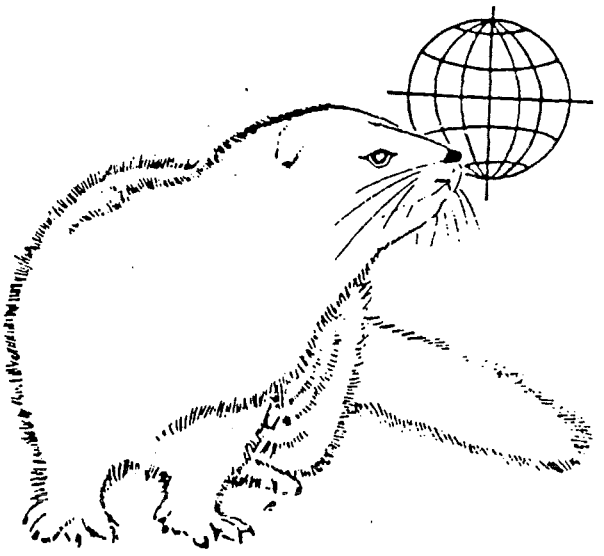

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5. Reproduction

6. Nutrition

6. Veterinary

IMPORTANT ANNOUNCEMENT

PAYMENT FOR ORIGINAL REPORTS EXCEEDING 6 PRINTED PAGES. As announced in SCIENTIFUR Vol. 16, No. 2, original reports will from January 1, 1992 be charged DKK 1,200.- per printed page exceeding 6 pages. This policy is still valid.

Notes
SCIENTIFUR
Vol. 17, No. 2, 1993

Over the years, it has sporadically been frustrating for me that I alone have been the person to write the Notes in SCIENTIFUR. From the beginning, the intention was that the column should be the place where colleagues and other persons in the fur industry should bring their comments or introduce new ideas.

On the other hand, I have had a column where I could inform the readers about my hopes and optimism as well as my frustrations and ideas regarding the future.

The past month has taught me that the Notes are read by the majority of the SCIENTIFUR readers. This I can see from the large number of letters of congratulation I have received from subscribers in connection with my 60th birthday.

Dear friends, from the bottom of my heart thank you for the many nice words you have sent to me. You have made me feel that my work with SCIENTIFUR - and the writing of Notes - is appreciated. A reaction like that is a great reward for me for my work in the past - and a great inspiration for the future. THANK YOU ALL FOR WRITING TO ME.

I am glad that during my 35 active years in the business there have in periods been really good skin prices. It is also promising that the price trends now show us that the deepest crisis in the fur industry until today - and still lasting - is on the way to become history.

Together we can therefore with optimism continue our activities in the most fascinating of areas - namely fur animal production.

It has been painful to note that so many colleagues - all over the world - have had to leave the scene because of the crisis. I think that both privately and professionally many of us have a lot to thank these excellent colleagues and friends for. We hope that they will - irrespective of their age - find a satisfactory continuation of their professional and private lives. I take this opportunity to ask you to accept my warmest thanks for our fruitful sparring matches over the years.

Over the years, a still greater part of fur animal research has been integrated in university and institutional research and has thereby changed towards more basic research. I am convinced that in the long run, the change will be positive. The trend has been very visible in SCIENTIFUR. Even though everybody realizes the huge need of basic knowledge regarding fur animal production, it is fact that never before has the industry had so much knowledge as the basis for a healthy development.

If the industry can also learn to handle the fur market, there are signs of a good future for our favourite - THE FUR ANIMAL INDUSTRY.

The removal of the IFASA and SCIENTIFUR office will take place during the months of July-August this year. There will be no change of addresses etc. until advertised in the August issue of SCIENTIFUR. If anybody wishes to contact me over the phone, I can be reached all through the summer on my mobile telephone: +45-30 81 12 31.

Thank you again for all the greetings I have received during the last month. Have a good summer - or winter in the southern hemisphere!

Your editor

Gunnar Jørgensen

Original Report

Variability of morphotic components of rabbit blood at different times of a 24 hour period

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Summary

In rabbits of the Grey Belgian Giant breed the average values of the morphotic components in blood change depending on the time of the 24 hour period when the blood is sampled. The lowest number of erythrocytes, hemoglobin concentration, hematocrit values and mean corpuscular hemoglobin concentration was found by sampling blood at 20:00, and the maximum level of the above mentioned components of hemogram - at 12:00. The highest amount of reticulocytes, which was observed at 4:00 and 8:00 in the morning, preceded in time the presence of the highest number of erythrocytes. The minimum amount of leucocytes and lymphocytes was observed at 16:00. Thereafter, an increase of the amount of these cells was observed and reached peak values at 12:00. The highest amount of eosinophils was recorded in the afternoon and in the evening. While assessing the considerable variability of morphotic components of rabbit blood during a 24 hour period, one should sample blood at the same time.

Introduction

On the grounds of available literature it has been asserted that almost all processes taking place within living organisms show oscillation during a 24 hour period (*Gamski, 1953*). Among a great number of experiments proving the existence of a day and night variability of physiological processes was the research on variability of the morphotic composition of blood (*Baranski et al., 1972; Bobek et al., 1978; Clark & Korst, 1969; Fox & Laird, 1970; Rewkiewicz-Dziarska & Gloskowska-Moraczewska, 1975*).

Since there is not much information, and often very fragmentary, on this subject, we carried out research with the aim of proving the influence of the time of day upon the variability of the erythrocytic and leucocytic picture in rabbits of the Grey Giant Belgium breed.

Material and methods

Ten nine months old male rabbits of the Grey Giant Belgium breed were examined. The experimental animals were from the private breeding farm in Bydgoszcz. They were similar as far as their genetic pattern and weight were concerned (6.5 kg up to 7.2 kg). The rabbits used in the experiment were kept in separate cages in a location of 18-20°C. The light-dark conditions (LD) were 12L (from 6:00 to 18:00):12D (from 18:00 to 6:00). The illumination was of 70 lux. They had free access to feed and water. They were fed ad libitum, a fodder LSK diet, used for these animals. Blood in the amount of 0.5 ml was sampled from the vena marginalis of an ear every 4 hours during a period of 2 days. In the samples, stabilized with Na-heparin, the following elements were determined: number of erythrocytes and leucocytes using "Picoscale" of Medicor (*Pawelski, 1977*), amount of reticulocytes (*Pawelski, 1977*), hematocrit coefficient using the microhematocrit method, hemoglobin level using the Drabkin method (*Pawelski, 1977*), and leucogram of peripheral blood (*Nikitin, 1956; Stankiewicz, 1973*).

Using the formula given by Stankiewicz (1973), the following erythrocyte coefficients were calculated: mean corpuscular volume (MCV), mean corpuscular hemoglobin weight (MCH), and mean corpuscular hemoglobin concentration (MCHC).

Statistical analyses (*Ruszczyc, 1978*) were carried out on the results obtained. Arithmetical mean ($\bar{x}$) and standard deviation (SD) were calculated, and differences between means were calculated by students t-test.

Results and discussion

Having analysed the data presented in table 1, it was found that the level of morphotic components in blood, determined during the experiments carried out on rabbits, changed depending on the time of day. It was found that the lowest absolute level of erythrocytes at 20:00 (5.23 10^{12}/l ± 0.28 10^{12}/l) was accompanied by: the lowest absolute content of hemoglobin (142 g/l ± 11 g/l), low hematocrit (39% ± 2%), and the lowest mean concentration of hemoglobin in a separate erythrocyte (36 g/dl ± 2.1 g/dl).

Table 1. Hematological variables in rabbit blood at different times in two consecutive periods of 24 hours. Values are mean ± standard deviation.

Components	N	Sampling time (hour) 8:00	12:00	16:00	20:00	24:00	4:00	t-test[1]
Erythrocytes (10^{12}/l)	20	5.23 ± 0.36	5.49 ± 0.38	5.45 ± 0.26	5.23 ± 0.28	4.38 ± 0.60	5.30 ± 0.18	8:00-12:00: **
Reticulocytes (‰)	20	13.00 ± 6.48	12.80 ± 7.16	10.30 ± 3.86	11.80 ± 4.64	11.60 ± 4.93	13.80 ± 5.87	8:00-16:00: **
Hemoglobin (g/l)	20	148.20 ± 15.00	160.90 ± 22.20	147.30 ± 13.80	141.50 ± 10.90	144.20 ± 10.00	141.90 ± 17.90	8:00-12:00: ** 8:00-20:00: ** 8:00-24:00: * 8:00- 4:00: *
Hematocrit (%)	20	40 ± 1	41 ± 2	40 ± 1	39 ± 2	39 ± 2	39 ± 1	8:00-12:00: ** 8:00-20:00: ** 8:00-24:00: * 8:00- 4:00: *
MCV (fl)	20	76.95 ± 3.73	74.15 ± 2.67	72.39 ± 1.48	74.25 ± 3.33	72.45 ± 3.68	73.18 ± 1.52	8:00-12:00: ** 8:00-16:00: ** 8:00-24:00: ** 8:00- 4:00: **
MCH (pg)	20	28.49 ± 1.18	29.30 ± 1.88	27.02 ± 1.65	27.04 ± 1.54	26.81 ± 1.05	26.74 ± 1.49	8:00-12:00: ** 8:00-16:00: ** 8:00-24:00: ** 8:00- 4:00: **
MCHC (g/dl)	20	37.03 ± 1.42	39.51 ± 2.21	37.35 ± 2.59	36.45 ± 2.16	37.04 ± 1.48	36.59 ± 1.83	8:00-12:00: ** 8:00-20:00: *

1) * = significant at $p < 0.05$, ** = significant at $p < 0.01$.

The maximum values for the above mentioned components were found at 12:00 (noon). The results we obtained were similar to the data obtained in rabbits (*Fox & Laird, 1970; Rewkiewicz-Dziarska & Gloskowska-Moraczewska, 1975*) and human beings (*Best & Taylor, 1971*) as regards the character of the day and night changes.

It should simultaneously be emphasized that the night period and morning period as compared to the light period of a day was characterized by a lower level of the components discussed of the erythrocyte system except for the amount of reticulocytes. The highest amount of these immature cells of the erythroblastic system recorded in the morning (4:00 - 14‰ ± 5.9‰, 8:00 - 13‰ ± 6.5‰) preceded the day occurence of maximum amounts of erythrocytes in the blood (table 1).

Probably the maximum amount of reticulocytes in blood during the morning hours, noticed both in our experiments and by other authors (*Clark & Korst, 1969; Rewkiewicz-Dziarska & Gloskowska-Moraczdwska, 1975*), resulted from the intensified process of blood production and maturation of erythroblastic system cells in blood production organs (*Clark & Korst, 1969*). The highest number of erythrocytes we observed during a day was probably, according to Best and Taylor (1971), a consequence of the intensified transformation of reticulocytes into erythrocytes taking place between 24:00 at night and 10:00 in the morning.

Considering the character of changes in leucocyte number, it was found that the minimum amount of leucocytes appeared at 16:00 in the afternoon (8.7 10^9/l ± 1.0 10^9/l).

In the next pe-riods of day and night, the systematic increase of the absolute amount of these cells was observed. Their highest level was observed at 12:00 (10.5 10^9/l ± 1.9 10^9/l).

The fluctuation of the number of leucocytes throughout the experiment depended first of all on the number of lymphocytes (table 2).

It was said by Fox & Laird (1970) that the increase of the general amount of leucocytes in rabbit blood of the New Zealand White breed was found at night.

The minimum amount of lymphocytes as well as leucocytes was found in the peripheral blood smear at 16:00 in the afternoon (5.94 10^9/l ± 0.70 10^9/l). The systematic increase of these cells in the peripheral blood smears was accompanied by an increased concentration of the gamma globulin fraction in serum in the same individuals (*Szymeczko et al., 1992*).

The maximum amount of neutrophils in our experiments similarly to the experiments of Fox & Laird (1970), Baranski et al. (1962), and Prokopowicz et al. (1972) was found in the evening, i.e. at 20:00 (3.23 10^9/l ± 0.31 10^9/l).

Table 2. Number of leucocytes in rabbit blood at different times in two consecutive periods of 24 hours. Values are mean ± standard deviation.

Components	N	Sampling time (hour) 8:00	12:00	16:00	20:00	24:00	4:00	t-test[1]
Leucocytes (10^9/l)	20	9.67 ± 1.70	10.52 ± 1.92	8.74 ± 1.03	9.19 ± 1.35	9.44 ± 1.05	9.61 ± 0.80	8:00-12:00: ** 8:00-16:00: **
Lymphocytes (10^9/l)	20	6.76 ± 0.92	7.99 ± 0.92	5.94 ± 0.70	5.88 ± 0.95	6.66 ± 1.02	6.95 ± 0.77	8:00-12:00: ** 8:00-16:00: **
Monocytes (10^9/l)	20	0.08 ± 0.07	0.08 ± 0.05	0.03 ± 0.03	0.03 ± 0.04	0.05 ± 0.05	0.05 ± 0.06	8:00-16:00: ** 8:00-20:00: ** 8:00-24:00: ** 8:00- 4:00: **
Neutrophils (10^9/l)	20	2.68 ± 0.28	2.41 ± 0.14	3.11 ± 0.33	3.23 ± 0.31	2.54 ± 0.30	2.52 ± 0.12	8:00-16:00: ** 8:00-20:00: **
Eosinophils (10^9/l)		0.03 ± 0.05	0.04 ± 0.04	0.05 ± 0.07	0.07 ± 0.06	0.07 ± 0.03	0.03 ± 0.03	8:00-20:00: ** 8:00-24:00: **
Basophils (10^9/l)		0.12 ± 0.16	0.05 ± 0.09	0.11 ± 0.09	0.09 ± 0.05	0.12 ± 0.07	0.07 ± 0.06	8:00-12:00: ** 8:00- 4:00: **

1) * = significant at $p < 0.05$
** = significant at $p < 0.01$

The highest amounts of eosinophils appeared in the afternoon and in the evening (table 2).

The data obtained in our experiments referring to this type of leucocytes were similar to the char-acter of day and night changes in rabbits of the New Zealand White breed (*Fox & Laird, 1970*), and differed from the experiment results obtained by Kamyk (1969) in white mice. In the mice, the highest amount of eosinophils in the peripheral blood was found in the afternoon, and the minimum amount was found at midnight. According to the author, light and darkness cause the characteristic changes of eosinophils during a 24 hour period. The day and night oscillations of the absolute amount of basophils presented in our experiments (table 2) were concurring with the periodic rhythm of changes found in rabbits of the New Zealand White breed (*Fox & Laird, 1970*).

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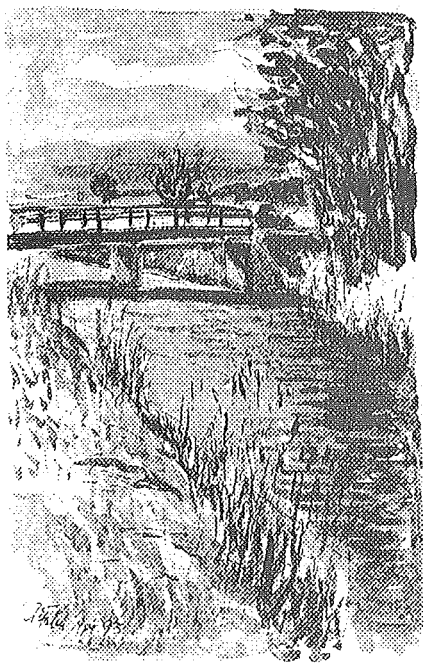

Original Report

Circadian and annual rhythm in the activity of captive beech marten (Martes foina)

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Abstract

The circadian and annual rhythm in the activity pattern of captive beech marten kept in an extensive captive environment were studied on the basis of regular video recordings in the period from February 1990 to March 1991. Feed intake and weight development of the beech marten were also recorded. Like their wild conspecifics the beech marten were only active in the dark period. The circadian rhythm demonstrated is supposed to be controlled by the changes in light-dark conditions. A large individual variation in activity level was found. A considerable part of the activity of the beech marten was stereotyped. The stereotyped activity increased distinctly at the beginning of the activity period and was not related to the eating/drinking activity. Changes in stereotyped activity between months were corresponded by changes in non-specific activity but were independent of the specific activity. The individual activity level was positively correlated to feed intake. Despite free access to feed and changes in the energy content of the feed, the beech marten maintained a constant body weight during the entire experimental period.

Introduction

The activity pattern is influenced by many external factors, some of which are periodical, such as the light/dark changes and the feeding time of domestic animals. By synchronizing inner circadian rhythms to these exogene periodical factors, the animal maintains a characteristic circadian rhythm adjusted to the surrounding environment.

The circadian rhythm of feral mustelidae can be adjusted to the light/dark period, the time when the prey appears (*Zielinski et al., 1983*), and predation pressure including pressure from man (*Skirnisson, 1986*).

Beech marten are described as opportunistic generalized predators. They eat what they can catch and manage: small rodents, birds, reptiles, fish, insects, vegetables, fruit, mushrooms, eggs, honey and carrion (*Goszczynski, 1976; Nyholm, 1970; Pulliainen, 1980A; Amores, 1980; Rasmussen & Madsen, 1985; Housa & Obrtel, 1981; Waechter, 1975*) and must therefore be regarded as omnivores.

In the description of the activity pattern of mustelidae, the species pine marten (*Martes martes*) (*Hurrel, 1968; Nyholm, 1970; Pulliainen, 1980B*), fisher marten (*Martes pennanti*) (*Powel, 1982*), ermine (*Mustela erminea*) (*King, 1989*), and mink (*Mustela vison*) (*Birks, 1986; Gerell, 1969; Marshall, 1935*) are described as being active in the day, at twilight, and at night, whereas beech marten (*Martes foina*) (*Skirnisson, 1986*) and badger (*Meles meles*) (*Harris, 1982*) are described as being active only at twilight and/or at night. The circadian rhythm in captivity has, however, not been described as far as beech marten are concerned.

In captive animals - zoo and farm animals - stereotyped patterns of behaviour may account for a considerable part of the total activity level of the animals (*Meyer-Holzapfel, 1968*). Stereotyped behaviour is often seen in insufficiently stimulated environments, whereas a sufficiently stimulated environment reduces the frequency of stereotyped behaviour (*Odberg, 1987*). Likewise, stereotyped behaviour is often seen just before expected feeding time. The occurrence of stereotyped behaviour is therefore supposed to be related to situations of conflict or frustration (*de Jonge et al., 1986*).

Previous investigations have shown that beech marten caught in the wild show stereotyped behaviour in captivity and that this behaviour accounted for a considerable part of the activity level of some individuals but that other individuals never showed stereotyped behaviour. Furthermore, differences were demonstrated in the stress physiological response pattern of stereotyping and non-stereotyping beech marten (*Hansen & Damgaard, 1993*). Similar differences were found in farm mink (*Bildsøe et al., 1991*). The differences found did not allow for an evaluation of the welfare of stereotyping individuals being better or worse than that of non-stereotyping individuals. It is also still uncertain whether the actual performance of stereotyped behaviour may have a stress reducing effect. The individual occurrence of stereotyped behaviour is at the moment to be regarded as a coping strategy which in itself does not permit an evaluation as regards welfare.

Several authors have tried to quantify the extent of stereotyped activity of farm mink. De Jonge et al. (1986) found that farm mink devoted on average (mean value) 2.5% per 24 hours or 15% of their active time to stereotyped behaviour. Bildsøe et al. (1990B) found, also on the basis of 24 hour video recordings, that mink females devoted 12% (mean value) of their active time to stereotyped behaviour. Differences in methods of calculation, housing of the animals, feeding routines/management as well as inheritance make it difficult to compare these results from literature.

The purpose of this investigation was to illustrate the circadian rhythm of beech marten caught in the wild and placed in outdoor enclosures exposed to natural light, weather and human beings but free from the constraints of hunting, and to relate the stereotyped and non-stereotyped activity to the circadian rhythm of eating-drinking behaviour. Furthermore, the investigation wanted to describe the seasonal variation in the types of activity mentioned as well as the weight development and feed intake of beech marten.

Materials and methods

Animals

The investigation was performed in the period from February 1990 to March 1991 and included 20 female beech marten (*Martes foina*) all captured in nature and housed singly in outdoor wire netting cages. 11 of the females had been kept in captivity from 1988, 7 from 1989, and 2 from January 1990.

Cage environment

The cages were 2.0 m high, 2.7 m long and 1.1 m wide and covered with stainless steel netting (25 mm x 40 mm). Each cage was furnished with 2 shelves, one in the left side 0.7 m above floor level (2.7 m long and 0.10 m wide) and one in the front of the cage 1.45 m above floor level (1.10 m long and 0.1 m wide) as well as with natural branches (birch or elm).

On the back of each cage 1 m above floor level a nest box (1 m x 0.5 m x 0.5 m) made of wood with a drop-in bottom (H 0.18 m x W 0.23 m x L 0.30 m) made of stainless steel netting was fitted to the cage.

Meteorological data were collected by the National Institute of Plant and Soil Sciences and represent local values. The data include: mean temperature over 24 hours, minimum tempera-

ture, rainfall, evaporation, mean wind velocity over 24 hours, and mean relative humidity over 24 hours.

Management and feeding
The animals were given wet mink feed ad libitum from a feed kitchen between 12:00 h and 15:00 h. Water was also given ad libitum. Feed intake was recorded 4 days a week in weeks 7, 9, 11, 14, 16, 18, 20, 22, 24, 26, 29, 33, 36, 42, 46, 50 in 1990 and in weeks 4, 9, 12, 16, 21 in 1991. Feed intake was calculated as the difference between feed given and feed left over the following day. Loss of water through evaporation from the feed was recorded, and apart from a few of the hottest summer days with a 9% loss, this had no great influence on feed intake. This loss has not been included in the calculations.

From June 11 to July 10 the amount of metabolizable energy was increased from 118 kcal to 182 kcal per 100 g feed. From December 15 to January 12 the amount of metabolizable energy was reduced correspondingly. In the intervening period there were only minimal changes in the energy content of the feed.

