of cortisol correlated negatively with nest box use and with relative increases in levels of cortisol following 20 min acute stress.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 505-511. 4 tables, 1 fig, 6 refs.

Whole-year nest boxes and resting platforms for foxes

Mikko Harri, Jaakko Mononen, Teppo Rekil & Hannu Korhonen

Whether whole-year nest boxes and/or resting platforms are a necesssity for foxes or for man is still a matter for conjecture. This is due to the fact that there are considerable differences in preferences between silver foxes and blue foxes, between and within individuals, and between nest boxes and platforms. It seems obvious that the function of the platform is that of an observation place while the nest box serves as a hiding place. Since the duration of use of both is short term, it seems probable that foxes do not prefer a solid floor to a mesh floor, nor do they use boxes or platforms as a shelter against cold. Furthermore, the most interesting question of whether the presence of platforms and/or nest box affects the temperament of the foxes or vice versa is still controversial.

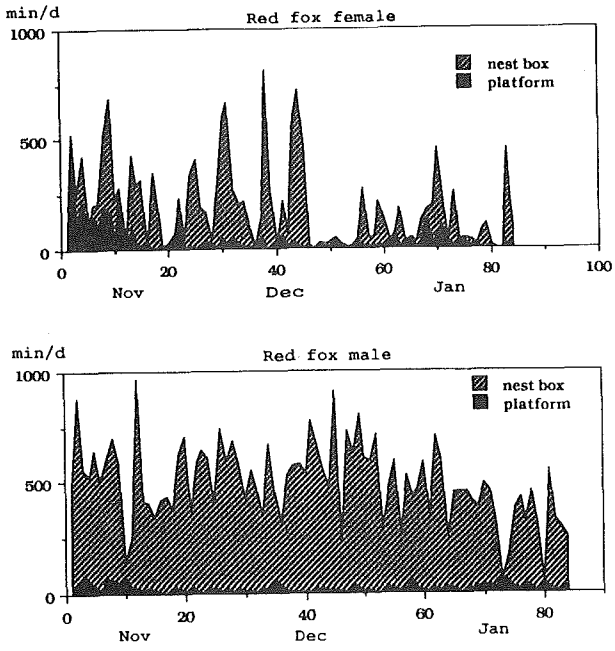


Fig. 7. Two individual patterns on use of a top-mounted nest box and a platform which served as an entrance to the nest box by farm-bred red foxes.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 512-519. 7 figs., 3 refs.

The relationship between open field activity, competition capacity and first year reproductive success among farmed silver fox cubs (*Vulpes vulpes*)

Morten Bakken

Silver fox cubs between 4 weeks and 7 months of age were subjected to various behaviour tests in non-social and social situations. The relationship between the test scores for both male and female cubs and the ability to predict reproductive performance among the female cubs under commercial farm conditions, from the behavioural test score, were assessed. The results indicated that female cubs with a high and those with a low competition capacity score when seven months old differed both in their activity scores in an open field test at 30 days of age and in reproductive performance in their first reproduction. Females exhibiting a defensive behavioural strategy (inactive females in the open field test with low competition capacity) weaned fewer cubs in their first reproduction than vixens with an offensive behavioural strategy (ac-

tive females in the open field with a high competition capacity). These results indicate that it is possible, to some degree, to predict a female cub's future reproduction potential from knowledge about her behaviour in social and non-social situations.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 520-528. 5 tables, 1 fig., 17 refs.

Handling of silver foxes at different ages pre-weaning and post-weaning and effects on later behaviour and stress-sensitivity

Vivi Pedersen

The effects of handling were studied in 344 silver foxes randomly assigned to eight groups. Seven groups were handled at different ages pre- and post-weaning and one group received no handling at all. Behavioural tests were carried out at the cub ages of 18, 24, 30 and 32 weeks and bleeding procedures at the age of 26 weeks. The results indicated that handling during weaning or post-weaning reduced the later fear responses of the foxes towards humans ($0.011 > p > 0.0001$, χ^2-test) at all ages tested, with the exception of at 30 weeks. No significant differences in fear responses were found between handled and non-handled groups or within the handled groups at that age. It was suggested that the general increase in fear responses in all groups at 30 weeks of age was caused by the bleeding procedure performed at 26 weeks of age. It was also suggested that handling during weaning and post-weaning reduced the fear responses of foxes towards humans when performed for three weeks or more, whereas handling pre-weaning had to be performed for six consecutive weeks before reductions in fearfulness could be found. The effects of handling were thought to be permanent because of low levels of fear among handled individuals at the age of 32 weeks. Levels of cortisol in the blood were concluded not to represent true base levels, and no conclusion could be drawn on the stress sensitivity of handled/non-handled foxes.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 529-535. 3 figs., 11 refs.