For females which were, in the period of heat, placed together with males, it was impossible to determine the individual feed intake. Only females placed alone are included in the calculations.

Handling of the animals
Once a week the animals were caught in a mink trap and checked visually. This lasted less than 5 minutes for each animal. The animals were weighed once a month except in the whelping period (March-May).

Video recordings
The activity pattern of the animals was recorded with a Hitachi KP 113 1/2" CCD camera and a Rainbow 7.5 mm auto iris optical instrument. By means of a 6 channel digital switch (VRC Krammer), allowing transmission of multiple video signals through a single channel medium, it was possible to record the activity in 6 cages at the same time on a time lapse recorder (Hitachi VT-L30E). In order to make night observations, infrared lamps were installed (IR 300/ 715 filter with Badger wide lens kit) on top of the camera. With this equipment it was possible to make 24 hour recordings of the 20 females over a period of 4 days.

The behaviour of the beech marten was recorded as follows: February 12-16, March 12-16, April 16-21, May 14-18, May 20-21, June 11-15, July 16-21, August 11-15, September 3-7, October 8-12, November 12-16, December 10-14, 1990, and January 22-26 and March 18-22, 1991.

Analysis of video recordings
The video tapes were analysed every 5 minutes for 24 hours by recording of the behaviour and position of the animals. The following selected behavioural elements were recorded:

1. Specific activity: carrying/manipulating objects, biting equipment, digging in gravel, sniffing/exploring.

2. Non-specific activity: moving without relation to objects or to another individual and without uniform pattern of movement.

3. Stereotyped behaviour: repeated, uniform pattern of movement with typical intensity apparently without any purpose.

4. Drinking and eating behaviour: contact with feed or water bowl.

The following positions were recorded:

5. In nest: in nest or entrance to tunnel.
6. On floor: on the floor of the cage.
7. Up: on branches, shelves, wire netting or on tunnel.

Furthermore, the following types of behaviour were recorded:

1. Total activity: specific activity + non-specific activity + stereotyped activity + drinking/eating + social interactions + defecation + grooming.
2. Non-stereotyped behaviour: total activity + stereotyped behaviour.

For each individual, a given form of behaviour within one hour was calculated as the percentage of the activity in question constituted per hour of the total number of behavioural observations per hour. Likewise, a given form of behaviour in a month was calculated as the percentage

which the activity in question constituted per 24 hours of the total number of behavioural observations per 24 hours.

Changes in housing and parallel experiments
At the end of April, 4 of the females had kits. The kits from 3 of these females were taken away from their mothers on July 8, and the last litter was removed on September 12.

In the period of heat from late June to late September a male was placed with a female and the pens were equipped with an extra conventional mink nest box without a tunnel. At video recordings in July, August, and September 8, 12 and 7 females, respectively, were placed with males.

In the period from November 5 to November 16, 18 females were included in an investigation of stress physiological responses to repeated blood sampling.

In September there were no recordings of two females due to a failure in video recording.

Statistics
For statistical analysis of behaviour or position between months the Wilcoxon signed rank t-test was used.

Variation in weight development was tested by means of the following model by the GLM-procedure:

$$Y_{ijk} = \mu + m_i + d_j + p_k + e_{ijk}$$

Y_{ijk} = measured value of weight for month i, individual j, pregnancy/lactation d
μ = general mean
m_i = effect of month i (i = February, March, April..... March)
d_j = effect of individual j (j = 1, 2, 3.....20)
p_k = effect of pregnancy/lactation k (k = preg./lact., non-preg.)
e_{ijk} = random variation.

Variation in feed intake and behavioural elements was tested by means of corresponding GLM-models in which was included the effect of activity level, heat, contact with male, weather observations (mean temperature over 24 hours (C), minimum temperature (C), rainfall (mm), evaporation (mm), mean wind velocity over 24 hours, and mean relative humidity over 24 hours (%)).

Results

Circadian rhythm
Circadian rhythm of total activity, stereotyped activity, non-stereotyped activity as well as drinking/eating activity is shown in fig. 1. In the light period, the beech marten stay in their nest boxes. In the dark periods, the beech marten are active in their pens. In the summer months from May to September the activity starts just before sunset and in July-August the activity period continues until just after sunrise. In the winter months from November to March, the start of the activity period is a little delayed in relation to the start of the dark period.

Total activity increases significantly at the start of the dark period and falls steeply immediately before sunrise. In January, February, March, April, and May the activity pattern has a bimodal structure with the first peak approx. 2 hours after sunset and another peak 3-5 hours before sunrise. When the nights are short, the activity increases until midnight and then it decreases again. In medium-long nights a constant activity level is maintained for 7-9 hours in the middle of the night, and when the nights are long an activity peak is seen in the middle of the night besides the activity peak after sunset and before sunrise.

Stereotyped activity increases significantly in the first 2 hours of the dark period. Thereafter an even decline towards sunrise is seen in the months of February, March, April and May. From June to September the level of stereotyped behaviour remains constant for 2-7 hours in the middle of the night until 2-4 hours before sunrise when the level falls significantly. From October to March the curve runs parallelly with the curve for total activity with 2 or 3 peaks in the course of the night.

In the period from September to March, the non-stereotyped activity is constant at night from 1-2 hours after sunset to 2 hours before sunrise. From April to August the non-stereotyped behaviour increases during the night and is at its maximum approx. 3 hours after midnight, whereafter it falls steeply.

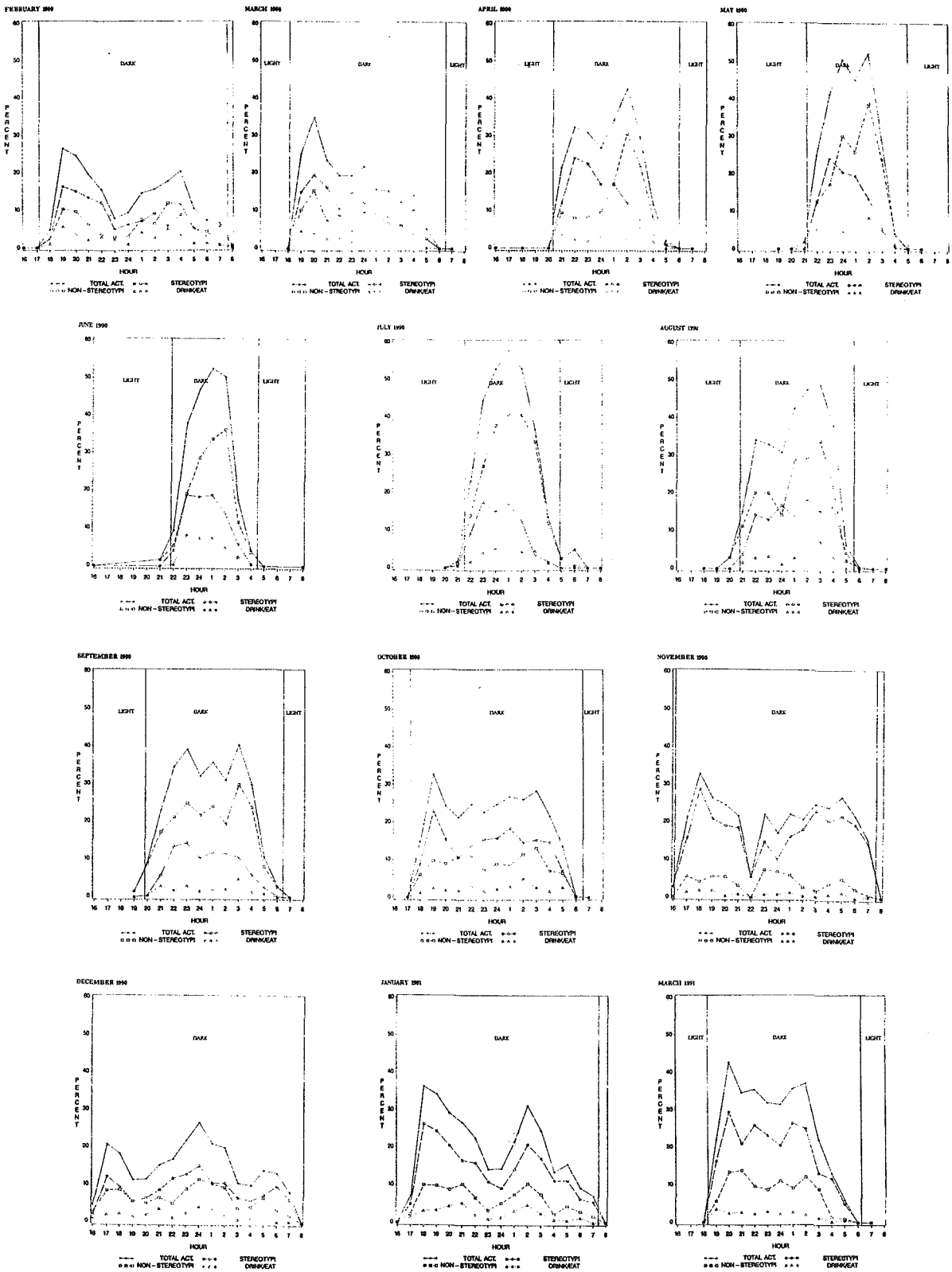

Figure 1 shows the circadian rhythm in total activity, in stereotyped and non-stereotyped activity and in eating-drinking behaviour distributed on months in the period from February 1990 to March 1991. The vertical lines show the time of sunset and sunrise.

From October to March the stereotyped activity constitutes the main part of the total activity level. After blood sampling in November it is seen that the predominant activity is stereotyped activity. The significant reduction in activity in November at 22:00 h is caused by blood sampling at this hour.

In the spring months of April and May the occurrence of stereotyped and non-stereotyped activity is identical but staggered so that the stereotyped activity is highest before midnight and the non-stereotyped activity highest after midnight. From June to September the level of non-stereotyped activity is higher than the level of stereotyped activity. The eating and drinking behaviour of beech marten continues throughout the night. No correlation in time between eating/drinking behaviour and the occurrence of stereotyped behaviour was found.

Annual rhythm

The monthly activity levels were subject to seasonal fluctuations (table 1).

The total activity level was higher in July and in August than in February, March, April, and June. No statistically significant difference between total activity level in the spring and in the autumn-winter was found.

An analysis of variance showed that 67% of the variation in total activity was caused by individual differences ($p < 0.001$, F-value 23.3) and the minimum temperature ($p < 0.05$, F-value 2.5). The period of heat and the possibility of social contact had no significant effect. There was a strong positive correlation between total activity and stereotyped activity ($R = 0.94$, $p < 0.0001$). A positive correlation was also found between total activity and non-stereotyped activity ($R = 0.68$, $p < 0.0001$).

Table 1. Per cent occurrence of behaviour per month calculated as average of population. Min.-max. values in brackets. ((beh. per 24 hours/tot. obs. per 24 hours) x 100).

	Total activity	Stereotyped	Non-stereotyped	Drinking/eating	Non-specific	Specific
February	8.4 (0.7-42)	4.8 (0.0-32)	3.6 (0.7-13)	1.6 (0.4-5)	1.3 (0.0-6)	0.8 (0.0-5)
March	8.6 (0.7-32)	4.9 (0.0-25)	3.8 (0.7-12)	1.3 (0.4-3)	1.3 (0.0-5)	1.2 (0.0-7)
April	9.7 (1.0-33)	4.9 (0.0-26)	4.8 (0.7-9)	1.0 (0.4-2)	1.9 (0.0-5)	1.8 (0.0-9)
May	10.4 (1.7-25)	4.0 (0.0-17)	6.4 (1.8-12)	1.4 (0.4-2)	3.0 (0.0-8)	2.0 (0.0-10)
June	9.1 (2.4-28)	3.4 (0.0-19)	5.8 (2.4-13)	1.3 (0.4-3)	2.4 (0.4-7)	2.0 (0.0-7)
July	12.0 (0.0-26)	3.2 (0.0-16)	8.8 (0.0-24)	1.1 (0.0-2)	5.1 (0.0-23)	1.9 (0.0-8)
August	12.6 (0.0-32)	4.8 (0.0-25)	7.9 (0.0-25)	1.1 (0.0-4)	3.7 (0.0-10)	2.2 (0.0-8)
September	12.1 (0.0-36)	3.6 (0.0-19)	8.5 (0.0-26)	0.1 (0.0-4)	5.7 (0.0-21)	1.4 (0.0-9)
October	11.8 (1.0-37)	7.2 (0.0-30)	4.6 (0.5-17)	1.2 (0.0-3)	0.9 (0.0-4)	2.0 (0.0-8)
November	14.0 (0.0-49)	10.8 (0.0-36)	2.7 (0.0-14)	0.6 (0.0-4)	1.5 (0.0-5)	0.6 (0.0-5)
December	11.2 (0.4-45)	6.7 (0.0-31)	4.5 (0.4-15)	1.4 (0.4-5)	1.8 (0.0-9)	1.2 (0.0-6)
January	12.8 (0.2-54)	8.9 (0.0-39)	3.9 (0.2-15)	1.5 (0.0-5)	1.9 (0.0-11)	0.5 (0.0-4)
March	13.0 (0.9-39)	9.1 (0.0-32)	4.0 (0.9-10)	1.0 (0.4-2)	1.2 (0.0-6)	1.7 (0.0-7)

When dividing total activity into stereotyped and non-stereotyped activity, two opposite seasonal rhythms (table 1) were found. In May, June, July, and September the level of stereotyped behaviour was significantly lower than in October, November, January, and March 1991. The non-stereotyped activity was higher in May, June, July, August, and September than in the other months. The individual variation ($p < 0.0001$, F-value 18.5) and the minimum temperature ($p < 0.0001$, F-value 7.9) explained 63% of the variation in stereotyped behaviour. The variation in non-stereotyped activity was caused by the individual variation ($p < 0.0001$, F-value 8.3) and by month ($p < 0.0001$, F-value 5.7). The weather had no significant influence on non-stereotyped activity. There was a positive correlation between stereotyped activity and non-stereotyped activity ($R = 0.38$, $p < 0.0001$).

A further division of the non-stereotyped activity into specific activity (see Materials and methods) and non-specific activity shows that the non-specific activity was higher in May, June, July, August, and September than in the other months of the year. The specific activity was lowest in February, March, November, and January.

The individual variation ($p < 0.0001$, F-value 4.7) and the relative mean humidity over 24 hours influenced the specific activity ($p < 0.0003$, F-value 5.5) and explained 34% of the variation. 46% of the variation in the non-specific activity was caused by: individual ($p < 0.0001$, F-value 5.8) and month ($p < 0.0001$, F-value 7.0).

A moderate positive correlation was found between stereotyped activity and non-specific activity ($R = 0.27$, $p < 0.0006$), whereas the correlation between stereotyped activity and specific activity was modest ($R = 0.18$, $p < 0.02$). The most significant variation in non-stereotyped activity was caused by variation in the non-specific activity ($R = 0.90$, $p < 0.0001$).

No significant annual variation was found in the eating/drinking behaviour of the beech marten, apart from an extremely low level in the month of November. November was atypical due to the previously mentioned blood sampling which, as regards time, coincided with a reduced frequency of non-stereotyped activity and an increase in stereotyped activity (*Hansen & Damgaard, 1993*).

Table 2. Per cent occurrence of position per month calculated as average of the population. Min.-max. values in brackets. (Position per 24 hours/tot. obs. per 24 hours) x 100).

	In nest box	On cage floor	On branch/shelf
February	91 (58-99)	6 (0.4-30)	3 (0.0-16)
March	91 (69-99)	6 (0.7-28)	3 (0.0-23)
April	90 (66-99)	7 (0.7-29)	3 (0.0-14)
May	89 (74-98)	6 (1.0-18)	5 (0.4-17)
June	90 (72-98)	7 (1.4-25)	3 (0.0-12)
July	87 (64-100)	7 (0.0-21)	7 (0.0-18)
August	86 (68-100)	7 (0.0-26)	7 (0.0-25)
September	87 (63-100)	5 (0.0-20)	7 (0.0-22)
October	86 (58-100)	8 (0.5-39)	5 (0.0-31)
November	86 (49-100)	9 (0.0-38)	5 (0.0-25)
December	88 (55-100)	8 (0.4-31)	4 (0.0-22)
January	86 (43-100)	8 (0.2-38)	5 (0.0-33)
March	86 (61-99)	7 (0.4-22)	7 (0.0-31)

Position in the cages

The position of the beech marten in the cages is shown per month in table 2. In July and August the beech marten are significantly less in their nest boxes than in February, March, April, and June ($p < 0.05$). The individual variation ($p < 0.0001$, F-value 9.8), month ($p < 0.02$, F-value 2.1), and minimum temperature ($p < 0.0008$, F-value 4.9) influence the animals's use of their nest boxes.

In July and August the beech marten spent more time on branches and shelves than in February, March, April, June, November, December, and January ($p < 0.05$).

The individual variation ($p < 0.0001$, F-value 9.8), month ($p < 0.02$, F-value 2.1), and mean wind velocity ($p < 0.03$, F-value 3.62) explained 48% of the variation.

No significant difference was found between months in the time the beech marten spent on the cage floor ($p > 0.05$). An analysis of variance showed that individual ($p < 0.0001$, F-value 19.4) and minimum temperature ($p < 0.03$, F-value 2.7) caused 62% of the variation.

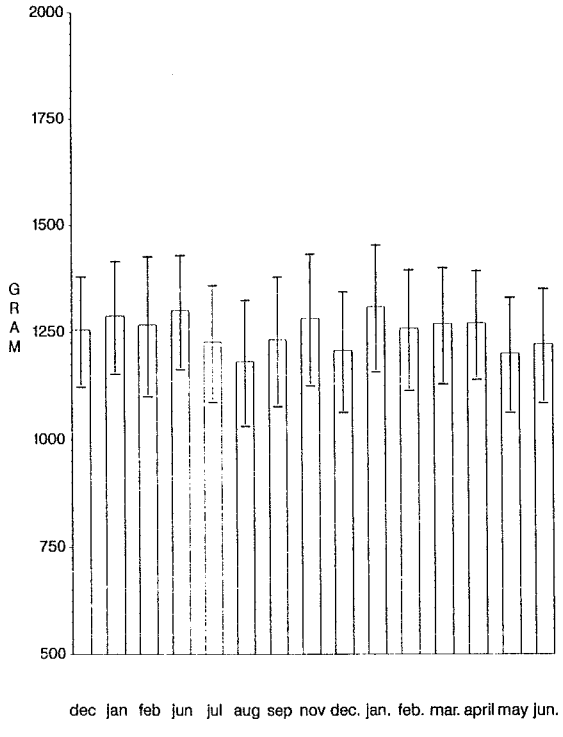

Figure 2 shows the average weight ± SD of the mink females in the period from December 1989 to June 1991.

Weight development

The weight development of the beech marten population is shown in fig. 2. The statistical test explained 85.8% of the variation. Differences between individuals (fig. 3) is the main reason for the variation ($p < 0.0001$, F-value 66.9), whereas month ($p < 0.0001$, F-value 7.5) and lactation/nursing ($p < 0.0001$, F-value 9.53) contribute less to the variation.

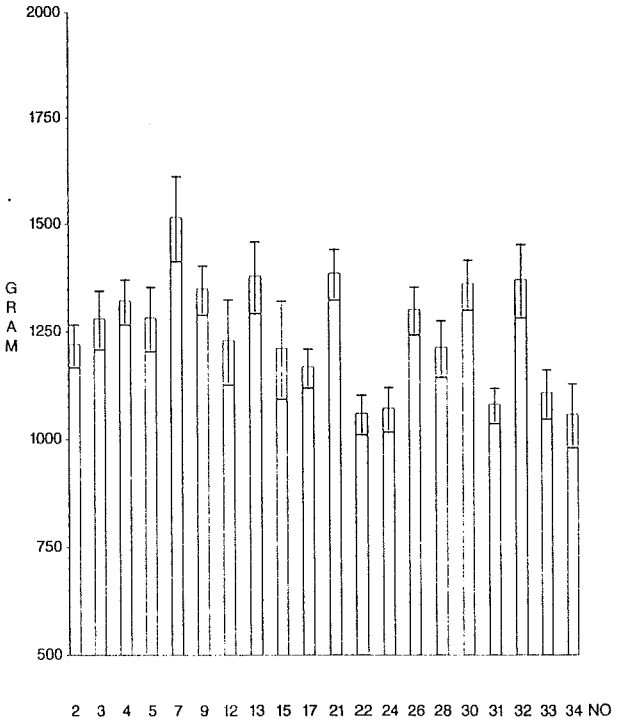

Figure 3 shows the average weight ± SD for each of the 20 females in the period from December 1989 to June 1991.

Feed intake

Feed intake in grams and kcal is seen from fig. 4.

An analysis of variance explaining 67% of the variation in grams of feed eaten showed a significant effect of individual ($p < 0.0001$, F-value 98.0), week ($p < 0.0001$, F-value 16.7), mean temperature, rainfall, evaporation, percent humidity ($p < 0.005$, F-value 4.7-5.8), and minimum temperature ($p < 0.027$, F-value 2.8).

From the 1491 recordings of feed intake and weather it was possible on 156 of them also to include behavioural parameters.

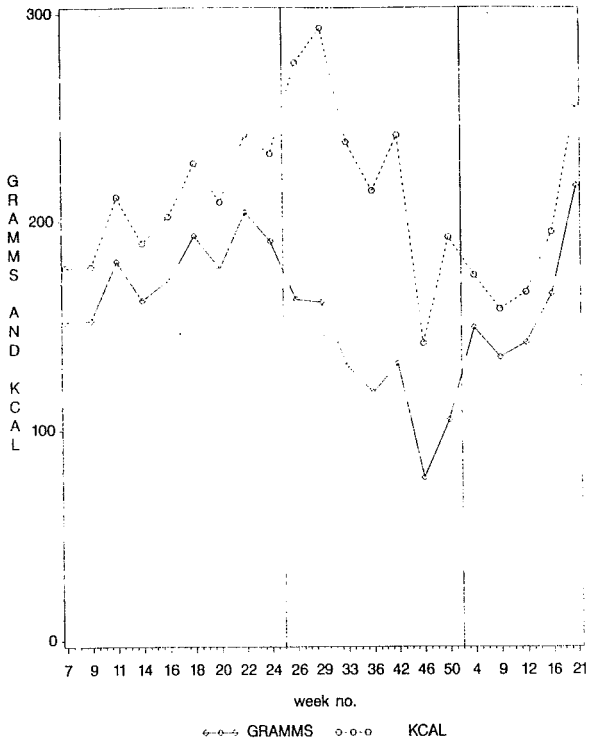

Figure 4 shows the average feed consumption in grams of feed and kcal per female in the period from February 1990 to June 1991. Pregnant lactation females are not included.

An analysis of variance explaining 75% of the variation in feed intake (grams) showed that individual ($p < 0.0006$, F-value 2.7), month ($p < 0.002$, F-value 7.8), daily mean temperature ($p < 0.002$, F-value 6.9), and total activity level ($p < 0.0001$, F-value 6.6) contribute significantly to the variation. The same factors had a statistically significant effect on the variation in metabolizable energy eaten (kcal).

An analysis of correlation showed that active forms of behaviour were positively correlated to feed intake in grams and kcal ($p < 0.0001$). Furthermore, there was a negative correlation between energy content in the feed and feed intake in grams ($p < 0.003$).

Discussion

Circadian rhythm

Beech marten are active in the dark period. Their active period varies with the length of the dark period. The beech marten were thus active in July between 22:00 h and 04:00 h whereas in January they were active between 17:00 h and 07:00 h.

The anatomical place of the prime endogen circadian pacemakers for photocally influenced circadian rhythms in vertebrate is the suprachiasmatic nucleus of the anterior hypothalamus. In addition to this master clock there seem to be other oscillators, e.g. in the ventromedial hypothalamus involved in food anticipatory rhythms (*Rosenwasser & Adler, 1986*).

It is doubtful whether from their visual hiding in their nest boxes the animals are able to connect the daily manual feeding once a day with the allocation of fresh feed. Furthermore, the beech marten had free access to feed (fed ad libitum), and the feed resources can therefore not have been determining the activity pattern. From investigations with farm mink it is known that if the animals are fed ad libitum, they do not develop any increase in activity just before feeding time (*Zielinski, 1986, Hansen et al., 1992*). Farm mink fed restrictively do, however, show an increase in activity just before expected feeding time (*Bildsøe et al., 1990A*).

Furthermore, the activity of beech marten does not seem to be affected by human activity at the farm, as farm personnel worked at the farm from 08:00 h to 16:00 h all year round.

The results obtained indicate that by means of exogenous periodical factors (Zeitgebers) in the environment - in this case the change in light/-dark conditions - the beech marten use the circadian system for temporal orientation. Good adaptation by the visual system to darkness followed by a higher feeling of security in the environment in relation to possible predators including man and to prey can determine the activity pattern. The relatively large eyes in comparison with, for instance, mink might indicate that beech marten have an especially good vision in the dark.

The results obtained as regards the circadian rhythm of these beech marten caught in the wild are identical with the results obtained by Skirnisson (1986) when observing the circadian rhythm of beech marten in the wild by telemetry.

In captivity a secure day shelter in the nest box can further maintain the night activity observed.

Beech marten which, in captivity, only have access to a conventional mink nest box without tunnel are more sensitive to human activity. To disturbances in the day hours close to the cages these beech marten often react with activity out in the cage (own unpublished observations).

Seasonal changes in activity
There is no unambiguous picture of the seasonal variation in the activity of mustelidae living in the wild. In feral mink (*Gerell, 1969*) the activity level is lowest in the summer months and highest in the autumn and winter months. Opposite, the activity of American Zobel (*Martes americana*) is highest in July/August and lowest in March-/April (*Zielinski et al., 1983*). These differences should probably be seen in relation to type of habitat, presence of food, predation and reproduction conditions.

Skirnisson (1986) found that beech marten living in villages were less active in the autumn and winter months than beech marten living in forests or fields which is probably due to differences in feed resources. Furthermore, he could in these periods demonstrate a significant positive correlation between total activity and minimum temperature. Our results also showed that when the minimum temperature increased, the total activity level also increased.

The increase in the total activity level of beech marten in July and August coincided with the heat period of the females. It was, however, not possible to demonstrate a statistically significant effect of heat or the fact that some of the females were at this time placed together with males. There is a large individual variation in activity level. This variation could express different levels of sensitivity to captivity and/or different adaptation strategies in the relatively insufficiently stimulated environment (*Hansen & Damgaard, 1993*).

Stereotyped behaviour
A distinct difference in circadian rhythm between stereotyped and non-stereotyped activity in the period from April to September was demonstrated. The stereotyped activity increases markedly immediately after the start of the dark period and remains constant - depending on the length of the dark period - for some hours and decreases again gradually towards sunrise. The non-stereotyped activity increased markedly throughout the night and was at its maximum 2-3 hours after midnight, decreasing abruptly before sunrise. The time when stereotyped behaviour occurred was not related to the eating/drinking activity and is, therefore, probably not motivated by hunger. In farm mink, fed restrictively, the increase in stereotyped behaviour just before feeding time is supposed to be related to non-rewarding appetence behaviour for feed (*de Jonge et al., 1986*). The correlation between stereotyped activity and feeding can therefore be indirect, as the activity period of farm mink fed restrictively is synchronized with feeding time. Experiments with a marked reduction of the quantity of feed increase the stereotyped as well as the non-stereotyped activity just before feeding time, but the stereotyped activity remained increased after the normal feeding routine had been resumed and after the animals had regained the weight loss induced (*Bildsøe et al., 1991*).

There seems to be a correlation between stereotyped activity and non-specific activity. The stereotyped activity decreased in the summer months and at the same time the non-specific activity increased. The opposite changes were seen in the winter months. The specific activity does not, however, seem to be influenced by changes in stereotyped activity.

This correlation between stereotyped behaviour and non-specific activity combined with an unchanged level of specific activity has previously been demonstrated in farm mink (*de Jonge et al., 1986*). The stereotyped activity of farm mink as well as of beech marten caught in the wild could express a routine/habit by which the non-specific activity of the animals is expressed as a repeated uniform pattern of movement in an insufficiently stimulated environment.

It is, however, possible that individual differences in the activity pattern of the animals contribute to the relation found between stereotyped and non-specific activity. Thus, an increased level of non-specific behaviour in animals not performing stereotyped behaviour will result in the changes found in the relation between ste-reotyped behaviour and non-specific behaviour in the summer months at population level.

Placement in outdoor pens
On average the beech marten spent between 86 and 91% of the 24 hours in their nest boxes, distributed over the 13 months in question. Corre-

spondingly, they spent from 5.5 to 8.8% on the cage floor and from 2.7 to 7.2% on branches/-shelves.

Farm mink spend approx. 70% of their time in the nest boxes, and the physiological stress level increases significantly at nest box deprivation (*Hansen et al., 1993*). To these mustelidae which, like other carnivores, spent a large part of their time resting, the nest box seems to be an important element in the cage design. In the period of heat, when male was placed with female, both animals preferred to use the original nest box to the extra conventional mink box placed in the pen. The result indicates partly a social acceptance by the beech marten and partly that they prefer a dark nest box to the conventional nest box.

The relatively uniform use of nest boxes by beech marten throughout the year takes place despite the annual variation in the length of the dark period.

In the summer months the activity of the population is limited to relatively few dark hours whereas in the winter months the activity is distributed over more hours (fig. 1).

The individual variation in the activity level had a considerable influence on the position of the beech marten in nest boxes, on branches/shelves, and on the cage floors. Time spent on branches/shelves was furthermore reduced when the wind velocity was increased, and the activity level in the wire netting cage was reduced at falling temperatures.

Feed intake and weight development

There was a significant positive correlation between the activity level and feed intake/energy consumption of the beech marten. Animals which were active more than 20% of the 24 hours used on average 204 grams of feed, whereas animals which were active from 5 to 20% and from 0 to 5% of the time ate 165 grams and 100 grams of feed, respectively.

An increase of the energy content of the feed from June to December resulted in a decrease in the feed intake of the beech marten. This is also seen from the negative correlation between energy content in feed and grams of feed eaten.

In the experimental period, the individual weight varies less than 100 grams, showing that the beech marten are capable of regulating their energy intake both in relation to energy content in the feed and to activity level, despite their free access to feed.

Weather changes affected the feed intake, but as the weather influenced the activity level, it was concluded that the most important factor in connection with feed intake/energy intake was the individual activity level. It has previously been demonstrated that beech marten in captivity developing stereotyped behaviour eat considerably more feed than beech marten not developing stereotyped behaviour (*Hansen & Damgaard 1993*).

Conclusion

Beech marten caught in the wild, kept in extensive captive conditions, were active in the dark period. The length of the activity period varied with the length of the dark period, but the total activity level remained constant. The circadian rhythm demonstrated is supposed to be controlled by the change in dark-light conditions, whereas human activity at the farm and feeding did not influence the activity pattern directly.

The most important factor in connection with the variation in activity level was the individual variation. Besides, low minimum temperatures had a reducing effect on the activity level.

A considerable part of the activity of beech marten was performed as stereotyped activity. The stereotyped activity increased significantly at the beginning of the activity period and was not related to the eating/drinking activity. Changes in the level of stereotypies between months were corresponded by changes in non-specific activity but were independent of specific activity.

A positive correlation was shown between the activity level and feed intake of the animals. Very active animals consumed twice as much feed as individuals with a low activity level. The individual weight remained more or less constant in the experimental period despite free access to ample feed.

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Original Report

Weight development and behaviour of mink in the nursing period with and without the use of spray watering

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Introduction

Mink likes to drink every 2 hours day and night (*Møller, 1991a,b; de Jonge et al., 1986*), and therefore water ought to be available 24 hours a day. In Denmark, a constant water supply is usually provided by automatic watering systems with drinking valves (*Møller, 1992*). It is easy to verify that there is water in the valves, but it is difficult to ascertain whether the mink drink the water they need. In the nursing period cases of dehydration of the females are seen, and for the kits an insufficient water intake may affect the weight development (*Møller & Lohi, 1989*). It is therefore important to clarify which factors affect the water intake of the mink.

The intake of drinking water by the kits is closely connected to their age and motor development. The kits start exploring the cage at the age of 5 weeks and if they come across water they are able to drink. They can not release a drinking valve until the age of 6 weeks (*Møller & Lohi, 1989*). The normal water supply is therefore often supplemented with various auxiliary devices which make the water in the existing system more easily accessible.

The spray watering system from Forelco is in principle quite another type which distributes a flat jet of water from the top of the cage. The producer states that "the system is meant for use in the nursing period and in periods with air temperatures of more than 28°C when it is difficult to maintain the right fluid balance. Spray watering can help the females cool down in a shower, and the kits can cover their need for liquid by licking water from the female's wet pelt".

Objective

The objective of this investigation was to illustrate the effect of spray watering in the nursing period on the weight development and behaviour of farm mink as well as on the hygiene in the cages.

The objective was met by

1. measuring the weight development of the female and of the kits,
2. recording the behaviour of mink females before, during, and after activation of the spray watering system, and recording whether the kits are licking water from the female's wet pelt,
3. estimating the hygiene in the cage and nest environment,
4. recording temperature and humidity in the cages.

Materials and methods

In a closed 6-row shed 96 pastel females was equipped with a spray watering system, and 100 pastel females were regarded as a control group. The experiment started on May 9, approximately

one week after most of the kits were born. The experiment ended at weaning when the kits were approximately 7 weeks old.

Females and kits were weighed the day after birth and from then on every fortnight until weaning. The kits were weighed by sex from the second weighing. Weighings which should have taken place on Saturdays were advanced to Fridays, and Sunday weighings were postponed until Mondays.

The spray watering system was on for 30 seconds at a time in connection with feeding at 9:00 and 14:00 and in the quiet periods at 11:00 and 16:00. In case of temperatures above 28°C, it was also turned on at 13:00 and 15:00 by thermostatic control. In order to obtain a uniform experimental treatment on all days, clocks, thermostats and magneto valves were installed for control of the spray watering system.

The behaviour of the females in the period with spray watering was observed two days a week at 09:00, 11:00, and 14:00, totally 11 days from May 10 to June 14. Observations were made by scannings of all cages in the experimental and the control group before, during and after the spray watering system was on. When scanning, the period with spray water was extended to 60 seconds to perform the observations in a satisfactory way. It was recorded whether the females were in the nest box og in the cage, if they were active, and if they used the spray water. It was furthermore recorded if the kits licked saliva from the corner of the female's mouth, and if they sucked water from the female's pelt. Owing to the observations, the nest boxes were not covered with straw.

The environment in cages and nests was evaluated in the morning before the spray water was turned on for the first time. The environment was given scores from 1 to 5, with 1 for dry and clean, 3 for greasy and tatty, and 5 for very wet and dirty.

The temperature was recorded every hour outside the shed, under the roof, at the level of the cage, and in two nest boxes from the spray water and the control group, respectively. The humidity was recorded every hour in two nest boxes from the spray water and the control group, respectively. The measurings were made with "Grant Squirrel" data loggers. The mink tended to move the nest away from the sensors in the nest boxes, and the results can therefore hardly give a real expression of temperature and humidity in the nest.

When the experiment started on May 9, there were 71 litters in the experiment group with an average of 6.72 kits and 65 kits in the control group with an average of 5.46 kits. Spray watering had no influence on the large difference in kit result or on the high percentage of barren females, but these factors must be included in the specification of the results.

Results

Weight development

As the spray watering system was started one week after birth, the weight change from 2 to 6 weeks after birth is used as an expression of the effect of spray watering on the weight development. It is thus not necessary to correct for the displacement in age of 1 day occurring at the weighings around weekends.

The weight development of females is illustrated in Figure 1.

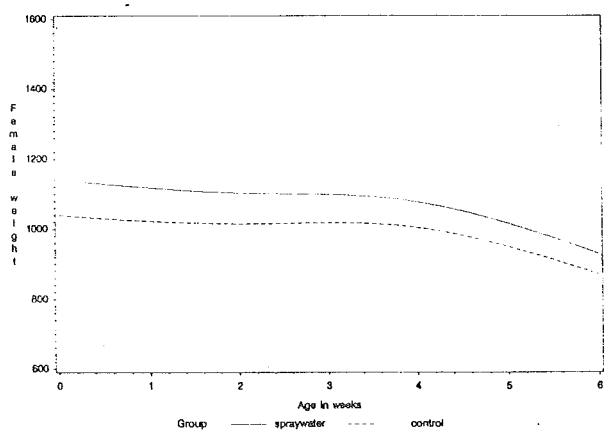

Figure 1. Weight development of nursing females with and without spray watering.

It appears from Figure 1 that the females with spray water were heavier than the females in the control group throughout the entire period. The females with spray water lost an average of 27 g more than the females without from week 2 to week 6 from birth. An analysis of covariance of the weight loss in the two groups, with the female's weight at birth and litter size as the two covariates, showed that the difference in weight loss could be referred to these factors (both with $p<0.001$). Spray water, therefore, had no effect on the weight development of the females.

Weight development of male and female kits is illustrated in Figures 2 and 3.

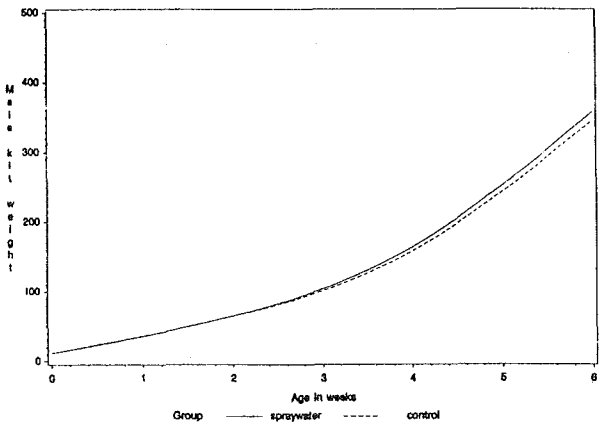

Figure 2. Weight development in the nursing period of male kits with and without spray water.

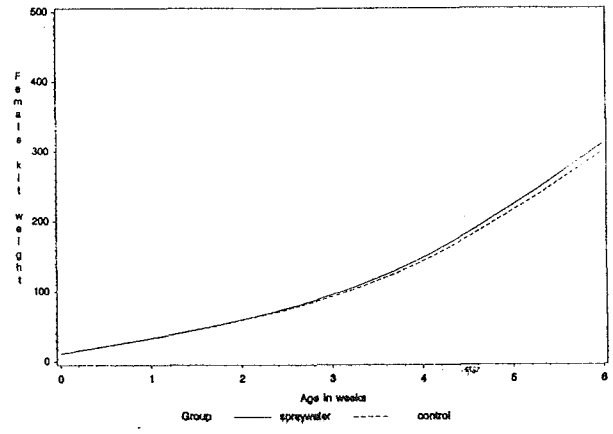

Figure 3. Weight development in the nursing period of female kits with and without spray water.

It appears from Figures 2 and 3 that male as well female kits with spray water grew a little better than the kits in the control group. The difference in weight gain from week 2 to week 6 was not immediately significant. An analysis of covariance in the two groups with litter size as covariate showed a generally negative effect of litter size. The effect amounted to 6 g per kit for males and 4 g per kit for females (both with $p<0.01$). As litter size was largest in the experimental group, spray water did have a significant, positive effect on weight gain for both sexes ($p<0.01$). Spray water thus meant an increased weight gain of approx. 20 g for males and 16 g for females.

Behaviour

The majority of the females used the spray water during the 11 days of observation. The frequency of females taking a "shower" appears from Table 1 for all, lactating, and barren females, respectively, in the experimental group.

It appears from the table that there is a large variation in the number of times the females used the spray water. On average, the 96 females used the spray water 7.6 times during the 33 observations. Only 4% of the females were never seen under the spray water, whereas 19% used it less than 4 times. 58% of the females used the water between 4 and 11 times, and 19% used it more often than 11 times. No females used the spray water each time. A χ^2 test showed that the barren females used spray water more often than the females with kits ($p<0.01$). Litter size, however, had no effect on how often the female used spray water.

The number of females active or under the spray water at the three times of observation appears from table 2.

Tell me: What is the difference between spray water and water spray ?

Table 1. Frequency of females observed in the shower under spray water during the 33 observations over 11 days.

No. of times in the shower	Total no. of females n=96	Lactating females N=71	Barren females n=25
0	4	3	1
1	5	5	0
2	9	8	1
3	4	3	1
4	8	7	1
5	4	4	0
6	5	5	0
7	14	11	3
8	7	4	3
9	8	5	3
10	3	1	2
11	7	3	4
12	5	3	2
13	3	1	2
14	2	1	1
16	1	1	1
17	2	1	0
18	2	2	0
20	2	2	0
25	1	1	0

Table 2. Number of active females in the experiment group before, during, and after the period with spray watering. Sum over 11 days for each hour.

Hour	9	11	14
Before spraying	210	122	136
Active at spraying	433	285	268
Of this in shower	318	197	214
After spraying	273	157	194

It appears from Table 2 that the activity in the experimental group and the use of spray water was highest in the morning and lowest around the middle of the day. The activity more than doubled when the spray water was activated, and almost 75% of the active females used the spray water. Afterwards the activity fell steeply to 1.3 times the level before spray watering.

The proportion of active females in the experimental group increased from 15 to 20% after the spray watering period. In the control group 15% of the females were active at both observations. The activity of the experimental females after the period with spray watering was significantly higher than before spray watering, and than the activity of the control females, both with ($p<0.001$).

The distribution of females active in the cage or under the spray water on the 11 days of observation appears from Table 3.

Table 3. Number of active females in the experiment group before, during, and after the spray watering period. Sum over 3 times of observation for each day.

Date	10/5	14/5	18/5	22/5	25/5	29/5	31/5	5/6	8/6	12/6	14/6
Before spraying	54	41	46	37	38	41	33	45	49	52	32
Active at spraying	167	122	134	97	73	77	64	96	73	41	43
Of this in shower	99	86	100	58	52	64	46	88	68	28	40
After spraying	61	73	77	59	38	48	41	65	78	47	37

It appears from the table that the activity of the females before spray watering was the same during the experimental period, whereas it was falling while the spray water was on. On the first three days of observation, the spray water activated three times as many females as before the water was on. Hereafter the activity was more or less doubled while the water was on. The females used spray watering in 33% of the cases on the three first days, whereafter it was used 19% of the times. On the other hand, an increasing proportion of the females which were active in the spray watering period did also use the water.

There was some correlation between the activity level before the period with spray watering and the number of females using the spray water ($r = 0.63$). A statement showed, however, that only 43% of the females, which had been active in the period just before, used the spray water. There was an even better correlation between the use of spray water and the activity level afterwards ($r = 0.74$), but only 56% of the females which were active afterwards, had actually used the spray water.

The temperature did have an effect on whether the passive females were lying in the nest or out in the cage. The proportion of females lying out in the cage could be described with the following equation of regression:

% passive females in the cage = $-41 + 3.75 * °C$ in the cages, $R^2 = 0.66$

This means that at a temperature above 11°C the females started lying out in the cages, at 15°C approx. 15% were lying out, at 20°C approx. 34% and at 25°C approx. 53%.

Saliva licking was observed the first time on the June 5, and after that it occurred in 2.5% of all observations. There was no difference in the frequency of saliva licking between the experimental and control groups before the period with spray watering. After the period with spray watering, the frequency of saliva licking increased to 4.5% in the experimental group against 1.8% in the control group. The difference was significant ($p<0.001$). In this material, no correlation was found between saliva licking and temperature.

The general impression was that females, which had used the spray water, shook off the water and rubbed their pelts against the cage before they went into the nest boxes. Only in one case out of 40, saliva licking was observed in a female which had used the spray water. In none of totally 2343 observations it was observed that the kits licked water from the female's wet pelt. A few times it was noted that approx. 6 week old kits licked water from the wire netting or from the straw on the bottom of the cage, when the spray water had stopped.