The effects of cage environment on the welfare of mink

Steffen W. Hansen, Bente Krogh Hansen & Birthe M. Damgaard

Sixty female male pairs of mink were placed in cages of three different sizes, i.e. 1.0 m², 0.27 m², and 0.1 m². In half of the cages of each cage size the animals were prevented from using a nest box. Based on behavioural observations of the females and stress physiological measurements of males and females, the significance of cage size and nest boxes to the welfare of farm mink was demonstrated. Furthermore, feed intake under these experimental conditions was recorded. In agreement with our previous investigations the results indicated that increasing the cage area, within the cage sizes tested, does not increase the welfare of farm mink. On the contrary some of the variables indicated reduced welfare for mink in large cages. Based on the behavioural and physiological variables used, we could, however, demonstrate an increase in: stereotypic behaviour, the heterophil/lymphocyte ratio, and the plasma cortisol concentration as well as a decrease in the number of eosinophil leucocytes in mink without nest boxes which is an indication of reduced welfare.

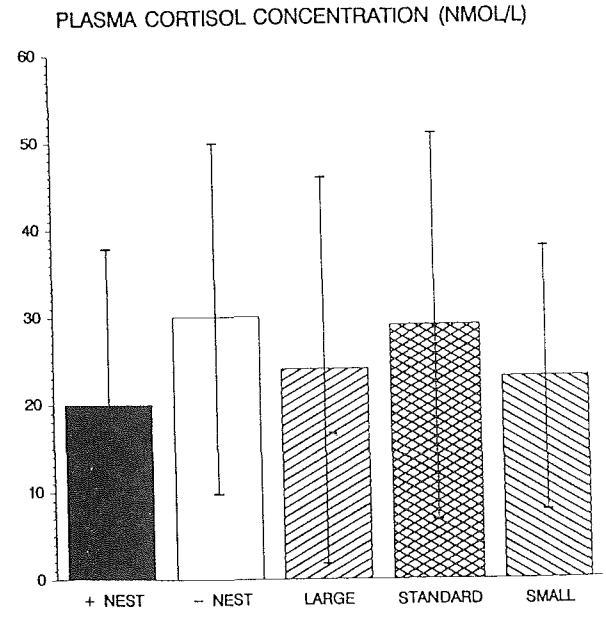


Fig. 4. Plasma cortisol concentration (mean ÷ SD) in mink females distributed on ÷ nest box and on cage size (large, standard, small).

Norw. J. of Anim. Sci., Suppl. 9, 1992, 536-544. 5 figs., 17 refs.

Sociability and dominance relationships in farmed blue foxes

Hannu Korhonen & Sakari Alasuutari

The aim of the present work was to study the social behaviour of a group of blue foxes (four males, four females) housed in a large ground-floored enclosure. Behavioural patterns were monitored by video recordings and direct visual observations. The results indicated that blue foxes are social animals whose hierarchical development properly begins at the age of 3.5 months, and reaches maturity in mid-winter. Males are generally dominant over females, although body weight and dominance rank do not necessarily have a significant correlation. Social ranking order is most pronounced during feeding times. It can be concluded that sociability has a marked importance also for foxes in captivity.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 545-549. 2 tables, 10 refs.