Environment

The cage environment was significantly better in the control group than in the group with spray watering (χ^2 test $p<0.001$). Most of the cages were clean and dry, but there were more wet and dirty cages in the spray water group. The nest box environment was more uniform, as almost all nests were given grade 1. There were a few more wet and dirty nests in the spray water group, but the difference was not significant. The distribution of the various grades appears from Table 4.

Table 4. Percent distribution of grades for environment in cages and nest boxes in the spray watering and control groups.

Grade	1	2	3	4	5
Cage spray watering	52.0	35.7	11.6	0.7	0
Cage control	64.5	29.0	6.1	0.4	0
Nest spray watering	92.4	6.1	1.3	0.2	0
Nest control	91.2	8.2	0.6	0	0

It was noted that the females in the experimental group often defecated under the spray water instead of at the back of the cage, as they normally do. This defecation pattern was more commen in females with kits than in females without kits, and the difference was significant in a χ^2 test ($p<0.01$).

In the experimental period the temperature varied between 3°C and 28°C with an average of 13°C. The temperature in the shed followed the temperature outside closely. The temperature in the nest boxes also varied with the temperature outside, but in general it was approx. 6°C higher. The nest boxes in the control group were 1°C warmer than in the spray water group, and the difference was significant ($p<0.001$).

The relative humidity in the nest boxes varied between 20 and 70%. The humidity was highest at night and lowest during the day, and no clear effect was seen of spray watering. The humidity was just under 5 percent units higher in the control group than in the spray water group, but the reason for this difference was rather an insufficient adjustment of the sensors than an effect of the spray water.

Discussion

It has previously been found that additional water supply can reduce the weight loss of the females and increase the weight gain of the kits if the weather is hot in the nursing period (*Møller & Lohi, 1989*). No effect is seen when the temperatures are below normal (*Møller & Lohi, 1988*). In 1990 the average temperature in May was 1.2°C above normal, whereas it was normal in June when the kits start looking for water. The conditions for proving an effect of the spray watering system existed, but they were not optimal. It is possible that a higher temperature in June might have had an effect on the weight gain of the females, a higher effect on the weight gain of the kits, or a changed behaviour in connection with the spray water.

The large difference in the starting weight of the females and in litter size could explain the higher weight loss of the females in the spray water group. Therefore, no effect of spray watering was seen on weight development which indicates that the spray water did not add a supplement to the water intake of the females. The negative correlation between litter size and the weight development of the females has not been found earlier (*Hansen, 1990*). That the weight of the females at birth has a negative effect on the weight development in the nursing period is in accordance with earlier investigations (*Tauson & Aldén, 1985*).

The negative effect of litter size on the weight development of the kits is in accordance with earlier results (*Hansen, 1989; Møller, 1992*). The positive effect of spray watering on the weight gain of the kits may be a result of the kits licking water from the cage and the floor material after spray watering. In that case the effect is the same as obtained from auxiliary devices on the drinking valves which give the kits access to water without releasing the valve. Experiments with drip watering in the nursing period has previously shown a positive effect on the weight development of the kits (*Møller & Lohi, 1989*). The effect of drip watering corrected for age at the time of weighing was not stated in the article. Later the effect on gain until 7 weeks has been calculated to be 60 g for males and 42 g for females. The reason why drip watering gave three times as high an effect as spray watering may be that the experiment lasted one week lon-

ger, that the mean temperature was 1°C higher in June, and that the drip watering was available all the time, whereas spray watering was only available in short periods.
The frequent use of spray water at the beginning of the period may be due to an interest of novelty, or that the females are activated by the disturbance caused by spray watering. The use is remarkable, as the females stay very much in their nests in early lactation. This may explain why barren females used the spray water more often than females with kits.
The reduction in the use during the period may reflect adaptation to the disturbance and or a reduced interest. A quickly reducing interest in new things has been described earlier in connection with the use of water trays and toys (*Hansen, 1990; Falkenberg, 1989*). The increasing share of active females using the spray water indicates that, as time went on, most females were only active to use that system.
Production-wise, it is of no importance that barren females use the spray water, as it was established to help the nursing females and their kits. The majority of the females with kits used the possibility from time to time, on average 21% of the times, so spray watering did not cover a daily need of the females, even though they used it regularly.
Even though there was correlation between the activity before, during and after the period with spray watering, there was large variation as to which females were active at what time. Less than half the females active in the period before, used the spray water when it was turned on. The majority of the females using the spray water were therefore activated by the water. Only a little over half of the females, which had used the spray water, were active afterwards.
That saliva licking is seen at the age of 5 weeks is in accordance with previous investigations, but then the kits' own water intake was followed by a reduction in saliva licking (*Møller & Lohi, 1989*). In this investigation, the frequency of saliva licking increased after spray watering. The reason may be that saliva licking is triggered by the increased activity and disturbance after spray watering, and thus was concentrated around the observation periods. This is supported by the fact that no difference was found in the period before spray watering. Why saliva licking occurred most often in females which did not use the spray water is not known. The function of saliva licking has not been documented. The correlation with the kits' own water intake indicates that intake of liquid is an important function, but a social funktion can not be excluded.

It is in accordance with previous observations that the kits did not lick water from the female's wet pelt (*Hansen, 1990*). Despite intensive surveillance, this phenomenon has only been observed once (*Jonasen, 1987*), and is therefore not considered to be of any practical significance. This is substantiated by the observation that the females shook off the water before they went into the nests.

As the kits lick water from the bottom of the cage during spray watering, the females' tendency to defecate here constitutes a health risk. It is therefore important to keep the cage clean of feces under the spray water as well as under the drinking valves. Nothing explains why some females defecated under the spray water, or why primarily the nursing females did that. Normally the females defecate at the back of the cage, but the use of spray water seemed to change this pattern. If the farm is supplied with dung gutters, spray watering will cause part of the water and feces to fall outside these.

The nest box environment was not affected by spray watering, as the females shook off the water before they went into the nest boxes. The cage environment was affected because the bottom got wet, and quite a few females defecated under the spray water. In the hot and dry weather it was no more, however, than ordinary cleaning could still maintain a good environment.

No significant effects on temperature or humidity in the cage and nest box environment could be found. The reason may be that the effect of spray watering was too short in relation to the measuring interval of one hour.

Conclusion

Under the temperature conditions given, spray watering had no effect on the weight development of the females in the nursing period. The kits had a higher gain from 2 to 6 weeks in the spray water group. The effect on growth may be caused by the fact that the kits licked water from the bottom of the cage after spray watering. The mode of operation thus corresponds to other additional watering systems, but as spray

watering is only available in short periods, the effect is limited.

The kits were not seen licking water from the female's wet pelt, and the behaviour does not seem to have any practical significance to the water supply of the kits. Saliva licking was observed most frequently in the experimental group after the period with spray watering, but the reason is more likely that the time of the behaviour is disturbed than that the frequency is increased.

The spray water activated many females, especially in the first three days, and gradually most of the active females used it. A large part of the females which had used the spray water were active in the period afterwards. The activity after spray watering was therefore higher than before, and higher than in the control group. In general, there was large variations as to which individuals were active before, during, and after the spray water period. Barren females used spray water more than nursing females, whereas litter size had no significance. Even though many of the nursing females used spray water, no effect on the production parameters measured could be found.

There was a clear correlation between temperature and number of females lying out in the cage.

Spray watering had no distinct effect on temperature or humidity in the environment. The hygiene in cages with spray watering was a little poorer than in cages without, whereas no difference was found in nest box environment. The reason was that the bottom of the cages were a little more wet and dirty, because nursing females often defecated under the spray water. This may have adverse consequences, as the kits lick water from the cage floor.

As the mink's requirement for liquid depends on temperature, it is likely that the effect of spray watering would be higher at temperatures above average in the month of June.

The behaviour and weight development of the females and the kits are in accordance with and supplement previous investigations. The correlation between temperature and the females position as well as the distinct dynamics in the activity of the individuals have not been described earlier. The function and importance of saliva licking need further clarification.

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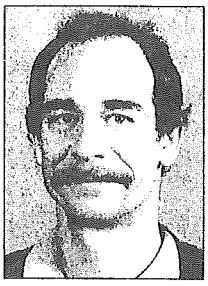
Stress reactions in farm mink and beech marten in relation to housing and domestication

Steffen Werner Hansen



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New doctor in the family. We congratulate Steffen W. Hansen with the new title and wish him success in the future.

The thesis is based on following reports:

1. Hansen, S.W. and Damgaard, B.M. 1991. Stress physiological, haematological and clinical-chemical status of farm mink placed in groups or singly. Acta. Agric. Scand. 41: 355-366.
2. Hansen, S.W. and Damgaard, B.M. 1991. Effect of environmental stress and immobilization on stress physiological variables in farmed mink. Behavioural Processes 25: 191-204.
3. Hansen, S.W. and Hansen, B.K. 1992. The effect of cage environment on the circadian rhythm, behaviour and feed intake of farm mink. Submitted to Acta. Agric. Scand.
4. Hansen, S.W. and Damgaard, B.M. 1992. Behavioural and adrenocortical coping strategies and the effect on eosinophile leucocyte level and heterophil/lymphocyte ratio in beech marten (*Martes foina*). Accepted for publication in Appl. Anim. Behav. Sci.

This report describes domestication processes which may have resulted in a reduced tendency to escape and in an increased threshold value for ilicitation of stress reactions in farm mink in relation to marten caught in the wild. The social acceptance by farm mink of animals of their own species is related partly to the solitary and territorial way of life of their wild relatives and partly to the production environment being poor in stimuli.

The possibility of evaluating the stress level on the basis of plasma cortisol, number of eosinophil leucocytes and heterophil/lymphocyte-ratio (H/L-ratio) is discussed in relation to results obtained by repeated immobilization of farm mink and to results obtained in less stressing but biologically relevant situations under various housing conditions.
The applicability of stereotypic behaviour as a behavioural indicator of stress is discussed.

It is concluded that the intensity and duration as well as the nature of stress have a decisive effect on the sensitivity of the adrenal glands to ACTH or on the capacity for secretion of cortisol. This effect influences the number of eosinophil leucocytes and the H/L-ratio. At moderate stress, farm mink react with an increase of the plasma cortisol level and the H/L-ratio as well as a decrease in the number of eosinophil leucocytes. In case of extreme stress, a habituation takes place causing the plasma cortisol level to decrease and the level of eosinophil leucocytes to increase.

The development of stereotypic behaviour is supposed to be caused by the frustration/con-

flict of captivity. Stereotypic behaviour may, however, also occur independently of the original causality and is thereby losing its value as an individual indicator of stress under actual housing conditions.

An evaluation of stress level based on individual behavioural or physiological variables therefore seems inadequate. By using several stress indicators, their mutual dynamics can be illustrated and the stress level evaluated on a broader basis. An evaluation of stress level ought to take into consideration the marked circadian and seasonal variations, such as effect of management routines and reproduction status proved as regards the stress physiological variables used.

A large variation in the way in which individuals react to stressors may cause the stress response on population level to be blurred. The conclusion, therefore, is that when evaluating stress level, the various types of individual stress reactions must be taken into consideration.

Ph.D. Thesis, 37 pp, 74 refs. In DANH, Su. ENGL (translated into English). Author's summary.

Behavioural and adrenocortical coping strategies and the effect on eosinophil leucocyte level and heterophil/lymphocyte-ratio in beech marten (*Martes foina*)

S.W. Hansen, B.M. Damgaard

Adaptation to captivity was examined in 18 female beech marten (*Martes foina*), all captured and kept in the experimental cage systems for 9 months prior to the study. The behaviour of the animals was recorded over 24 h and feed intake measured in two periods over 5 days. Plasma cortisol concentration, number of eosinophil leucocytes and the heterophil/lymphocyte-ratio were measured by repeated blood sampling in the day and night hours. The purpose of the investigation was to evaluate the adaptation to captivity by establishing on the individual level the association between total activity, stereotypic activity and plasma cortisol. On the basis of the possible association, eosinophil leucocytes and heterophil/lymphocyte-ratio were indicators of welfare, demonstrating the applicability of the physiological variables. The results made it possible to conclude that the population can be divided into two types with regard to coping strategy. An active type characterized by a high activity level (A), in which the majority of activities is of stereotypic nature, and a passive type with a low activity level (B) not showing any stereotypic behaviour. Active beech marten are furthermore characterized by a considerably larger feed intake than passive beech marten. Active beech marten react to acute stress by increased stereotypic behaviour and a faster and larger cortisol response than passive beech marten which react by a generally reduced activity. Type A has a higher basic level of eosinophil leucocytes and a longer lasting reduction of the level as a response to repeated acute stress than B. At repeated acute stress, A reacts with a quicker and more constant increase in the heterophil/lymphocyte-rate than B. At the same time a circadian variation in plasma cortisol concentration and number of eosinophil leucocytes was demonstrated, showing that the levels were higher in the morning than in the evening.

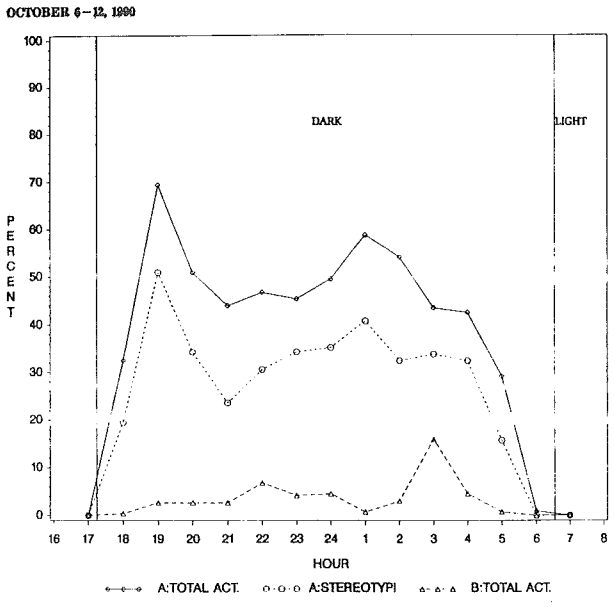


Fig. 1. Circadian rhythm of total activity and stereotypies (in percent of total observations per hour) in high active (A, n = 8) and low active (B, n = 10) beech marten in October

Applied Animal Behaviour Science, 35, 369-388, 1993. 3 tables, 7 figs., 3 refs. Authors' summary.

Early experience with the farm environment and effects on later behaviour in silver *Vulpes vulpes* and blue foxes *Alopex lagopus*

Vivi Pedersen

Seventy-one silver fox and 141 blue fox cubs were exposed to constant visual contact with the farm environment from the age of 2 to 8 weeks. The exposure consisted in opening a door in the nest box facing the feed gang-way. Control cubs (33 silver and 77 blue foxes) were reared in similar but closed nest boxes. All cubs were tested at the age of 12-16 weeks and again at the age of 23-28 weeks; during these tests the behavioural responses of the foxes towards a human being were recorded. Both tests showed that in the two species, the early experience with the farm environment reduced the fear responses of the foxes towards humans. The conclusion of the study was that early visual experience with the farm environment makes the foxes better adapted to captivity, including the presence of humans.

Behavioural Processes, 25, 163-169, 1991. 3 figs., 16 refs. Author's abstract.

Effects of whole-year nest boxes on cortisol, circulating leucocytes, exploration and agonistic behaviour in silver foxes

Leif Lau Jeppesen, Vivi Pedersen

An experiment was carried out for a period of 2 years, using 50 silver fox vixens kept in cages with nest boxes, and 50 vixens kept in barren wire cages without any sort of equipment. At the end of the experiments, the animals living with access to nest boxes had lower base levels of cortisol and eosinophils, and higher base levels of lymphocytes. They also were less fearful towards humans and more active/explorative in an open field test. It was concluded that these animals were less stressed than those living without nest boxes, a result that could have practical implications for the welfare of foxes during everyday life on the farm.

Behavioural Processes, 25, 171-177, 1991. 5 tables, 9 refs. Authors' abstract.

Effects of immobility stress and feed restriction on stereotypies in low and high stereotyping female ranch mink

Mogens Bildsøe, Knud Erik Heller, Leif Lau Jeppesen

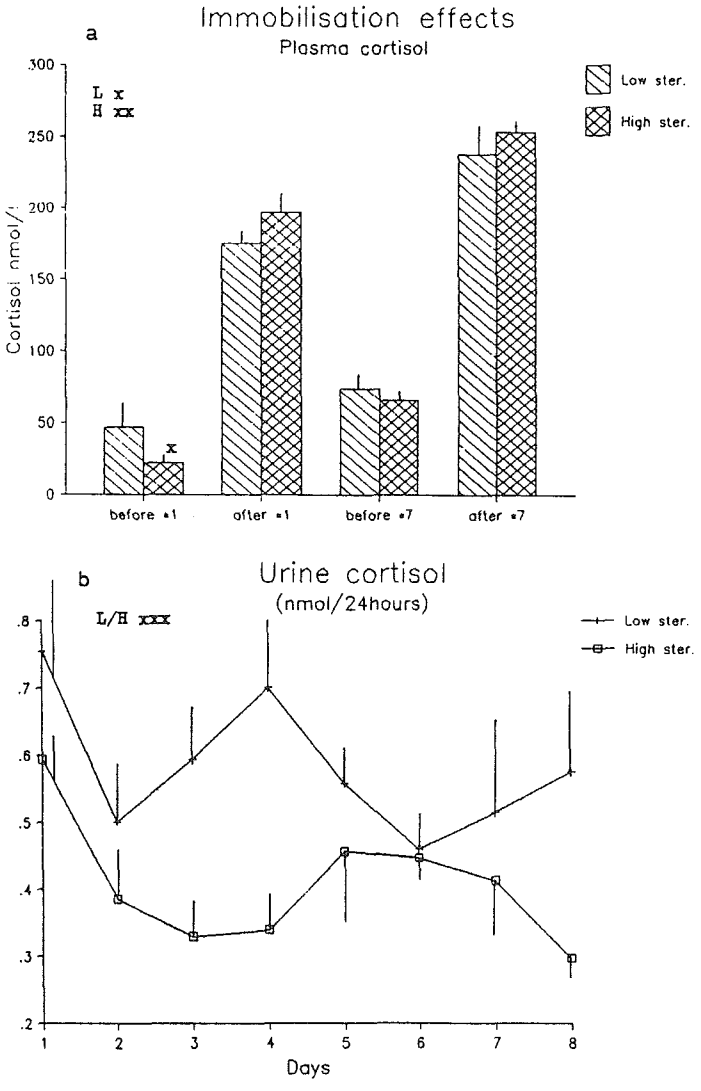


Fig. 2. Circulating cortisol levels in response to immobilisations and daily urine free cortisol excretion three weeks after immobilisations.

Two experiments were conducted to examine the effects of repeated immobilisations and feed restriction on normal activity and stereotypies in low and high stereotyping female ranch mink. Repeated immobilisations had immediate inhibitory effects on normal activity and stereotypi

es in both groups, whereas feed restriction had the opposite immediate effects. Subsequent to both immobilisations and feed restriction, stereotypies were increased, whereas normal activities returned to pre-experimental levels. Repeated immobilisations were followed by increases in cortisol levels in both low and high stereotyping females. High stereotyping females had lower baseline cortisol levels than low stereotypers but tended to show higher cortisol responses to immobilisations. These results indicate that stressful experiences may affect stereotypies, but that the direction of the changes de-pends on the type of stressor as well as the duration of exposure to the stressor. It is moreover suggested that stereotypies can be emancipated.

Behavioural Processes, 25, 179-189, 1991. 3 figs., 17 refs. Authors' abstract.

A study of the use of resting platforms by farmbred blue foxes

M. Harri, J. Mononen, H. Korhonen, K. Haapanen

There are general demands and recommendations drafted by animal welfare organizations that a resting platform with a solid surface be provided for farmbred foxes kept in wire-mesh cages. The aim of the present study was to evaluate whether or not blue foxes themselves prefer to use the platforms and to determine the underlying factors affecting their use. Data were collected by direct visual observation combined with automatic sampling on a total of 47 blue foxes for 120 24-h days altogether. The animals included individuals of both sexes and both yearlings and older foxes. The platforms, forming a shelf inside the cages, were mounted in place in summer or autumn, and their use was observed up to late winter. All foxes used the platforms. They spent an average of 6.8±1% of their daily time or 98±15 min day^{-1} on the platform. A major portion of the use comprised visits of short duration. The platforms were used more during the working day, when short visits were also most common, than during the evening/night hours. Open platforms were used more than platforms with walls (150 vs. 19 min). The interest the animals showed in the platforms decreased with time. Unexpectedly, the platforms were used more at or above freezing temperatures than during really cold weather (120 vs. 67 min). Wind alone did not increase platform use, but high wind combined with high temperature promoted use. Inter-individual differences contributed to 59% of the variance of use, followed by the type of platform (walls vs. no walls) (17%) and temperature (5%). The effects of sex and orientation of the platforms with respect to the sun were not significant.
The results do not support the hypothesis that the platforms function as shelter, rather the platforms were used because they were available. Because of large inter-individual variation in the preference for platforms, this trait can be increased easily through selection, provided that future experiments can confirm the beneficial effect of the platforms on the animals' welfare.

Applied Animal Behaviour Science, 30, 125-139, 1991. 4 tables, 3 figs., 15 refs. Authors' abstract.

An analysis of fear and aggression during early development of behaviour in silver foxes (*Vulpes vulpes*)

I.Z. Plyusnina, I.N. Oskina, L.N. Trut

The relationship between the development of behaviour in a novel situation and plasma cortisol level was analysed in 30-, 45- and 60-day-old domestic (D) foxes and foxes selected for enhanced aggresiveness (EA) towards man (Experiment 1). In the EA foxes, the increase in defensive responses (fear and aggression) was associated with a significant rise in plasma cortisol level at 45 and 60 days of age. The D foxes showed no defensive responses up to Day 60 and there were no associated changes in plasma cortisol level.
In experiment 2, chloditane, an inhibitor of adrenal cortex function, injected to the EA pups from Days 38-44 and 45-52 of life, attenuated fear and increased locomotor activity in the novel situation; there was an associated decline in plasma cortisol level. Treatment with chloditane, however, did not affect the number of foxes showing aggression in the novel situation and at the appearance of man both at the age of 60 days and in adulthood.

Experiment 3 demonstrated a significant increase in locomotor activity in the novel situation and a decrease in the number of EA foxes exhibiting aggression after treatment with l-tryptophan (a precursor of serotonin synthesis)

after the age of 60 days. The EA foxes treated at an early age with l-tryptophan showed a significant attenuation of aggression when adults. Taken together, the results demonstrate that plasma cortisol level and the fear response are related and also that enhanced aggressiveness affects greatly the development of behaviour in the EA foxes and contributes, together with the fear reaction, to limitation of the socialisation period.

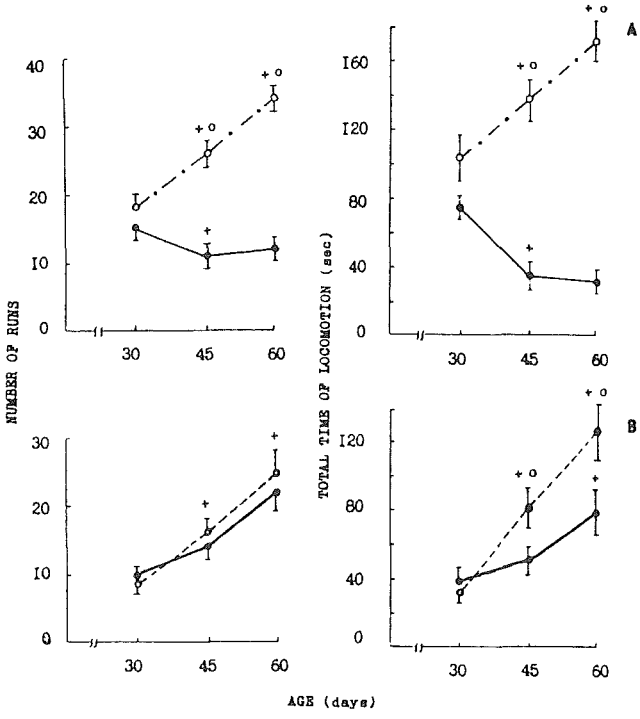


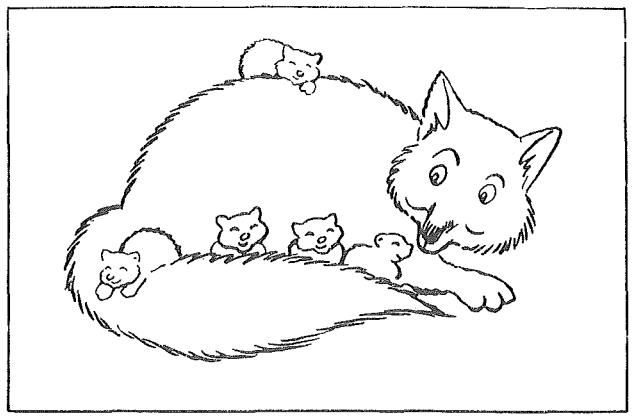
Fig. 1. The time course of changes in number of runs and total locomotion time in foxes of different ages. (A) Tame (-·-·-), EA (——), foxes; (B) chloditane-treated (---), oil-treated (——) foxes from the enhanced aggressive population. $^{+}P<0.05$ compared with the preceding age group by the Student's t-test. $^{o}P<0.05$ compared with the tame pups (A) or with the chloditane-treated pups (B) by the Student's t-test.

Applied Animal Behaviour Science, 32, 253-268, 1991. 4 tables, 4 figs., 41 refs. Authors' summary.

Infanticide in silver foxes

B.O. Braastad, M. Bakken

Over a period of 6 yr, the behaviour of 21 young silver fox females (with no previous litter) and 18 adult females, from 24 h before parturition to 72 h after the birth of the last cub, was monitored by means of a video camera. Four of the adult females had previously killed their cubs. Litter size at birth averaged 3.7 plus or minus 1.7 and 4.8 plus or minus 1.4, resp. for young and adult females, and litter size 1 wk after parturition averaged 1.8 plus or minus 1.9 and 3.5 plus or minus 2.1 resp. (both p 0.05). 11 of the young and 5 of the adult females killed one or several of their cubs, and litter size 1 wk after parturition averaged 1.0 plus or minus 1.5 for these females vs. 4.0 plus or minus 1.6 for normal females (p 0.001). 90% of cub deaths occurred within 1 wk of birth, and 70% occurred during the night. The deaths of kits of young females occurred mostly during parturition or soon after birth, whereas the av. time of death for the cubs from adult females was 38.7 plus or minus 29.3 h after birth. All cubs killed were eaten by their dam. No prior overt signs of abnormal behaviour were noted in females killing their cubs.



Norsk Pelsdyrblad, 66 (5), 9-11, 1992. In NORW. 1 table, 17 refs. CAB-abstract.

The economics of fur pelt production

Leif Jarle Asheim

In order to examine the economics of Norwegian fur pelt production, this report focuses on six main areas relating to the industry. (i). The structure of the fur farming industry, and how extensive and widespread it is; (ii) labour input in fur farming, and seasonality of labour relative to agricultural labour in general; (iii) profitability of fur farming, and most significant economic factors affecting returns (iv) extent to which fur farming has been combined with agriculture, forestry, and supplementary sources of

income; (v) extent to which the economics and development of the fur farming industry are determined by world market conditions; and (vi) future prospects and challenges facing the industry. On average, the number of farms engaged in pelt production is declining, whilst the number of breeding animals per farm is increasing. Profits from fur farming tend to fluctuate: feed is the most important expenditure, and thus the most effective way of improving profitability is to obtain cheaper and better feed. The seasonal variations in labour input make combining fur farming with agriculture a realistic option. Pelt prices on the world market have been declining steadily due to increased competition and excess supply, as well as stagnant and declining demand. Prospects for the fur industry are not bright: if progress is to be made, the industry must become more market oriented, cutting feed costs and opening new markets.

Norwegian Agricultural Economics Research Institute, research report A-013-90, 1990. In NORW, comprehensive english summary. 16 tables, 17 figs., 46 refs., CAB-abstract.

Endogenous circannual rhythms and photorefractoriness of testis activity, moult and prolactin concentrations in mink (*Mustela vison*)

L. Martinet, M. Mondain-Monva., R. Monnerie

Mink are seasonal photosensitive breeders: testis activity is triggered when days have less than 10 h light. Increasing and decreasing plasma concentrations of prolactin induce the spring and autumn moults. In a 5 year experiment, males were maintained under short days (8 h light:16 h dark) at 13°C or long days (16 h light:8 h dark) at 21°C, winter and summer conditions, respectively. Under winter and summer conditions, circannual cycles of prolacting secretion and moulting were observed at intervals of about 11 months. Recurrence of testis cycles was not evident. In a second experiment, males were maintained under an 8 h light:16 h dark cycle from the winter solstice or under 10 h light:14 h dark, 12 h light:12 h dark or 14 h light:10 h dark cycles from 10 February. Under 8 h light:16 h dark cycle, testis regression was slightly later than under natural conditions, indicating photorefractoriness. However, mink remained sensitive to light: the longer the photoperiod, the faster the testis regression. In a third experiment, males were transferred uner 8 h light:16 h dark or 16 h light:8 h dark from 15 May (group 1), 12 June (group 2) or 4 July (group 3); males submitted to long days received melatonin capsules on the day of transfer. Increasing concentrations of follicle-stimulating hormone (FSH) and luteinizing hormone (LH) and testis volume were shown by half the males in group 2 and nearly all the males in group 3; the constant release of melatonin from implants was more efficient than short days; but in the three groups, prolactin concentrations decreased in the few days after short-day or melatonin treatment. Overall, the results demonstrate endogenous circannual rhythms of prolactin secretion, body weight and moulting. Although a refractory period to short days was observed, the annual cycle of testis activity totally relies on the annual changes in daylength.

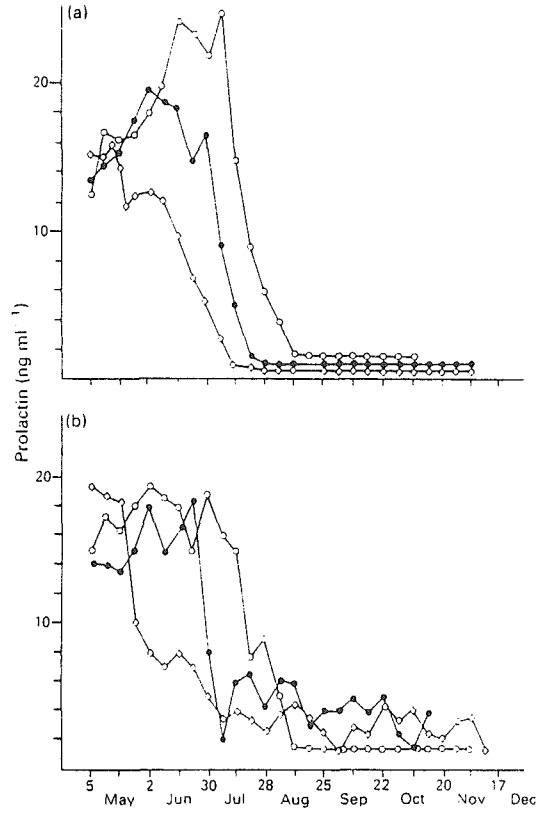


Fig. 7. Mean concentrations of prolactin in mink transferred under (a) short days (8 h light:16 h dark) or (b) long days (16 h light:8 h dark) and given melatonin implants. Transfer on (◊) 15 May, (●) 12 June, and (o) 4 July.

J. Reprod. Fert., 95, 325-338, 1992. 1 table, 7 figs., 48 refs. Authors' summary.

Association between live grading scores, skin characteristics and auction price in mink

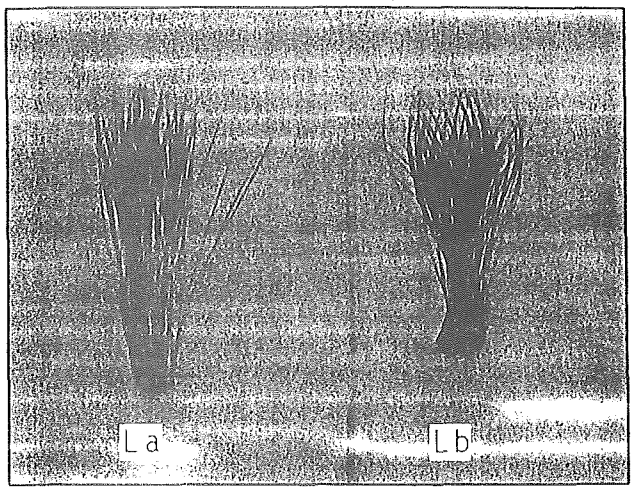
Hilkka Kenttämies

The relationships between scores for general appearance assessed in August and November and the size and quality of scanblack and pastel male pelts were studied. The size of pelt was more closely associated with general appearance graded in August than in November. The reverse situation was found for the quality of pelt. Fur defects observed in live minks reduced pelt quality. Size, quality and colour of pelts in scanblack males differed between farms, and in pastel males, differences between farms were found in pelt quality and clarity. The pelts of males with high scores in live animal grading were sold for 4-14 Finnmark more than medium or low scoring ones. Skin prices were more affected by the date of auction than by grading scores.

Acta Agric. Scand., Sect. A, Animal Sci. 42, 185-190, 1992. 6 tables, 22 refs. Author's summary.

Metallic sheen in mink - once again

Leena Blomstedt



Compared with pelts from normal mink, those from mink with the metallic sheen defect have guard hairs which are bent, slightly longer than average, and with greater distances between them. An account is given of some trials comparing the development of hair in normal and affected mink. The defect is most common in black mink, more males than females are affected and the h2 of the condition is fairly high (0.33-0.52). Selection of breeding mink and changes in nutrition have reduced the incidence of seriously affected pelts in Finland to 2-3% and approx. 20% of pelts are slightly affected.

Finsk Pälstidskrift 26 (2), 44-47, 1992. In SWED. CAB-abstract.

A new type of lesion associated with severe fur damage in Canadian ranch foxes and an investigation of possible causes

Margaret H. Hardy, Linda E. Tackaberry, Mark T. Goldberg

In the silver fox, as in its wild ancestor, the red fox (*Vulpes vulpes L.*), the annual growing phase (anagen) of guard hair follicles occupies at least four months. Severe damage to the hair coat near the end of this growing period was reported in 1985 on many ranches in New Brunswick and Nova Scotia. A histological analysis of serial sections of skin biopsies showed a marked increase in nuclear aberrations in the hair matrix of anagen guard hair follicles. These nuclear aberrations indicated that cells were undergoing apoptosis, a controlled form of cell death. Tissues from affected and unaffected foxes for histological and toxicological analysis, as well as other data, were obtained during visits to 26 ranches in 1986 and 34 ranches in 1987. Histological sections of the 1987 skin samples showed the mean percentage of nuclear aberrations in 43 unaffected foxes to be 0.08 ± 0.01 (SEM), while that for 49 affected foxes was 0.51 ± 0.23. The four foxes with the most severe coat damage also had the highest incidences of guard hair matrix cells with nuclear aberrations, ranging from 20 to 100 times greater than the mean for unaffected foxes. The mitotic index of the hair matrix, which normally remains fairly constant during the hair growth phase, was similar for unaffected and affected foxes (1.83 ± 0.06 and 1.97 ± 0.07 respectively). Although our analyses of field data have not established a specific environmental factor associated with increased nuclear aberrations, the possible involvement of toxic agents in follicle damage may warrant further investigation.

Can J Vet Res 55, 71-75, 1991. 1 table, 3 figs., 16 refs. Auhtors' summary.

Acoustic Nerve Nuclei (*nuclei n. vestibulocochlearis*) of the polar fox (*Alopex lagopus*)

S. Herec, Z. Milart, A. Bujak, I. Ziolo

Investigations were carried out on transverse sections of 7 *medullae oblongatae* of sexually matured *Alopex lagopus*. The paraffin slices were stained by the method of Klüver-Barrera or Nissl. In the paper four *nuclei vestibulares; medialis, caudalis, lateralis* and *rostralis* are described. These nuclei contain multipolar cells of different sizes. *Nucleus vestibularis caudalis* is the longest and the most caudally situated. *Nucleus vstibularis medialis* is the richest in the number of the cells. *Nuclei cochleares dorsalis* and *ventralis* contain medium size, fusiform and oval nuerons. The described nuclei of the polar fox are more similar to those which appear in carnivorous than to those in herbivorous animals concerning the structure and topography.

Annales Unviersitatis Mariae Curie-Sklodowska Sectio DD, Medicina Veterinaria, 43, 7-13, 1988. In POLH, Su. ENGL, RUSS12 figs., 21 refs. Authors' summary.

Head arteries in the silver fox

H. Frackowiak, B. Zawidzka

Investigations were carried out on 26 corrosion preparations of the arteries in the head of the silver fox, including 19 male specimens and 7 female. The preparations were made with the arteries injection method using vinyl-chloride-coloured acetone solution.

It was observed that the arrangement of the arteries in the head of the silver fox resembled the arrangement of the arteries in the wild red fox and the dog.

Individual mutability and asymmerty were observed in the silver fox as well as in the red fox and the dog as regards the outlet of certain arteries.

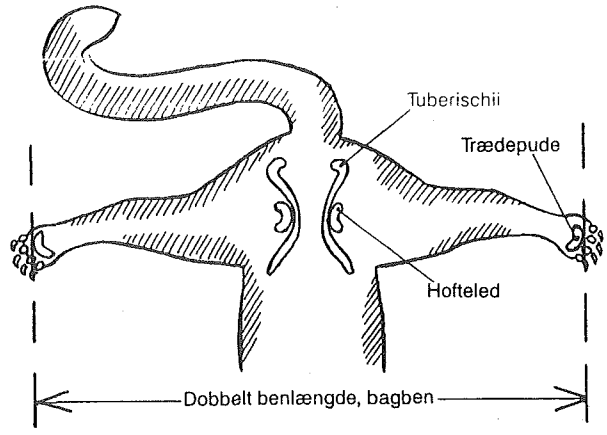
The mutability and asymmetry were observed most often in the outlet of the maxillar artery, the mandibular alveolar artery, the posterior deep temporal artery as well as the eye arteries.

Roczniki Akademii Rolniczej w Poznaniu. Zootechnika, no. 220, p. 27-36, 1990. In POLH, S. ENGL, RUSS. 3 figs., 10 refs. Authors' summary.

What is pelt length, and how can it be measured?

Erik Nyengaard

A study of 31 mink males revealed that pelt length could be predicted on the basis of measurements of both back legs before pelting with almost the same accuracy as on the basis of body weight (54 vs. 62%), whereas back length measurements on the live animal resulted in an accuracy of only 34%.



Dansk Pelsdyravl, 55 (2), p. 91, 1992. In DANH. 1 fig. CAB-abstract.

Progeny testing in mink

Genetic variation within and between populations

Peer Berg

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New doctor in the family. We congratulate Peer Berg with the new title and express our best wishes for his future scientific work with fur animals.

The thesis is based on three papers

I. Feed consumption and efficiency in paternal progeny groups in mink.
II. Variation within and between populations of mink.
1: Weight and skin length.
III. Variation within and between populations of mink.
II. Skin and fur characteristics.

and a general discussion of these papers. The first paper was published in Acta Agric. Scand., Section A, Animal Science and the two others are accepted for publication in the same journal.

The material was from progeny testing of scanblack males on a test station over two years. Control groups (full-sibs) were placed on the farms of origin. The design allowed for a differentiation of genetic and non-genetic differences between populations. Further, genetic and non-genetic sources of variation within populations could be estimated.

A genetic variation in both feed consumption and feed efficiency was found, both within and between populations. Feed efficiency had a positive correlation to body weight and gain. Due to a medium to low correlation between periods, a definition of period is nessesary to be able to compare measures of feed efficiency. Feed consumption showed high positive correlation between periods.

Genetic variation was found in weight and skin length both within and between populations. Genetic variation within populations was lower than in other studies estimating genetic variance within one population. Maternal effects were important (10% to 40%) but decreasing from 0.47 in July to 0.06 at pelting (body weight). Genetic and non-genetic differecnes between populations were on average up to nearly two phenotypic standard deviations. Sex-environment and sex-genetic level interaction were found.

Also for fur and skin characteristics a significant genetic variation was found within and between populations. Genetic and environmental differences between populations were generally smaller than for body weight and skin length. Sex-environment and sex-genetic level interactions were significant for traits with a large sexdimorphism. A threshold-liability model yielded different parameters on a liability scale than a linear model on the observed scale for discrete traits.

Implications of genetic variation between and within populations and the utilization of this variation, breeding goals, subjectively graded traits and sex dimorphism are discussed. There is a potential for a more efficient utilization of the total genetic variation through selection across populations, crossbreeding and maintaining genetic diversity to accomodate possible future changes in production conditions.

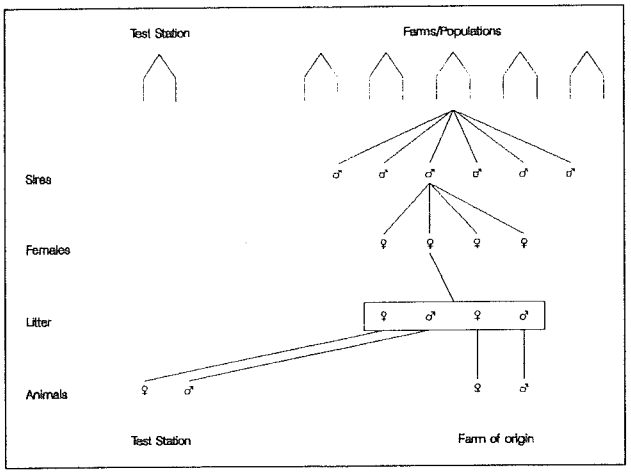

Fig. 4.1. Sampling of the progeny test groups, as described in the text.

Ph.D. Thesis. In ENGL. 4 tables, 4 figs., 36 refs. Author's summary.

IgG allotypes of the domestic mink: Genetics, Expression and Evolution

I.I. Fomicheva

A brief review summarized the results we obtined with the identification, analysis of population distribution, genetics, expression, and evolution of 12 IgG allotypes in the American mink and several closely related mustelids. The American mink is a unique species with respect to expressed allotypic polymorphism of Igλ chains. In contrast to the rabbit, human, mouse and rat, the phenotypic expression of IgCγ allotypes shows unusual variations which mask their true genetic relationships (linkage of Cγ genes; Cγ = constant region of IgG chains). The allotypic IgG polymorphism in the American mink during mustelid phylogenesis underwent saltatory changes. A parallel between the data on changes in IgG allotype frequencies in man and mink with disease is emphasized. In mink, these changes are provided by allotype-specific activation of the expression of the 2 CH genes (CH = constant region of the Ig heavy chains). The results make apparent the need of including more taxa in investigations of Ig genetics. In addition, Aleutian disease of mink is presented as a model of human disease.

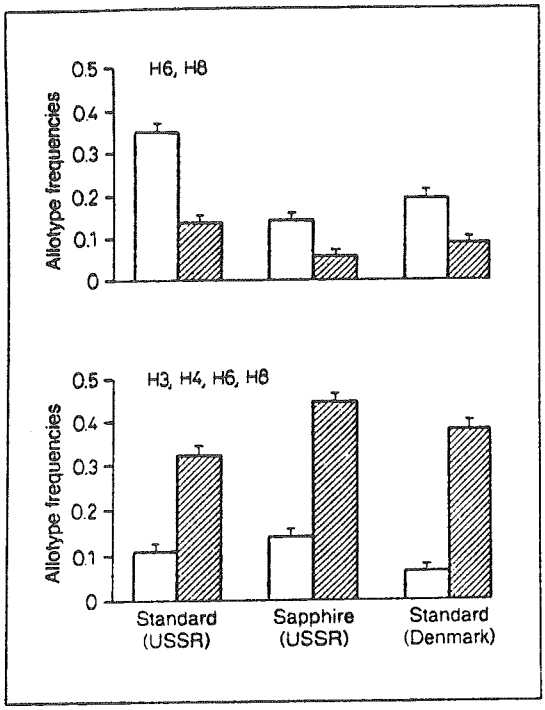

Fig. 13. Frequencies of phenotypes H6, H8 and H3, H4, H6, H8 among AD-free and AD-affected mink in 2 farm populations. Open columns = normal mink; hatched columns = AD-mink.