Use of chronic jugular catheterization for repeated blood sampling to measure diurnal variations in blood parameters in mink

Christian F. Børsting & Birthe M. Damgaard

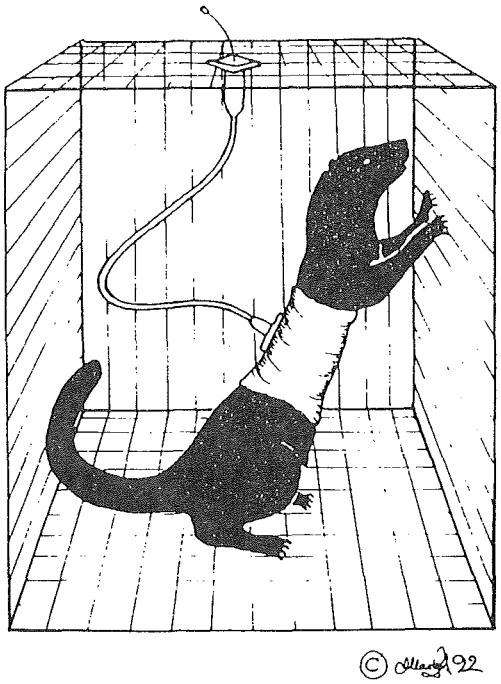


Fig. 1. Mink with tethering system for remote blood sampling.

A surgical procedure to insert chronic jugular catheters in mink has been adapted. To take repeated blood samples, a tethering system was used where the catheter was protected by a spiral spring. Swivels at both ends of the spring allowed the mink to move freely. Diurnal variations in concentrations of glucose, lactate, urea, total lipid, triglycerides, cortisol and insulin were measured. Glucose, lactate and cortisol levels were rather constant, indicating that blood sampling did not stress the mink, and therefore the method is very useful in studies where repeated blood sampling is needed. Significantly ($p < 0.01$) positive correlations were found between the plasma concentrations of glucose, lactate and cortisol, as well as between triglycerides, total lipids and urea.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 550-556. 3 tables, 2 figs., 7 refs.

The number and activity of nipples in two-year-old females of arctic fox (*Alopex lagopus* L.) and their effect on rearing performance

Andrzej Frindt, Marian Brzozowski, Tadeusz Kaleta, Anna Kaczko & Roman Jaroszuk

The aim of this study was to determine the number of active nipples in a population of foxes comprising 91 two-year-old females and to compare this with the number of nipples in primiparae. The number of reared cubs per female was also determined and compared with the number of nipples. The relationship between the number of nipples and the number of reared cubs was analysed and also the correlation between the number of born and reared cubs. The effect of litter size on the number of reared young foxes was ascertained.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 557-561. 3 tables, 9 refs.

Production systems and management in Danish mink production

Steen Møller

Large variations in production systems and management were found between farms, but an effect on production results could rarely be demonstrated. The basic needs for housing of mink can be met in many ways, and different management systems may work perfectly. It is more

important that the farmer is skilled at what he is doing, and that he is confident with his production and management practices. Production systems and management often differed between feed kitchen, indicating a regional or advisory effect. Thus, a variation in production results between feed kitchen may be due to differences in production systems or management. Whelping results were better in double than in multi row sheds and on farms where the breeding animals were mixed than where males and females were placed in separate groups. The growth functions give good descriptions of the weight development and can be used as standard curves for scanblack male mink kits. A positive correlation was found between average skin length and quality on Danish farms. Correlations between August and October weight and skin length and quality indicated a difference in body length between mink strains.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 562-568. 2 tables, 2 figs., 14 refs.

Environmental enrichment in relation to behaviour in farmbred blue foxes

Sakari Alasuutari & Hannu Korhonen

The purpose of the present study was to clarify to what extent environmental enrichment (nest boxes, stones, large enclosure) affects behaviour in farmed blue foxes. A group of eight foxes was placed into a large L-shaped ground-floored enclosure (surface area 224 m^2) Use of the extra equipment and surface area was monitored by video recordings and by direct visual observations. The utilization of the enclosure surface area was not evenly distributed, but there were certain subareas which the animals obviously preferred. In general the use of nest boxes was minimal, but the roofs were somewhat more favoured. It was observed that the foxes clearly preferred to lie on the stones only as cubs.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 569-573. 2 tables, 1 fig., 3 refs.

Fur properties

Pelage growth and structure in fur animals. Why is pelt research necessary?

Leena Blomstedt

High quality fur production requires an understanding of normal hair growth and pelt structure. Comparison to normal pelt is vital in pelt defect research. Fur animal research is diversifying with new scientific methods applicable also in the every day life of the farmer. Hair cycles, moulting and proper pelting age are being clarified for most farmed fur animal species. Effects of factors such as hormones and feed on hair growth and fur quality have been considered. Anatomical and biochemical skin composition in relation to the age of the animal and to fur defects are of present interest.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 577-585. 1 table, 37 refs.