Exp Clin Immunogenet, 8, 185-218, 1991. 8 tables, 17 figs., 74 refs. Author's abstract.

Hormology of the Lpm system of allotypes in the American mink and the Gp system of allotypes in the domestic pig

V.I. Ermolaev, E.G. Mirtskhulava, M.A. Savina, I.G. Gorelov, R.S. Matichashvili, O.K. Baranov

The article presents the results of a search in pigs for allotypes of a protein homologous to the Lpm-macroglobulin (α_1M) of the mink and a study of the organization of the corresponding immunogenetic system. For this purpose, antisera detecting five allotypes of the α-macroglobulins were selected from the bank of reagents previously produced for porcine serum protein

allotypes. It was established that the αM1 allotype is a marker of a protein homologous to the mink α_2M and the human α_2M. The remaining allotypes (αM2-αM5) mark the second isotypic variant of porcine α-macroglobulins, homologous to the mink Lpm (α_1M). The materials of the international comparative test showed that the αM1 marker is a new allotype, while αM2-αM5 correspond to four allotypes of the Gp system (globulin of pig) described previously.

On the basis of these immunochemical data it was concluded that the Lpm system of the American mink and the Gp system of the pig are homologous. Since the investigated allotypes belong to α-macroglobulins, it is suggested that the locus controlling them be called the AM locus. It is advisable to give the same notation to the homologous locus of the mink, instead of the previously used Lpm. The genetic control of the five allotypes was studied and the structure of the porcine AM locus was analyzed in detail. The organization of this locus in the pig is compared with the homologous locus of the mink.

Translated from Genetika, Vol. 27, No. 2, 304-315, 1991. 4 tables, 3 figs., 29 refs. In ENGL, Su. RUSS. Authors' summary.

Activation of the expression of two immunoglobulin CH genes of American mink during Aleutian Disease infection

I.I. Fomicheva, D.K. Tsertsvadze, O.Yu. Volkova, N.A. Popova, S.I. Smirnykh, N.A. Kisteneva, K.N. Kuznetsov, V.F. Kudashev, Yu. D. Kaveshnikov

The genetic allotypic polymorphism of immunoglobulins secreted by mink after infection with Aleutian disease virus (plasmacytosis) was investigated. It was shown that the expression of two of the four allotypes of the constant region of the γ-heavy chain, which is considered stable throughout ontogenesis, is sharply activated in most of the infected mink. Such allotype-specific regulation of the expression of the immunoglobulin CH genes may also occur in the immune response in humans, where many data have been accumulated on the association of individual Gm-allotypes with a whole series of diseases.

Translated from Genetika, Vol. 27, No. 5, 895-902, 1991. In ENGL, Su. RUSS. 3 tables, 39 refs. Authors' abstract.

Investigation of mink MHC (MhcMuvi) class I molecules by isoelectric foucusing (IEF)

L. Wienberg, B. Aasted

Mink (*Mustela vison*) class I leucocyte antigens, here abbreviated MhcMuvi according to the proposal given by Klein et al. (1990), were characterized by isoelectric focusing (IEF), using Triton X-114-extracted and neuraminidase-treated membrane proteins from spleen cells, followed by immunoblotting and development with a murine monoclonal antibody raised against denatured major histocompatibility comples (MHC) class I antigens.

Muvi class I antigens were investigated in a group of 97 Danish mink (including five families), of six types (Standard, Wild, Pastel, Pearl, Violet and Sapphire), and a group of 110 French "Wild" mink. For each mink type maximally six protein bands in IEF were identified. Standard, Pastel and Sapphire mink only exhibited from tow to four bands. This indicated to us restricted polymorphism of the Muvi class I antigens for these mink. The restriction patterns varied from farm to farm. In the family material the Muvi antigens were found to segregate as expected.

The French Wild mink were all naturally infected with Aleutian disease virus (ADV), a parvovirus, and their disease status classified as progressive or non-progressive. There were approximately 50% in each group. The mink were grouped into one of five class I muvi profiles. When the profiles were compared to progressive versus non-progressive disease status, we found that mink with Muvi profile 4 and 5 almost exclusively (13 out of 15) were classified as having progressive Aleutian disease.

European Journal of Immunogenetics, 18, 165-173, 1991. 5 figs., 10 refs. Authors' summary.

Mink serum amyloid A protein. Expression and primary structure based on cDNA sequences

G. Marhaud, G. Husby, S. Bruce Dowton

The nucleotide sequences of two mink serum amyloid A (SAA) cDNA clones have been analyzed, one (SAA1) 776 base pairs long and the other (SAA2) 552 base pairs long. Significant differences were discovered when derived amino acid sequences were compared with data for apoSAA isolated from high density lipoprotein. Previous studies of mink protein SAA and amyloid protein A (AA) suggest that only one SAA isotype is amyloidogenic. The cDNA clone for SAA2 defines the "amyloid prone" isotype while SAA1 is found only in serum. Mink SAA1 has alanine in position 10, isoleucine in positions 24, 67, and 71, lysine in position 27, and proline in position 105. Residue 10 in mink SAA2 is valine while arginine and asparagine are at positions 24 and 27, respectively, all characteristics of protein AA isolated from mink amyloid fibrils. Mink SAA2 also has valine in position 67, phenylalanine in position 71, and amino acid 105 is serine. It remains unknown why these six amino acid substitutions render SAA2 more amyloidogenic than SAA1. Eighteen hours after lipopolysaccharide stimulation, mink SAA mRNA is abundant in the liver with relatively minor accumulations in the brain and lung. Genes encoding both SAA isotypes are expressed in all three organs while no SAA mRNA was detectable in amyloid prone organs, including the spleen and intestine, indicating that deposition of AA from locally synthesized SAA is unlikely. A third mRNA species (2.2 kilobases) was identified and hybridizes with cDNA probes for mink SAA1 and SAA2. In addition to a major primary translation product (molecular mass 14,400 Da) an additional product with molecular mass 28,000 Da was immunoprecipitable.

The Journal of Biological Chemistry, Vol. 265, No. 17, 10049-10054, 1990. 5 figs., 43 refs. Authors' summary.

Original Report

Cryoembryopreservation of carnivora embryos: Mustela erminea

S.Ya. Amstislavsky, L.F. Maksimovsky, Yu.G. Ternovsky, D.V. Ternovsky

The Institute of Cytology and Genetics, The Institute of Biology,

Russian Academy of Sciences, Siberian Branch, Novosibirsk

Summary

The possibility of ermine embryos being successfully cryopreserved has been shown. The influence of the freezing program and the stage of embryo development on the survival of embryos was investigated. The freezed-thawed ermine embryos of the early stages of development were transferred to the right uterine horn of the recipient stoat and were cultured there for 26 days. Some of these embryos developed *in vivo* to the large delayed blastocysts.

Introduction

Nowadays, there is an urgent need to save endangered species. To illustrate, today more than 70 species and subspecies of carnivorous mammals are disappearing [ref. 1]. This paper has been written by researchers who have been engaged in captivity breeding of European mink (*Mustela lutreola*) for a number of years [ref. 2].

Cryopreservation of embryos performed at a temperature of liquid nitrogen has become a more reliable method to conserve genofunds. Cryoembryo banks of lineal mice have been created in several laboratories [ref. 3]. Attempts are being made to apply the above technology in order to conserve genofunds of rare animals mainly of the ruminant family [ref. 4]. However, it is worth noting that certain mammalian embryos are strongly affected by cryogenic procedure [ref. 5-8]. First of all, it applies to carnivorous animals (ref. 5+6], as well as swine embryos [ref. 7+8], might be caused by abundant phospholipids in the embryos of these species [ref. 6].

In this paper, a possibility of cryopreservation of embryos for carnivorous mammals has been studied. To carry out the investigation, ermine (*Mustela erminea*) has been chosen since the embryonic development prior to implantation in this species is rather well studied [ref. 9].

Materials and methods

To obtain the embryos, young female stoats were mated with adult males. All the ermine females used were oestral. The results of mating were estimated by male sperm cells available in the vaginal smear preparations made after coupling. Washing out of embryos for cryopreservation was conducted during the period from the first till the 272nd day of pregnancy. To flush the embryos standard techniques were used [ref. 10].

Ermine embryos of different developmental stages were frozen on the programming unit. Embryos were frozen in plastic straws using 1 M

DMSO (dimethylsulphxide) as a cryoprotectant. The equilibration with DMSO was made at +2°C. Seeding was initiated at -7°C. One group of embryos was cooled at the rate 0.5°C/min and plunged into liquid nitrogen (program 1). The other group of embryos was cooled to the same plunging temperature (-40°C) at the rate of 0.3°C/min (program 2). After cryopreservation the embryos were thawed by placing the straws into a water bath (+37°C) for a period of 10 sec. Frozen-thawed embryos were tested and photographed. Some embryos were transferred after cryopreservation into the right uterine horn of the female recipient on the 8th day of physiological pregnancy. Simultaneously, the right oviduct was ligated to prevent the recipient's own embryos from getting into the right horn of uterus.

Results and discussion

The use of program 1 to freeze the ermine embryos resulted in damaging the zona pellucida and blastomere practically throughout the experiment (fig. 1). After freezing the ermine embryos according to program 2, the results were different, i.e. in most cases the zona pellucida survived intact and the embryo as a whole revealed normal morphology (fig. 2). Especially promising were the cryopreservation results with delayed blastocysts. After cryopreservation of such blastocysts the zona pellucida was safe and the trophoblast clearly identified (fig. 2 e,f.), though there was certain blastocyst collapse after thawing.

Moreover, one significant point to notice is that in the course of cryopreservation large as they are (500 mkm and more), the delayed blastocysts remained morphologically intact, which might have resulted from increased tolerance of unfavourable factors during the diapause [ref. 11]. Various developmental stages of mammalian embryos are known to be differently susceptible to cryogenic procedures [ref. 8, 12-14]. According to our data, ermine morula and earlier blastocysts (the 9th-12th day of embryo development post coitum) as well as later delayed blastocysts (the 1st-5th month of pregnancy) successfully stand program 2 and cryopreservation at the temperature of liquid nitrogen. Nevertheless, being large, the delayed blastocysts are difficult to transfer into the recipient's uterus. So to create a cryoembryobank of the above species preference should be given to earlier blastocysts and morolu.

Fig. 1. The ermine blastocyst after cryopreservation at -196°C (the freezing program 1).

In the last experiment (see table 1), the ermine embryos which underwent cryopreservation were transferred into the female recipient's uterus. Here, 16 embryos of different developmental stages (morulas earlier blastocysts and dividing embryos of the 6th day post coitum) were transferred into the recipient's uterine horn on the 8th day of physiological pregnancy. According to the data obtained the recipient's own embryos pass from the oviduct to the uterus later: namely on the 10th-11th day of pregnancy [ref. 9]. How-ever, to prevent own embryos from passing to the uterine horn in which frozen-thawed embryos had been transferred, the relevant oviduct was ligated.
The female recipient was opened on the 34th day of pregnancy. The right uterine horn was flushed. The frozen-thawed morulas and other embryos of earlier stages of development (fig. 2 c,d) that were cryopreserved and then transferred to the recipient's right uterine horn had developed *in vivo* to the large delayed blastocysts. The above blastocysts were of different sizes. Some of them conformed to the recipient's own embryos flushed from the left uterine horn (the control) in their dimensions, but the others failed, with their diameters being less (fig. 3 a,b). The discrepancy between the dimensions of the cultured in uterus embryos can be explained as the result of different developmental stages of the embryos transferred.

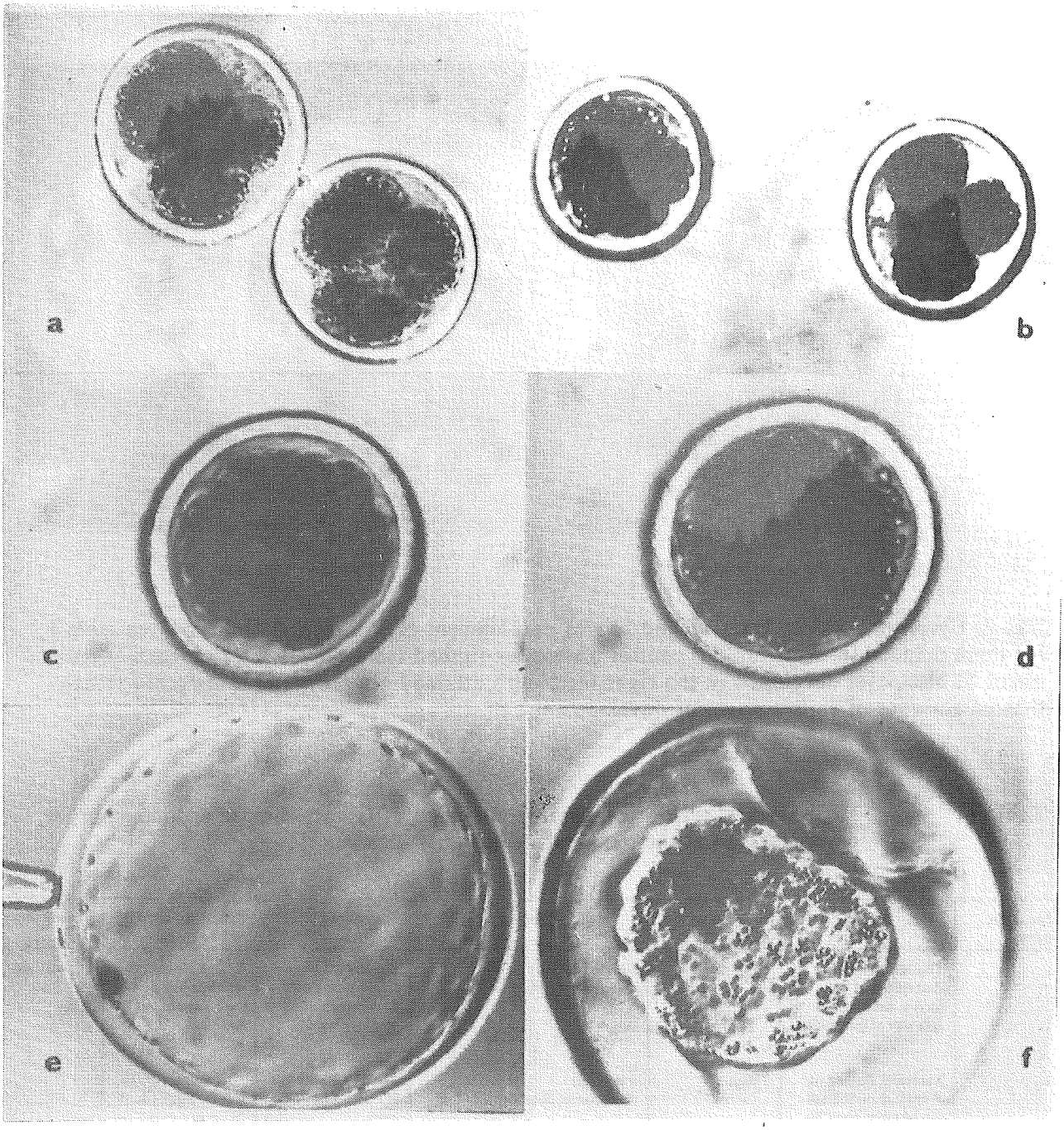

Fig. 2. The ermine embryos at different stages of development after cryopreservation at -196°C (the freezing program 2). a) 7th day embryos before freezing; b) 7th day embryos after cryopreservation at -196°C; c) 9th day morulas before freezing; d) 9th day morulas after cryopreservation at -196°C; e) 90th day delayed blastocysts before freezing; f) 90th day delayed blastocysts after cryopreservation at -196°C.

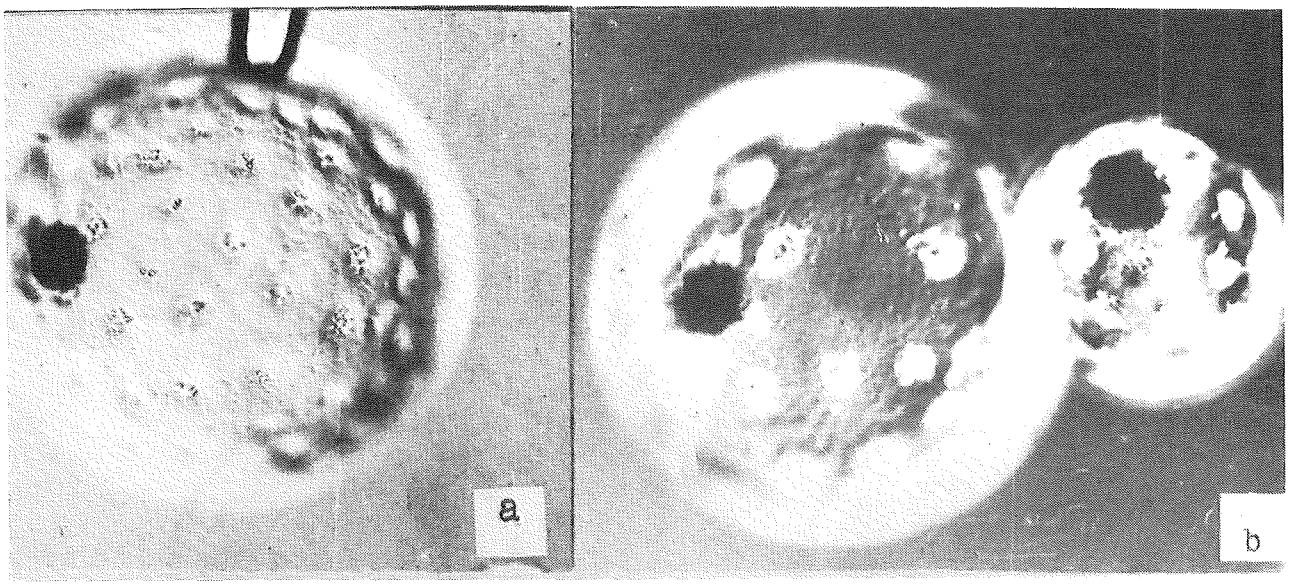

Fig. 3. Cyropreservation, transfer and *in vivo* development of the ermine embryos (see table 1 for more detailed information). a) control blastocysts flushed from the left uterine horn of recipient; b) blastocyst developed in the right recipient's uterine horn from the transferred frozen-thawed embryos of earlier stages of development.

Table 1. Experimental scheme on *in vivo* cultivation of frozen-thawed ermine embryos cryopreserved at the temperature of liquid nitrogen

No. of the straw	Frozen	Period of storage at -196°C	Thawed	Transferred into * recipient	Developed after ** *in vivo* culture	Control ***
1	4 earlier blastocysts flushed out of the uterine horn on the 12th day of pregnancy	307 days	4 earlier blastocysts no apparent damages	16 embryos transferred with their developmental stages being different:	4 large blastocysts which conform in their dimensions the control (fig. 3 b)	6 blastocysts (fig. 3 a)
2	3 morulas flushed out of oviduct on the 9th day of pregnancy (fig. 2 c)	7 days	3 morulas no apparent damages (fig. 2 d)	4 earlier blastocysts (12 days post coitum)	3 blastocysts of the smaller sizes (fig. 3 b)	
3	11 dividing embryos (5-6 blastomeres) flushed out of oviduct on the 6th day of pregnancy	7 days	9 embryos in several ones blastomeres are partly damaged	3 morulas (9 days post coitum) 9 dividing embryos (6 days post coitum)	1 degenerated embryo (not shown in the fig. 3)	

*: Transplantation into the right uterine horn. Simultaneous ligation of the right oviduct.
**: Embryos were flushed out of the right recipient's horn on the 34th day of pregnancy.
***: As control the left uterine horn embryos of the same animal were used.

Our experiments with ermine embryos show that, after having been kept at -196°C, embryos of several carnivorous species do survive. A recently possibility of domestic cat embryos being successfully cryopreserved has been shown [ref. 15]. We hope that these results would enable cryoembryobanks of valuable but endangered carnivorous species to be created.

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Birth of first fox cubs from embryo transfer

L. Jalkanen

Surgical transfer of four embryos from a silver fox female in Finland to a different female 9 days after insemination with semen from a red fox male on 14 Mar. resulted in the birth of 4 healthy cubs on 9 May. Future plans for the non-surgical transfer and freezing of silver fox embryos are considered.

Finsk Pälstidskrift 26 (6-7), p. 167, 1992. In SWED. CAB-abstract.

A study on artificial insemination in mink

Hao Yifeng

From 1983 to 1986, semen of mink was collected with electroejaculation and artificial insemination. Eighty-one ejaculates were obtained from 94 collections. The success rate was 86.2 percent. Semen volume, sperm density and sperm motility were 0.11±0.01 ml, 100.70±20.99 millions and 0.716±0.021, respectively. Twenty-four samples of semen were frozen. The resuscitation rate of the semen after thawing was 83.7 percent.
In 1985 five female mink were inseminated through the vagina with the frozen, thawed semen by the conventional method. Two minks were pregnant and each gave birth to 2.0±1.0 baby mink.

Acta Veterinary et Zootechnica Sinica, Vol. 21 (1), p. 31-35, 1990. In CHIN, Su. ENGL. 4 tables. Author's abstract.