Circannual melatonin rhythm in mink and its significance in fur growth and reproduction

Maija Valtonen, Olli Vakkuri & Leena Blomstedt

Quantitative collection of night-time urine was used to elucidate the temporal relationship between the total amounts of nocturnal melatonin production and furring and breeding cycles in mink. Under natural light conditions the production of melatonin increased in late summer in both male and female mink coinciding with the rest phase of the summer fur coat and was followed by the autumn moult. A decline of melatonin excretion occurred in males in late autumn at the time of testicular recrudescence. In springtime high melatonin secretion in January dropped to low levels in both sexes in March, the recognized time of nidation in females and observed testicular involution in males as well as initiation of spring moult. It appears that

in mink the total amounts of nocturnal melatonin secretion do not change in direct relation to the duration of the daily dark period. Instead, significant seasonal increases or decreases were seen in association with moulting periods and reproductive changes.

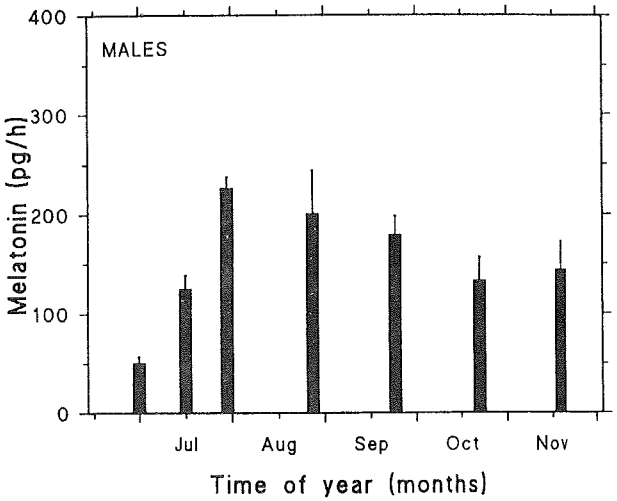


Fig. 1. Autumnal melatonin excretion (mean ÷ SEM) in five adult male mink, collection of night-time urine.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 586-592. 4 figs., 13 refs.

Pelage development in melatonin-treated mink

Shigeharu Fukunaga, Kaoru Kohno, Fumio Nakamura & Keiji Kondo

The effects of melatonin on the autumn molt in mink skin were investigated by means of the changes in tyrosinase activity and histological parameters. Melatonin-treated mink molted twice in autumn and their hair activity, the amount of underfur and tyrosinase activity also exhibited twin peaks during the experimental period. Seasonal changes in tyrosinase activity were correlated with those in histological parameters in both control and melatonin-treated mink. These results indicate that exogenous melatonin accelerates not only hair production but also melanogenesis in mink skin.

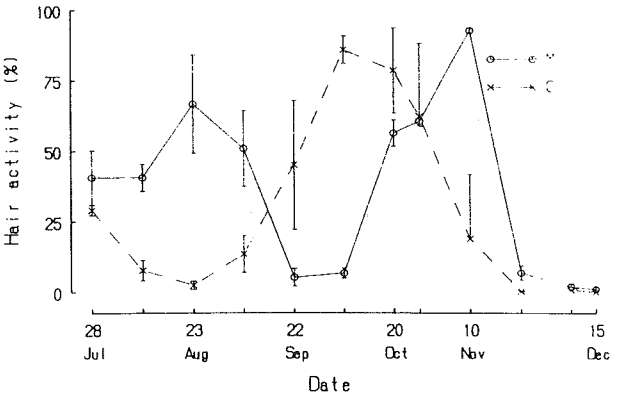


Fig. 3. Seasonal variations in the ratio of hair activity in mink. The vertical line represents SD.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 593-598. 4 figs., 15 refs.

Quantitation of elastic fibres in the reticular dermis in mink using electronic image analysis

Palle V. Rasmussen

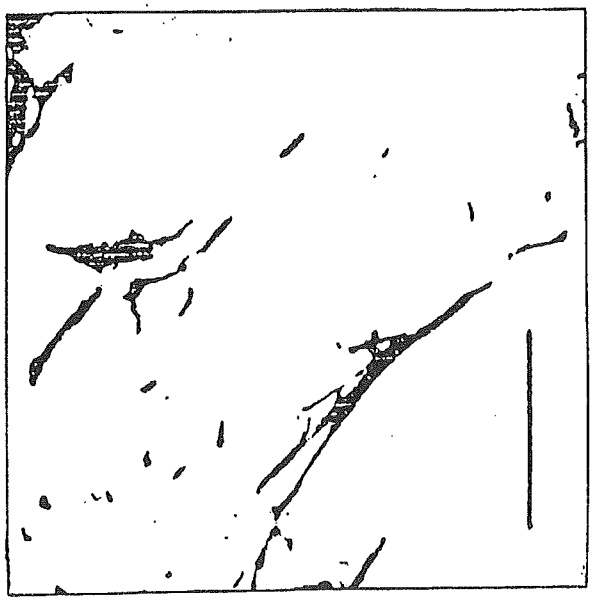


Fig. 2. Electronic image analysis. The area fraction of elastic fibres (black areas) is 5%. The volume fraction is then 1.10 %. Scale = 50 μm.

Examinations of mink pelts with reduced hair quantity on boty hip areas (RHH) led to an illustration of factors of importance to the local stretching properties of the skin. At pelting, skin

biopsies from hip and back were obtained from 14 control animals thought to have a low probability of developing RHH, and 42 animals with an expected high probability of developing RHH. Histological sections were made, and the elastic fibres in these sections were stained selectively according to a modified orcein method. The volume fraction of elastic fibres in areas of *stratum reticulare* between the hair groups was determined according to stereological principles. Microscopy and electronic image analysis were used. The individual volume fractions were between 0.4 and 0.7 % and were normally distributed in both groups. On a group level, no genetic differences or correlation with the degree of RHH could be proved.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 599-603. 4 figs., 13 refs.

Capillary electrophoresis as an efficient tool in studies of pelt glycosaminoglycans

Søren Michaelsen, Mai-Britt Schrøder & Hilmer Sørensen

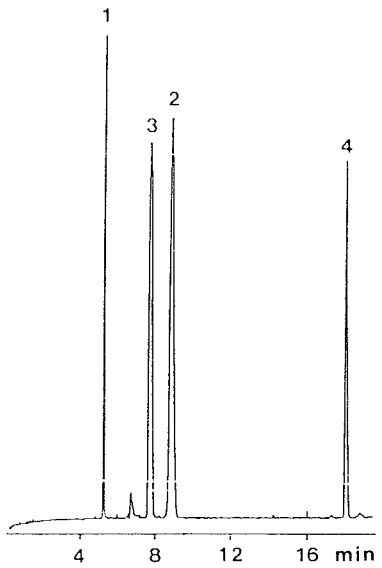


Fig. 2. Electropherogram of GAG-disaccharides dissolved in water. 1 = ΔDi-OS (0.45 mg/ml), 2 = ΔDi-4S (0.80 mg/ml), 3 = ΔDi-6S (1.6 mg/ml), 4 = ΔDi-diS_B (0.40 mg/ml). Buffer: 18 mM borate, 30 mM phosphate, and 50 mM CTAB (pH = 7.0); Temperature: 30°C; Voltage: 20 kV.

Glycosaminoglycans (GAGs) and collagen glycoproteins are skin constituents assumed to be important for the properties of mink pelts. Exact structural information on GAGs in mink skin is needed, and seems to be obtainable by utilization of the structural features of GAGs. These provide analytical advantages by means of enzymatic cleavages by various lyases (EC.4.2.2.) which allow a gentle release of disaccharide units. High performance capillary electrophoresis (HPCE) based on cetyltrimethylammonium bromide (CTAB) has now been developed as an efficient method of analysis of these GAG-disaccharide units. The influence of varying separation conditions on separation parameters has been investigated. The results indicate the possibility of changing separation conditions according to the samples analysed. GAG-disaccharide units from various chondroitins and GAGs in mink skin have been analysed by the HPCE method after protease and chondroitinase treatments.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 604-612. 1 table, 7 figs., 13 refs.