Profiles of oestradiol-17β and progesterone and follicular development during the reproductive season in mink (*Mustela vison*)

G. Lagerkvist, E.J. Einarsson, M. Forsberg, H. Gustafsson

Plasma concentrations of oestradiol-17β and progesterone were studied in yearling mink females. The blood samples were collected from 2 March until 13 April in females not subjected to mating and in females mated on two consecutive days, early or late in the breeding season, or with 8-9 days between matings. Peaks in oestradiol-17β were recorded on the day of first mating, in relation to the second wave of growing follicles, and in early April, around the time when implantation should have occurred. Significant rises in progesterone were recorded from 17 to 21 March and were slightly later in females mated late in the season.
Histological studies of ovaries from unmated females revealed that the number of "active" follicles exceeded the number of degenerated or luteinized follicles until 7 April, after which the number of degenerated follicles increased rapidly. Degeneration was followed by luteinization. On 15 April, ovaries were collected from two females having 15 luteinized follicles each. These females had increased plasma concentrations of progesterone.
These studies indicate that in female mink, peaks in oestradiol-17β coincide with the first mating as a result of the copulatory act and that unmated females appear to experience a luteal phase in the absence of ovulation.

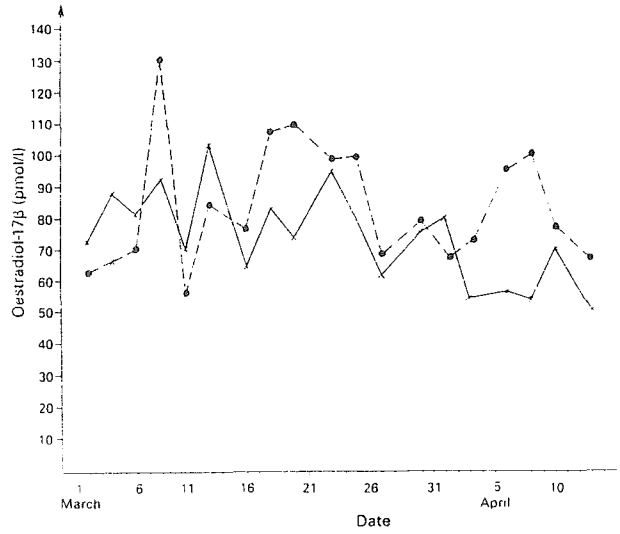

Fig. 2. Plasma concentrations of oestradiol-17β (least squares (LS) means) in female mink mated 9-11 March and remated after 9 days (----) and in females not subjected to mating (—). Standard errors of the LS means depend on whether comparisons are made within (s.e. range 9-14 pmol/l, mean 10·5 pmol/l) or btween groups (s.e. range 19-29 pol/l, mean 23 pmol/l).

J. Reprod. Fert. 94, 11-21, 1992. 3 tables, 5 figs., 37 refs. Authors' summary.

Seasonal modulation of androgen synthesis in the mink (*Mustela vison*) is associated with qualitative changes in testicular steroidogenesis in vitro

K.M. Tähkä, T. Teräväinen, C. Sundqvist

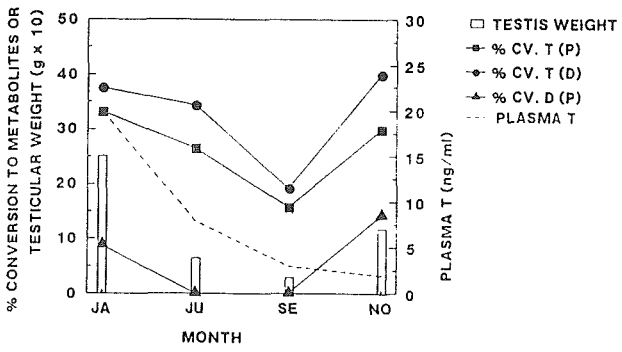

Fig. 1. Seasonal changes in testicular weight, plasma testosterone levels, and the in vitro conversion of P and DHA to androgens (T and DHA). %CV.T (P) = % conversion of P to T; %CV.T (D) = % conversion of DHA to T, %CV.D (P) = % conversion of P to DHA. Data on plasma testosterone levels from Sundqvist et al. ('84). With the exception of the in vitro production of T from DHA, the seasonal changes observed in these parameters were all statistically significant and also correlated positively with each other (n = 3 - 14).

Annual changes in testicular weight and microsomal androgen synthesis were studied in the mink (*Mustela vison*). Testicular samples were taken at different phases of the annual reproductive cycle. Steroidogenesis was assessed by investigating seasonal differences in the testicular conversion of [4-^{14}C] pregnenolone (P) and [4-^{14}C] dehydroepiandrosterone (DHA) to metabolites *in vitro*. The steroid metabolites were identified by thin-layer chromatography. Seasonal changes in the capacity of the testis to produce testosterone from DHA and P correlated positively with the annual reproductive cycle of the species as well as with our earlier findings on plasma testosterone levels. Although the percentage conversion to testosterone (T) from both substrates decreased (39.8% to 19%, DHA; 33% to 15.5%, P) during testicular regression, the in vitro production of androstenedione (A) was increased. The A/T ratio changed from 0.32 (DHA) and 0.42 (P) during testicular activation in November to 1.9 (DHA) and 2.52 (P) during regression in September. Both substrates were utilized efficiently throughout the reproductive cycle. During testicular regression the decreased conversion to T was associated with a marked qualitative and quantitative increase (per unit weight) in the production of unidentified metabolites. The conversion to 5α-reduced androgens appears to be insignificant, since none of the main 5α-reduced testicular androgens were identified at any phase of the reproductive cycle.

Our data suggest that the observed differences in testosterone production *in vitro* are in part due to changes in the activity of 17β-hydroxysteroid dehydrogenase and possibly also in the enzymes catalyzing the conversion of C_{21} steroids to androgens. It would also appear that seasonal modulation of androgen synthesis in this species is associated with a prominent qualitative shift in testicular steroidogenesis rather than with a marked reduction in the microsomal capacity to use the substrates.

The Journal of Experimental Zoology, 258, 231-239, 1991. 6 tables, 5 figs., 34 refs. Authors' abstract.

GnRH-stimulated LH and FSH release by perifused anoestrous red fox pituitary cells: gonadal steroid modulation

M. Bonnin, M. Mondain-Monval, M.C. Audy

In this study, gonadotropin releasing hormone (GnRH)-stimulated luteinizing hormone (LH) and follicle stimulating hormone (FSH) secretions in the red fox (*Vulpes Vulpes L.*) have been studied during anoestrus using perifused dispersed pituitary cells. The objective was to compare LH and FSH responses to pulses of GnRH in lactating and non-lactating females and to examine the feedback of gonadal steroids. Our results indicate that the pituitary sensitivity to GnRH was greatly reduced in lactating females compared with non-lactating females. Treatment *in vitro* of cells during 24 h (short-term effect) by progesterone (P) or oestradiol (E_2) induced an increase of LH and FSH release, indicating that even during anoestrus, pituitary cells are able to respond positively to gonadal steroids. In contrast, administration of P or E_2 *in vivo* for several days by silastic capsules (long-term effect) induced a reduction of LH and FSH releases by pituitary cells *in vitro*. Thus, steroids

act directly on the pituitary but their action is time- and dose-dependent. During anoestrus in the fox, particularly during lactation, P and E_2 might exert a potent negative feedback control on pituitary secretion. In the red fox (*Vulpes vulpes L.*), the fact that GnRH-stimulated LH and FSH secretions are reduced in lactating females more than in non-lactating females, suggests that P (secreted *in vivo* during lactation, probably as a consequence of a luteotrophic action of prolactin) and E_2 secreted jointly during episodic phases of oestrogenic activity, may be responsible for decreased pituitary responsiveness observed during early anoestrus. This action of gonadal steroids might occur in association with a specific role of prolactin or a suppressive effect of suckling.

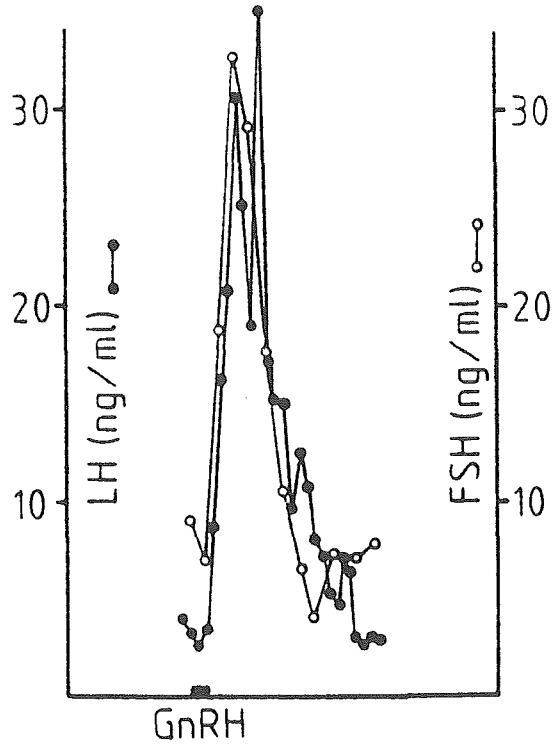

Fig. 1. Representative profiles of LH (●---●) and FSH (o---o) responses to an 8-min pulse of 1 nM GnRH by fox pituitary cells: each point corresponds to the concentration of gonadotropins in 2 min fractions of eluates.

Animal Reproduction Science, 27, 319-333, 1992. 4 tables, 4 figs., 38 refs. Authors' abstract.

Regulation of the reproductive cycle

O.L. Rapoport, V.G. Bernatskii, V.D. Cheprasov

27 low-fertility female mink and 9 sexually experienced male mink were implanted in May with a capsule containing melatonin and "other" hormones. In Sep., testis enlargement and vulval swelling occurred. Matings took place between 3 and 20 Oct.; 25 of the females were mated by 8 of the males. Ten of the mated females whelped, and litter size averaged 4.5.

Krolikovodstov i Zverovodstvo, No. 5, p. 8, 1991. In RUSS. 3 tables. CAB-abstract.

How the inability to perceive photoperiod affects the onset of puberty and subsequent reproductive function in mink

R.J. Aulerich, K.A. Koudele, A.C. Napolitano

The results of this study indicate that the eyes are the most important component in the eye-SCG-pineal axis in mink because, without them, the animals became disynchronous with the photoperiod despite other treatments. There was no spontaneous regeneration of the gonads and the postbreeding season atrophy of the testes was slowed in blinded animals, indicating that mink require the photoperiod to stimulate reproductive function was well as to hasten its end.
The SGC may have an inhibitory role in gonadal recrudescence because without it, the testes of the males enlarged sooner than in intact males. However, the effect of the eyes overshadowed that of the ganglia--blind + SCGx animals responded the same as blinded-only animals. The SCGx females responded the same as other sighted females. Therefore, the role of the ganglia in sighted mink needs to be further defined.

Research report from the Michigan State University Agricultural Experiment Station, East Lansing, p. 85-96, 1991. 13 figs., 7 refs. Authors' conclusion.

Heat detection and determination of optimum insemination time in polar fox (*Alopex lagopus*)

M. Barta, I. Jakubicka

Oestrus cycles were investigated in seven polar foxes: the investigation consisted of evaluation of clinical symptoms of heat (*vulva enlargement*), measurement of vaginal mucus electrical resistance, and determination of progesterone concentrations in the blood plasma of foxes; the objective was to determine optimum insemination time. The females were inseminated with fresh semen intravaginally by means of a pseudopenis, a day following the record of maximum electrical resistance of vaginal mucus and at the minimum progesterone concentration in blood plasma of 30 $ng.ml^{-1}$. The females were reinseminated on the following day. The insemination dose had a volume of 1 ml with sperm concentrations of 150.10^{16}. Clinical symptoms of heat were observed in six out of the seven test foxes. Heat detection by means of measuring vaginal mucus electrical resistance was successful also in six females. Progesterone test enabled heat detection in five females. Out of six inseminated females, five foxes became pregnant (83.3%) and a total of 33 cubs were born; this is 5.5 cubs per female.

Veterinarni Medicina - UVTIZ, Vol. 36 (6), 355-360, 1991. In SLOE, Su. ENGL, SLOE. 2 tables, 2 figs., 16 refs. Authors' summary.

Collecting the sperm of male foxes by electroejaculation in halothane anaesthesia

M. Barta, I. Jakubicka

A method has been developed for the collection of ejaculate from anaestesized foxes. General anaesthesia was produced by inhaling 3 to 5% narcotan mixed with oxygen, the inhalation rate being two litres per minute. An electroejaculator with a bicolar electrode, introduced in the rectum, was used for the electrostimulation of ejaculation. The voltage needed to produce the ejaculation effect and the number of impluses depended on the individual. The average amount of ejaculate per one collection was 0.86 ml, sperm motility percentage 74.80%, sperm concentration 270.62 x 10^3 spermatozoa per mm^3, and average pH value 6.87.

Veter. Med., 34 (10), 637-640, 1989. In SLOE, Su. RUSS, ENGL, GERM. 1 table. Authors' summary.

Monitoring of red fox (*Vulpes vulpes*) reproduction 1990

Erik Lindstrøm, Christina Lindstrøm

Red fox (*Vulpes vulpes L.*) reproduction (ovulation frequency and rate, whelping frequency, mean litter size, and % subadults in the winter (Nov-March) sample, tables 1, 2 and 3) is monitored post mortem in vixens shot by hunters in three areas of Sweden (fig. 1). Within the Grimsö Wildlife Research Area, the minimum number of litters is also monitored by den counts and observations of juveniles (table 4).
In this report we describe the reproduction during 1989. The low vole densities in the Bergslagen and Västerbotten areas resulted in poor reproduction, as expected. The Småland material was too small to permit any analysis on a yearly basis. A more detailed description of the project in English is given in report 3257 from the National Swedish Environment Protection Board.

Statens Naturvaardsverk - Sweden, Report no. 3957, 11 pp, 1990. In SWED, Su. ENGL. 4 tables, 7 figs. Authors' summary.

Investigation on cub production in blue foxes in central Norway. I.

O.A. Eldøy

In 1991, questionnaires were sent to 290 blue fox breeders in Norway, and approx. 120 responded. The average incidence of failure to conceive was 23% for young females and 16% for adults, the percentage of abortions 9 and 7% resp., that of females giving birth to a litter was 69 and 77% and that of weaning a litter was 59 and 69%. The percentages of breeders not using artificial light, removal of males or females or open enclosures prior to mating were 90.2, 7.0, 58.2 and 74.6% resp. of breeders that moved

females, 32.8 and 46.1% did so before the mating period or 1-2 wk after the beginning of the mating period. 80% of breeders reduced rations for females before 1 Jan., and 75% increased rations well before the beginning of mating. Details are given of nutrition and the main causes of cub mortality.

Norsk Pelsdyrblad 66 (2), p. 4-6, 1992. In NORW. 6 tables. CAB-abstract.

Investigation on cub production in blue foxes in central Norway. II.

O.A. Eldøy

Data on blue fox females at approx. 120 farms in Norway, with an average litter size of 4.25 cubs, were analysed. Artificial light before the beginning of mating or later during the mating period had no beneficial effect on litter size. Moving females and males 2 wk or 1 wk resp. after the beginning of the mating period appeared to have a slight beneficial effect on litter size. Litter size appeared to be increased by allowing animals access to a run 1-2 wk after the beginning of the mating period. Litters were larger at farms where the duration of the mating period was 4-6 wk than at those with shorter or longer mating periods, and mid-season mating produced larger litters than early or late matings. Females given reduced rations between 1 Jan. and 1 Feb. had larger litters than those restricted before 1 Jan., and females given extra rations and vitamin supplements during the mating period, pregnancy and lactation had larger litters than those given no supplement.

Norsk Pelsdyrblad, 66 (3), p. 10-11, 1992. In NORW. 7 tables. CAB-abstract.

Investigations on the whelping performance of blue foxes in central Norway

O.A. Eldøy

Questionnaires on 6000 blue fox females at 130 fox farms in 5 areas of central Norway were analysed. In 1991, 69% of young females and 77% of adult females gave birth to a litter, and 59 and 70% resp. weaned a litter. The average kit mortality was 28.4%. Litter size at birth ranged from 3.83 to 5.38 cubs for blue fox females mated with blue fox males and from 1.50 to 5.15 for blue fox females mated with silver fox males, and there were marked differences between areas; it ranged from 4.10 to 5.97 cubs for fe-males given vitamin or mineral supplements and from 3.42 to 5.24 for non-supplemented females. Results are compared with those in 1990.

Norsk Pelsdyrblad, 66 (5), p. 16-19, 1992. In NORW. 4 tables. CAB-abstract.

Whelping results in 1991

K. Pesso

For 370623 mink, 15197 polecat, 68944 blue fox, 18624 silver x blue fox, 77827 silver fox and 7032 raccoon dog females mated in Finland in 1991, the number of young born per mated female averaged 4.15, 5.73, 5.43, 4.38, 2.80 and 4.80 resp. Compared with 1990, the total numbers of mink, blue, crossbred and silver foxes and polecats born decreased by 10, 54, 68, 46 and 36 %, resp.

Finsk Pälstidskrift 25 (8-9), p. 159, 1991. In SWED. 1 table. CAB-abstract.

Rearing performance of mink at farms in Schleswig-Holstein

J. Lamp

Of 5156 females mated in 1989, 91.6% gave birth to a litter, and the litter size per female mated and whelping averaged 5.23 and 5.71 resp. Of these females, 61% were mated twice within a period of 8-10 days, 24% were mated once, 13% were mated twice at an inverval of 2 days, and 2% were mated 3 times within 14 days; litters tended to be smaller for mink mated once than for those mated twice or 3 times. Females aged 1-3 yr had a better reproductive performance than younger and older females. Data are tabulated for the performance of various colour types.

7 Arbeitstagung über Haltung und Krankheiten der Kaninchen, Pelztiere und Heimtiere, 31 May bis 1 Juni, p. 74-79, 1990. In GERM. 2 tables, 2 figs. CAB-abstract.

Original Report

Winter energetics and feeding activities in the male mink

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Fur Farming Research Station,
SF-69100 Kannus, Finland

Summary

The present paper provides comparative data on the energetics and feeding activities of male mink of different initial body sizes during the coldest part of winter. The results showed that heavier mink tend to eat somewhat more than lighter mink; thus initial weight differences easily persist throughout the actual winter period. A decrease/increase in the ambient air temperature consequently decreases/increases the feed intake of the mink. The dependence of feed consumption (y) on the daily minimum temperature (x) is described by the equation: $y=381.3 + 2.18x$ ($p<0.001$;$F=60.63$). The ambient air temperature significantly affects locomotor activity: the colder the temperature, the less the animals move about and vice versa. It can be concluded that despite its high basal metabolic needs and modest thermoregulation, the mink does well in the cold because of its specific behavioural adaptations.

Introduction

Winter places many special demands on the thermoregulation, energetics and behaviour of animals living in Northern Hemisphere. Particularly smaller animals may have difficulties because of their relative small body surface area and limited thermoregulatory capacity (*Schmidt-Nielsen, 1984*). A typical example of such an energetically uneconomical species that lives in northern conditions is the mink (*Mustela vison*). It has a small, elongated body, a thin fur coat, short legs and a relatively high basal metabolic rate (*Iversen, 1972; Korhonen et al., 1983*). Nevertheless, it can survive even north of the Arctic Circle (*Syrjälä-Qvist et al., 1990*).

Although energetics and thermoregulation in the mink have been studied rather intensively, there is still lack of information as concerns feeding behaviour, locomotor activity and body size in relation to the ambient air temperature during the winter. The purpose of the present study is to provide such comparative data for farmed male mink of different body size.

Materials and methods

The experiments were carried out at the Fur Farming Research Station of Kannus (63.54 N, 23.54 E) in Western Finland. Three experimental weight groups were formed: (1) light animals (mean body weight at the beginning of the experiments 2096 ± 57 g), (2) medium-sized animals (mean weight 2264 ± 55 g) and (3) heavy animals (mean weight 2578 ± 118 g). Initially, each group was comprised of 10 male mink of farm origin, but soon after the start of the experiment one mink from both groups 2 and 3

died; thus, finally these two groups had only 9 animals. The mink were accustomed to the test conditions for about a week. The actual experiments began on January 4th and lasted for 8 consecutive weeks of the coldest winter period. Body weights were measured four times during the experiments.

The animals were fed a commercial standard fresh feed once daily (*c.f. Korhonen et al., 1986*). Each mink was housed in its own cage that was equipped with a special feeding tray. The daily feed intake as well as feed remains were carefully controlled individually. In addition, during 8 days the feed consumption of the mink was measured four times daily (in the morning, at midday, in the afternoon, the following morning) to estimate their daily intake profiles.

Feeding behaviour and locomotor activity of the animals were measured with video camera equipments (CDD video camera 720, Bische UB-480 tape recorder, Koyo monitor, Bische 12-300 infrared light; 500 W). Video recordings were made during 10 days of different ambient air temperatures. Three animals from each of the three body size groups were used for the video recordings.

The results were statistically treated by analysis of variance, regression analyses and by the Pearson's product moment correlation.

Results

At the beginning of the experiments, the body weights of the groups were significantly different ($p<0.05$) from eachother (table 1). At the next weighing time (Jan 29), however, the difference between the light and the medium groups had disappeared ($p>0.05$), but during the third and last weighings the earlier differences between the groups reappeared ($p<0.05$). Thus, it can be concluded that the weight differences between mink of different initial body sizes remain rather constant throughout the winter period.

Table 2 summarizes the weekly feed consumption in the groups. No significant differences ($p>0.05$) were found between the groups, except during weeks 4 and 5, when the feed intake of group 2 was lower ($p<0.05$) than that of the other groups.

Group 3 (heaviest minks) showed a tendency towards a slightly higher, but insignificant, feed intake (often 10-20 g daily) than the lighter groups. In relation to body mass, however, the consumption in each group was of about the same order of magnitude.

Daily feed consumption (y) was affected by ambient air temperature (x) according to the following equations: (1) in relation to circadian minimum temperature; $y=381.3 + 2.18x$ ($p<0.0001;F=60.63$), and (2) in relation to circadian mean temperature; $y=377.9 + 3.02x$ ($p<0.0001;F=65.60$). However, no significant relationship ($p>0.05$) was found between feed consumption and daily maximum temperature. In summary, equations (1) and (2) clearly showed that a decrease/increase in ambient air temperature consequently resulted in decreased/increased feed consumption in male mink during the coldest winter period.