Skin length and skin quality

Ejner Børsting & Niels Therkildsen

The breeding objective in mink is to improve pelt price especially through increased pelt length and pelt quality. That is selection on traits scored on live kits. Experiments carried out at Research Farm "South" are in good agreement with other experiments and show that live body weight has a correlation to pelt length of 0.6 - 0.9. The live grading for pelt quality has a correlation of 0.3-0.5 to grading of the raw pelt for quality. The length of the live kit has a lower correlation to pelt length than the body weight and it does not indicate the negative correlation to live grading for quality as clearly as the body weight does. Live body weight and quality grading of the live animal's pelt are concluded to be the best traits for indirect selection on pelt length and pelt quality.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 613-619. 7 tables, 9 refs.

Effects of dietary zinc, silicium and selenium on mineral content of fur in silver foxes during fur maturity

Dusan Mertin, Vitalij V. Stepanok & Valerij I. Georgijevskij

The aim of our work was to study the influence of salts of zinc ($ZnSO_4$ $.7H_2O$), silicium ($C_7H_{14}O_3NSiCL$) and selenium ($C_{19}H_{22}Se$) on the mineral content of fur of silver foxes during the period of fur maturity. The mineral ingredients were added to the feed ration in the form of a saline solution and were administered from birth to the period of fur maturity. Mineral elements from samples of fur were determined by means of dispersion and röntgen fluorescent spectrometry as follows: K, Ca, Mn, Fe, Cu, Zn, Br, Rb, Sr and Pb. Our results revealed that zinc significantly increases the content of K, Ca, Mn, Fe, Cu, Sr; silicium increases K, Ca, Mn, Fe, Cu, Br, Rb, Sr and selenium increases K, Mn, Fe, Cu, Br, Rb, Sr in comparison with the control group. It was also found that the content of Pb was significantly decreased in all the trial groups.

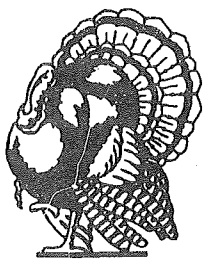
Norw. J. of Anim. Sci., Suppl. 9, 1992, 620-625. 3 tables, 25 refs.

Application of an aluminosilicate-V for degreasing fur coats

A.F. Kuznetsov, I.V. Barsov, N.V. Mukhina & A.A. Kuznetsov

Application of vermiculite improves the appeal of the furs and is ecologically advisable. Furthermore, it should be noted that vermiculite is chemically inert, harmless, sterile, ecologically pure and cheap.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 626-628. 3 tables.



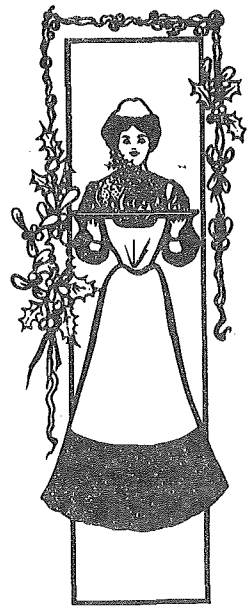
Surface morphology and innervation of defective guard hairs of American mink - *Lutreola vison* Schreber, 1774)

Milan Vanek & Jitka Hanzlová

Hair samples with typical defective bent quard hairs were resected from the dorsal somatic regions of six males and five females of *L. vison.* In electronographs from transmission electron microscopy the shape and structure of cuticular

cells in the proximal segment (stem) of the guard hairs were the same as those of clinically healthy animals. Lancet-like segment, uneveness and conspicuous sharpness of apical parts of the cuticular scales were clearly seen. Another distinctive character was unhomogeneity up to destructivity of the cuticular cell structure in comparison with guard hairs that were unchanged pathologically. The material was also treated under the usual transmission electron microscopy. The following types of nerve endings were observed: (1) Bundles of non-myelinized nerve fibres in mesenchyme hair sheaths, the so-called free penicillate nerve endings. Non-myelinized axons are surrounded by processes of Schwann's cells, (2) Pilo-Ruffini's complexes, i.e. a greater number of axonal endings containing numerous mitochondria, surrounded by a narrow fringe of Schwann's cells and associated peripherally with numerous collagen fibrils.

Norw. J. of Anim. Sci., Suppl. 9, 1992, 629-636. 11 figs., 16 refs.



The mineral supply of mink and foxes.

Anne-Helene Tauson, Sweden, Bragi Lindal Olafsson, Iceland, Jan Elnif, Denmark, Jouko Treuthardt, Finland and Øystein Ahlstrøm, Norway.

The book "The mineral supply of mink and foxes" was written at the initiative of the Committee for Feeding, Division for Fur Animals, Scandinavian Association of Agricultural Scientists. The work was supported financially by the Nordic Council of Ministers. As so far neither any overall information about fur animals' need for and tolerance to various minerals, nor any compound tables regarding the mineral content of feed ingredients were to be found, it was decided to establish a working group which was given the task to update the existing knowledge about minerals on the basis of literature and by collecting the existing analytical data on feed ingredients for fur animals. Furthermore, the group was asked, wherever the present knowledge was sufficient enough, to suggest feeding requirements and tolerance limits for various minerals.

With this report the knowledge of the mineral supply of fur animals has been updated. It is the hope of the working group that this knowledge will now be more easily accessible to researchers as well as advisers and feed producers. It is also the hope of the working group that this report will give inspiration to future research projects concerning the mineral supply of fur animals.

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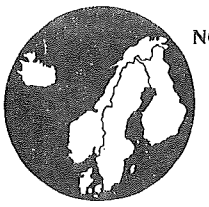

NORDISKA JORDBRUKSFORSKARES FÖRENING

Production systems and management in Danish mink production.

Steen Møller

The purpose of this project was to describe the variation of the production systems and management on mink farms and feed kitchens (FK) in Denmark, and to evaluate the importance to the production result of the differences found. Five mink FK were selected, representing the concentration of mink farms in the various regions. From each FK 4-5 mink farms were chosen to represent differences as regards environment, management, quality etc. The production systems were described after visits to the farms, and the breeders were interviewed concerning their management in all production periods. Information regarding number of animals, feed intake, fur qualities, breeding results etc. were collected from the various data bases of the Danish Fur Breeders Association. The weight development of the animals was followed by means of a comprehensive weighing programme. Kits were weighed in the nursing period and in the growth period until pelting, breeding animals in the winter period between pelting and mating.

Production systems

Production systems are described and evaluated in relation to existing knowledge about the importance of cages, nest boxes, watering systems, feed machinery, muck systems and types and location of sheds. General labour requirements are discussed in relation to the number of females and level of automation on each farm.

The design of mink sheds and cages, of no documented importance to production, was limited to a few standards. In this material, differences were found in whelping results between double- and multi-row sheds. The explanation may be differences in klimate, light conditions or use of eletric light in the sheds. The design of nest boxes and watering systems, which may be of great importance to the production result, showed large variations. The variations expressed

different ways of obtaining the same effect, and no differences in results were found. Large variations were found in the design of muck systems, but they are only of importance to the labour situation of the farmer.

The large wariation in production systems indicate that the basic needs for housing of mink can be met in many different ways. The importent thing is that the needs are met, not how they are met.

Top nester cages and Forelco's circulation watering system were widely distributed in southern Jutland. Breeding boxes with a U-cylinder were common in northern Jutland, whereas the rest of Jutland used rectangular breeding boxes with drop-in bottoms and screens. Such geographic differences are a result of the location of the equipment producers as well as a regional or advisory effect.

All ordinary mink cages complied with the recommended guidelines regarding size, which was not the case for some of the top nester cages. Recommendations as regards nest boxes, screening, feeding and water supply were met on all farms. Most farms were located on dry soil, and the sheds were orientated with consideration to topographical conditions but not to the compass relations.

Management and husbandry.
Management and work routines in the different production periods is discussed on basis of existing knowledge. Management on the project farms revealed large variations between farms. The differences were often connected with the feed kitchens, indicating a regional or advisory effect. This was especially obvious in connection with mating routines and selection of breeding animals.

However, an effect on production results could rarely be demonstrated. This indicate that there is not one correct way to manage a mink farm. The main impression from the project was that many different systems may work perfectly. The importent thing is that the farmer is skilled at what he is doing, and that he is confident with his management practices.

Whelping results were better on farms where the breeding animals were mixed than where males and females were placed in groups. The mating systems used exploited to a high extent the special estrus cycle of mink. All project farms weaned the kits early in the period from 6 to 9 weeks after birth, which is least stressful for the kits as well as for the female. The majority of the kits were placed in pairs of one male and one female after weaning. Each farm had a certain level of pelt bites for males as well as females, but there were also different levels from year to year. This indicates a farm effect, but also a common environmental effect within years. Farms with large skins of good quality and farms with a poor whelping result apparently had most pelt bites. Breeders giving priority to quality above size had the best combination, but the quality of the subjective grading is found to be more important than the priority of properties.

Weighing of kits in the nursing period.
The weight development of the kits in the nursing period is presented, and a function for the growth curve is fitted to data. The importance of farm, feed kitchen, age and litter size is analysed and discussed. Daily gain of the kits, sexual differences and correlation between kit weight and weight at pelting, body and skin length are discussed. The weight of the kits around the age of 31 days depended on litter size as well as farm, even though the groups weighed had been chosen among litters which were as uniform as possible. It is therefore important to select homogenous groups for weighing and to weigh at a certain age, if the weights are to be immediately comparable. The early development of the kits gives a good impression of their final weight and of the skin size, and therefore a high weight at weaning is desirable in practice. The development is, however, linked to litter size, and a considerable part of the development potentialities is thus determined already at birth. Other reasons for variation in weight at weaning can often be compensated for after weaning. It is therefore more important to avoid problems, e.g. diseases, which restrict gain and cannot be compensated for later, than to feed for maximum weight at weaning.

Weighing of weaned kits.
The weight development of the kits on the project farms is presented and a function for the growth curve is fitted to data. The weight development is discussed in relation to sexual differences, feed intake, daily gain, final weight, skin length and skin quality. Correlations bet-

ween feed intake, weight development, skin size and skin quality were illustrated by means of comparisons of farms with long skins of good quality and short skins of poor quality, respectively.

As regards feed intake, October weight, skin length and skin quality, differences were found between farms and, with the exception of feed intake, also between years. On all farms and at all times of weighing, the variation amounted to approx. 10% of the weight. Females weighed 74% of males in July decreasing to 55% in September, which remained constant until pelting. The amount of energy fed varied with up to 43 kcal/animal/day corresponding to 4-5 kg of feed per skin produced.

The well known, negative correlation between skin length and skin quality was not found for the average skin production of the project farms. Nationally, the correlation even proved to be positive. A grouping of the project farms according to skin length and quality showed no difference in weight nor in daily gain, whereas feed intake was highest in the group of farms with good skin length and quality, especially in 1985 and 1986. The reason may be a difference in body length resulting in less fat animals and thus a better quality at the same weight. The differences between the animal strains on the farms must be a result of the quality of the breeders' selection according to size and quality, but there was no correlation between the experience of the breeders or the size of the farm and skin length and quality.

An ideal weight development curve must take into consideration the body length and the quality of the animals on the individual farm. The importance of conditions such as feed utilization, activity of the animals, and weather conditions must be better clarified, before an ideal weight curve for each farm can be found and substantiated with certainty.

Weighing of breeding animals

The weight development of breeding animals in the winter period was described in relation to the strategy of the breeders. The importance to breeding result, problems in the winter period and mortality is investigated, and the possibilities of feeding in relation to body condition (g/cm body length) is discussed.

The breeding animals lost weight quickly just after pelting, irrespective of the farmers strategy regarding weight development. No fixed weight limits can be given, but at a weight reduction of more than 30%, or to less than an average of 900 g, the thinnest females will have difficulties coping with a period with severe frost. There was a correlation between the mean temperature in January to March and mortality on a national basis. As the coefficient of variance for breeding animals was approx. 10% as for other times of weighing, there will always be thin animals even though the average weight is not too low. The problems with the weight loss of the breeding animals are caused by the fact that breeding animals are fed as if they were going to be pelted. Therefore they are later reduced very much in weight, in order to make flushing possible. The best solution would therefore be to select breeding animals early and avoid the heavy fattening in the autumn. As first year females are especially sensitve, whereas the weight of the males is of minor importance, it would be most effective to weigh first year females.

Based on the many weighings, a programme for control weighing of mink in the nursing period, growth period, and in the winter period is suggested. The purpose of the weighings, the need for selection and size of groups to be weighed, and times for weighing as well as the application of the weighing results are discussed.

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Produktionssystemer og produktionsstyring på danske minkfarme

Production systems and management on Danish mink farms

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