Table 1. Body weights of light (group-1), medium (group-2) and heavy (group-3) minks during the experiments. Means (± SD) with a different letter are significantly different ($p<0.05$)

Date	Group-1	Group-2	Group-3
Jan 7	2096 ± 57[a]	2264 ± 55[b]	2578 ± 118[c]
Jan 29	2354 ± 110[a]	2427 ± 104[a]	2674 ± 105[b]
Feb 2	2367 ± 112[a]	2505 ± 82[b]	2748 ± 131[c]
Feb 29	2415 ± 89[a]	2546 ± 87[b]	2743 ± 148[c]

Table 2. Weekly feed consumption (mean ± SD) of the experimental groups. S=significance: NS=not significant, *p<0.05. T=ambient air temperature (°C)

Days studied		Group 1	Group 2	Group 3	S	Tmin	Tmax	Tmean
7.-12.1.	(1)	346 ± 24	329 ± 53	323 ± 68	NS	-14	-3	-8
13.-19.1.	(2)	372 ± 57	364 ± 59	372 ± 55	NS	-13	-4	-8
20.-26.1.	(3)	372 ± 53	353 ± 88	382 ± 44	NS	-7	-1	-4
27.1.-2.2.	(4)	362 ± 59	344 ± 72	387 ± 28	*	-3	+2	-1
3.-9.2.	(5)	372 ± 52	346 ± 86	381 ± 51	*	-8	-2	-5
10.-16.2.	(6)	370 ± 63	373 ± 62	385 ± 47	NS	-7	-3	-5
17.-23.2.	(7)	343 ± 84	329 ± 98	363 ± 80	NS	-12	-3	-7
24.-29.2.	(8)	369 ± 59	372 ± 59	384 ± 39	NS	-3	+2	0

The circadian profiles for feed intake are presented in tabel 3. The mink were fed at 8:30 A.M. The first weighing of feed intake (1) was performed 2 hours after the feeding (10:30 A.M.). During this first interval the mink consumed on average (calculated from the total 8-day material) 13.9% (i.e. 1/7) of the daily feed given. The second weighing (2) was 4.5 hours after the morning feeding (1:00 P.M.). Up to now, 24.0% of the daily feed had been consumed. At the third weighing time (3), i.e. 6 hours after feeding (2:30 P.M.), the intake reached the amount of 32.1% of their daily consumption. The last weighting (4) was carried out the following morning at 8:30 A.M. At this time, the mink had normally eaten almost all of the daily 400 g feed ration. Thus, it can be said that male mink generally consume the major part (2/3) of the daily feed ration outside the time interval of 8:30 A.M. and 2:30 P.M.

There were also some differences in the daily intake profiles between the groups. During the first two hours group 1, group 2 and group 3 consumed 12.5%, 13.5% and 15.7%, respectively. After 4.5 hours the corresponding percentages were 23.0, 22.4 and 26.5, and after 6 hours 30.4, 31.9 and 34.2. Thus, the heaviest group tended to eat the most and the lightest group the least.

From table 3 we calculated the feed consumption of the three first weighings (i.e. the actual daily consumption), and calculated the regression between this daily consumption (y) and ambient air temperature (x); the equation is: $y=121.4 - 1.76x$ ($p<0.01$; $F=7.311$). Thus, on cold days minks tended to eat the most during the daytime, and vice versa.

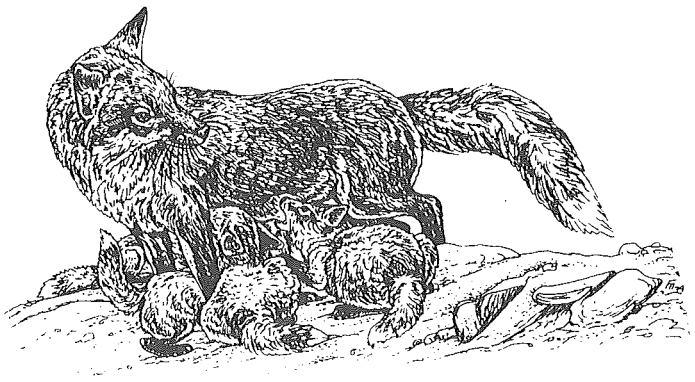

Table 3. Cumulative feed intake (% of total daily 400 g ration) of the groups. T=ambient air temperature (°C). For feed weighings see Results.

Date	Weighings	Group 1	Group 2	Group 3	Tmin
Jan. 16	(1)	15.8	14.5	13.8	-6
	(2)	27.3	25.8	24.5	-10
	(3)	33.3	37.5	32.5	-8
	(4)	94.0	91.3	98.0	-17
Jan. 21	(1)	11.8	13.8	8.8	-6
	(2)	20.0	20.3	21.3	-4
	(3)	31.0	36.3	29.3	-3
	(4)	100	94.0	100	-13
Jan. 23	(1)	11.0	13.5	20.0	-1
	(2)	20.8	23.0	32.8	-1
	(3)	27.3	28.8	38.8	-1
	(4)	94.0	88.5	93.5	-4
Jan. 28	(1)	5.0	7.0	10.5	+5
	(2)	20.0	20.0	27.0	+6
	(3)	24.5	27.0	31.5	+7
	(4)	96.5	92.3	98.3	-1
Feb. 6	(1)	15.3	16.3	20.3	-14
	(2)	28.5	24.8	26.8	-9
	(3)	33.3	37.8	34.8	-8
	(4)	100	85.5	95.3	-13
Feb. 18	(1)	11.0	11.8	14.0	-2
	(2)	22.5	18.8	22.8	-3
	(3)	27.8	29.3	30.8	-3
	(4)	88.8	82.8	97.5	-7
Feb. 19	(1)	15.5	16.0	18.8	-6
	(2)	23.8	24.8	30.5	-4
	(3)	37.8	32.0	37.5	-3
	(4)	93.0	84.8	91.0	-13
Feb. 20	(1)	14.3	15.0	19.5	-11
	(2)	21.3	21.5	26.3	-6
	(3)	28.0	26.5	38.5	-3
	(4)	73.8	62.0	86.8	-17

As calculated from the total material studied, the daily rate of activity in the mink averaged 198 ± 67 min. For group 1, group 2 and group 3 the total daily mean activity rates were 207 ± 62 min, 180 ± 49 min and 218 ± 90 min, respectively ($p>0.05$). The daily activity rates of each group separately are given in table 4.

Table 4. Circadian locomotor activity, time spent eating and circadian number of eating episodes for each mink group. The data are expressed as mean ± SD

Date	Group	Activity rate (min/day)	Eating (min/day)	Eating (episodes/day)	Tmin (°C)
Jan. 16	1	240 ± 82	84 ± 68	18 ± 13	-6
	2	252 ± 21	41 ± 8	11 ± 1	
	3	248 ± 89	37 ± 3	10 ± 4	
Jan. 17	1	190 ± 50	55 ± 38	12 ± 8	-10
	2	183 ± 18	48 ± 17	10 ± 1	
	3	135 ± 59	33 ± 9	9 ± 5	
Jan. 18	1	172 ± 65	75 ± 35	12 ± 5	-20
	2	134 ± 23	51 ± 16	11 ± 2	
	3	130 ± 18	66 ± 18	12 ± 4	
Jan. 20	1	210 ± 61	74 ± 41	15 ± 4	-6
	2	138 ± 59	43 ± 14	13 ± 6	
	3	131 ± 11	42 ± 6	10 ± 1	
Jan. 22	1	198 ± 72	98 ± 68	26 ± 15	-6
	2	154 ± 32	47 ± 12	16 ± 1	
	3	247 ± 26	48 ± 3	12 ± 1	
Jan. 31	1	251 ± 40	82 ± 55	19 ± 7	-5
	2	198 ± 28	48 ± 2	18 ± 2	
	2	261 ± 73	48 ± 11	13 ± 4	
Feb. 2	1	264 ± 58	67 ± 12	18 ± 9	-3
	2	217 ± 38	42 ± 8	13 ± 4	
	3	299 ± 11	41 ± 13	13 ± 2	
Feb. 18	1	166 ± 35	98 ± 33	15 ± 5	-17
	2	162 ± 32	48 ± 15	11 ± 5	
	3	103 ± 11	29 ± 16	5 ± 3	
Feb. 19	1	219 ± 71	72 ± 36	13 ± 9	-21
	2	178 ± 63	33 ± 20	9 ± 4	
	3	328 ± 95	19 ± 8	5 ± 1	
Feb. 20	1	155 ± 54	90 ± 25	15 ± 3	-2
	2	187 ± 60	60 ± 12	13 ± 1	
	3	238 ± 89	55 ± 14	13 ± 2	

Ambient air temperature had a very significantly effect on locomotor activity; the colder the temperature, the less the mink moved (dependence on circadian minimum temperature: $F=4.573$, $p<0.05$; on circadian maximum temperature: $F=10.066$, $p<0.01$: on circadian mean temperature: $F=6.981$, $p<0.01$).

There was no significant relationship ($p>0.05$) between the daily locomotor activity rate and feed consumption. The same held true for the relationship between individual locomotor activity and body weight ($p>0.05$).

On average the mink spent 57 ± 31 minutes eating daily. The mean circadian number of eating episodes was 13 ± 6. For the individual numbers, see table 4. Significant group differences were found between circadian numbers of eating episodes: group 1 ate the most frequently, i.e. on an average 16 ± 8 times, which differed significantly ($p<0.05$) from group 2 (12 ± 4) and group 3 (11 ± 4). Group 2 and group 3 did not differ from each other. A similar tendency held true for the time spent on eating: group 1: 79 ± 39 min, group 2: 46 ± 13 min and group 3: 42 ± 15 min ($p<0.05$). It is tempting to conclude that the smaller mink spent more time feeding due to their smaller stomach volume, which forced them to eat more frequently than the larger individuals.

A significant dependence ($p<0.05$) was found between the circadian numbers of eating episodes and ambient air temperature; the colder the temperature, the less frequently the mink ate. The daily activity profile of their eating rhythms was rather similar to that of their common daily activity rhythm. Thus, the mink ate less frequently during the middle and early part of the nights. Most often, they were observed to consume their feed before midday and in the evening.

Discussion

The results show that ambient air temperature regulates the daily activity of mink; with increasing cold the mink decreases its locomotor activity, and vice versa. The lower critical temperature of mink is about +24°C (*Korhonen et al., 1983*), and an ambient air temperature of -5°C requires the mink to almost double its metabolic rate. Therefore, it is for the mink, energetically more economical to stay in the shelter of a well-isulated nest than to move about at lower temperatures.

It was found that with a decreasing ambient air temperature, the mink also decreases its feed consumption. The fact is that in cold weather the feed also freezes, which partly prevents the mink from eating very efficiently. During the warm weather the mink ate less during the daytime than during the cold weather. This behaviour is reasonable because on cold days the feed is less frozen, especially during the daytime, as daytime temperatures are the highest then and the shortest time has elapsed since the last feeding, which best guarantees access to unfrozen feed. Furthermore, it should be noted that on cold days decreased feed intake is partly compensated by decreased activity and shelter provided by the nest.

Feeding behaviour plays a marked role in the daily activity budget of the mink. The fact that that the mink eats on average 13 times in a 24-hour period is interesting, and can be explained at least by the following reasons: (1) The stomach volume of male mink is about 50-70 ml which can hold 75 g fresh feed at once (*C.f. Mink production, 1985*). Thus, mink cannot consume the total daily feed portion (400 g) at once but is forced to eat frequently. (2) The length of the gastrointestinal tract of the mink is very short, i.e. only four times its body length (*c.f. Mink production, 1985*). Therefore, feed passes through the tract rather rapidly, in about 3 hours. The short gastrointestinal tract and small stomach volume significantly regulate its daily locomotor activity, forcing the mink to leave the nest every now and then throughout the day. The circadian activity of mink, which in the present study amounted to about 3.5 hours, thus consists of short bursts of activity between resting periods.

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Dietary regulation of intestinal brush-border sugar and amino acid transport in carnivores

R.K. Buddington, J.W. Chen, J.M. Diamond

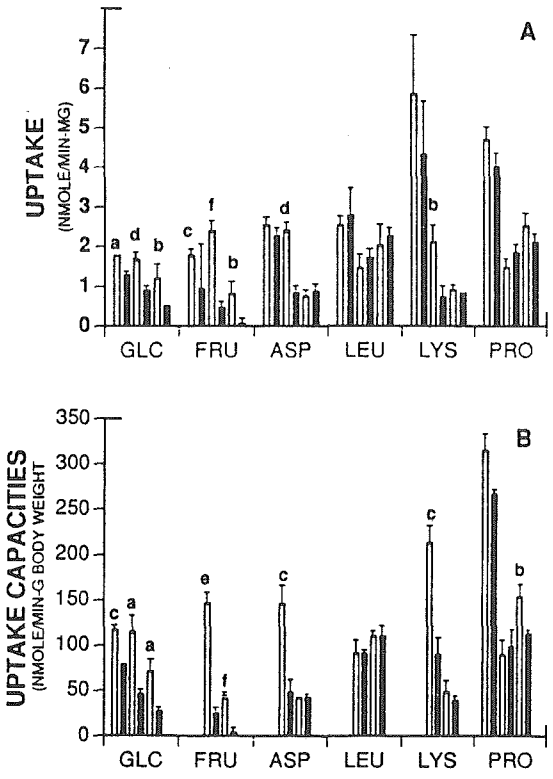


Fig. 1. A: uptake rates (nmol·mg^{-1}·min^{-1}) for Glc, Fru, Pro, Asp, Leu, and Lys averaged over entire length of small intestine of mink fed HC (open bars) and HP (solid bars) diets for 3 (1st pair of bars), 10 (2nd pair of bars), and 25 days (3rd pair of bars). Values for Fru, Asp, Leu, and Lys at 3 days are averaged from only proximal and midintestinal regions. B: uptake capacities (nmol·min^{-1}·g body wt^{-1}) of small intestine for Pro and Glc after 3 days of feeding (1st pair of bars) on HC (open) and HP (solid) diets and for Glc, Fru, Pro, Asp, Leu, and Lys after 10 (2nd pair of bars) and 25 days (3rd pair of bars) of feeding on 2 diets. Levels of significance for effect of diet: $^{a}P = 0.05$; $^{b}P = 0.025$; $^{c}P = 0.01$; $^{d}P = 0.005$; $^{e}P = 0.0025$; $^{f}P = 0.001$).

The ability of omnivores and herbivores to regulate reversibly their intestinal brush-border nutrient transporters is functionally related to the unpredictably variable composition of their natural diets. To determine whether carnivores are able similarly to regulate the activities of their intestinal nutrient transporter, we fed to three species of vertebrates that are carnivorous as adults (cats, mink and leopard frogs) diets with either at least 50% digestible carbohydrate or with negligible carbohydrate levles. Rates of transport for the sugars glucose and fructose and the amino acids (AAs) aspartate, leucine, lysine, and proline were measured throughout the intestine (only proline and glucose in the frogs) by an *in vitro* sleeve everted method. Although all three species consume much carbohydrate during early development, only the mink was able to regulate sugar transporter activity in response to changes in levels of dietary carbohydrate. In contrast, the sugar transporters of the cat were unresponsive to varying carbohydrate levels, and long-term feeding of a high-carbohydrate diet caused down-regulation of sugar transport in frogs. Of the three species, only the mink is a member of a family that includes omnivorous species, whereas all members of the families to which the cat and frog belong are carnivorous as adults. All three species were able to regulate rates of AA transport, though the patterns and magnitude of the responses differed between species as well as between AAs, suggesting independent regulation of some AA transporters. Combining these results with published studies of five other species, we conclude that the ability of a species to regulate its intestinal brush-border nutrient transporters in response to changes in dietary composition has been programmed during evolution by the natural diet.

American Journal of Physiology, 261, 4 PT 2; R793-R801, 1991. 5 tables, 3 figs., 21 refs. Authors' summary.

Effect of evening primrose oil as a feed supplement on reproduction in the blue fox

Anne-Helene Tauson, Mats Forsberg

Addition of evening primrose oil (EPO) to a blue fox diet in the reproduction period was evaluated in an experiment with 2 groups, each of 12 male and 25 female blue foxes, regarding the effects on reproductive performance. The experiment was carried out as a field trial and the experimental period lasted from March 10 until the end of the mating season (males) or early July (females). During this period the control group was fed the standard diet of the farm and the experimental group was fed the same diet supplemented with 4.5 g EPO and 2.5 mg

zinc sulphate per animal and day. An addition of 10 mg vitamin E per 500 mg EPO was made. The results were evaluated regarding male and female treatment effects. There was an increased rate of abortions in the EPO-group but, simultaneously, a non-significant decrease in the frequency of barren females, resulting in a similar level of females without litters in both groups. A tendency for increased litter size in the EPO groups was found, mainly as an effect of male treatment, which might indicate an effect on semen quality.

Acta vet. scand. 32, 345-351, 1991. 3 tables, 16 refs. Authors' summary.

The effects of fiber supplementation on diet digestibility by silver foxes

W.L. Faulkner, D.M. Anderson

A digestibility study with silver foxes weighing 6.5±0.1 kg was conducted to evaluate five fibers (Hemicellulose (X), α-cellulose (C), pectin (P), oat bran (B) and oat hulls (H)) added at 5% to a meat-type diet (A). Apparent digestibility of dry matter in diet P (65.1%) was significantly poorer ($P<0.05$) than all others except C (69.1%). Addition of all fibers reduced digestibility of acid detergent fiber. Diet P resulted in weight loss, increased water consumption, and faster rate of passage than diet A ($p<0.05$).

Canadian Journal of Animal Science, 71 (3), 943-947, 1991. In ENGL, Su. FREN. 1 table, 12 refs. Authors' abstract.

Vitamin A in the urine of carnivores

F.J. Schweigert, E. Thomann, H. Zucker

Vitamin A levels (retinol equivalents) in the urine of canines were between 423 ng/ml (dog) and 6304 ng/ml (silver fox). Neither vitamin A nor vitamin E was found in the urine of herbivores, omnivores and rodents. No vitamin A but low levels of vitamin E were detected in cats. Vitamin A in the urine was present as retinol and retinyl esters (basically retinyl palmitate/-oleate). The total excretion of vitamin A represented 15 to 63 % of the daily uptake in dogs, while less than 4% of vitamin E was excreted. Results after precipitation and ultracentrifugation indicate that similar carrier proteins may exist for retinol, retinyl esters and α-tocopherol in the urine. The biological significance of this phenomenon is discussed with regard to the high concentrations of retinyl esters in the blood plasma of carnivores bound to lipoproteins.

Internat. J. Vit. Nutr. Res. 61, 110-113, 1991. 2 tables, 13 figs. Authors' summary.

Guanidino compound metabolism in arginine-free diet induced hyperammonemia

D.R. Deshmukh, K. Meert, A.P. Sarnaik, B. Marescau, P.P. de Deyn

Guanidino compounds, intermediates of arginine metabolism, are altered in many pathological conditions especially those involving the urea cycle. Arginine and creatine play an important role in nitrogen metabolism whereas other guanidino compounds such as guanidinosuccinic acid and N-acetylarginine are toxins. Our objective was to investigate the relationship between guanidino compounds and hyperammonemia. Young and adult ferrets were fed a single meal of either an arginine-containing diet (ACD) or an arginine-free diet (AFD). Guanidino compounds were determined by HPLC in the plasma, liver, kidney and brain 3 h after feeding the specified diet. Only young ferrets fed AFD developed hyperammonemia. Plasma and kidney arginine was decreased whereas guanidinosuccinic acid was increased in young ferrets fed AFD. Hepatic creatine and kidney and brain guanidinoacetic acid were significantly decreased in this group. These results indicate that AFD-induced hyperammonemia produced decreased methylation activity in the liver and transamidination activity in the kidney. Elevated guanidinosuccinate levels coupled with deficient hepatic creatine synthesis may play a role in the pathophysiology of hyperammonemia.

Enzyme, 45, 128-136, 1991. 4 tables, 25 refs. Authors' summmary.

Vitamin E disturbance in mink after rabbit offal feeding

H. Zimmermann

Feeding of long-stored rabbit offal caused vitamin E deficiency in young males in the growing period. Breeding stock was not affected. Sickness was characterized by swelling of the head and increased contents of Creatin-Kinase in blood samples. The incidence rate amounted to 10% with a 3% mortality loss. Early treatment with vitamin E was successfull (oral 1.5 g/100 mink). The compatibility of vitamin E is, as is well known very good. To the contrary, overdosage of Selenium in vitamin E + Selenium injections can result in poisoning.

Der Deutsche Pelztierzüchter 66 (6), p. 6, 1992. 4 refs. Author's abstract.

Effects of a technical PCB preparation and fractions thereof on ethoxyresorufin *O*-deethylase activity, vitamin A levels and thymic development in the mink (*Mustela vison*)

B. Brunström, H. Håkansson, K. Lundberg

Clophen A50, a technical preparation of polychlorinated biphenyls (PCBs), was separated into four fractions; three containing di- and tricyclic impurities such as naphthalenes and dibenzofurans. Clophen A50, the four fractions, and a synthetic mixture of the biologically most active non-*ortho*-chlorinated congeners (3,3',4,4'-tetra-,4,4',5,-penta-, and 3,3',4,4',5,5'-hexachlorobiphenyl), were separately mixed in the feed and given to females during the reproductive season. The concentration of a given compound in the feed mixture was equivalent to its concentration in the feed mixed with Clophen A50, Hepatic 7-ethoxyresorufin *O*-deethylase (EROD) activity in adults was enhanced 2-3 times by Clophen A50, the fractions containing non- or mono-*ortho*-chlorinated congeners, and the synthetic mixture. In neonatal kits delivered by females treated with non- or mono-*ortho*-chlorinated congeners, EROD was enhanced to about 30 times the control value. No live kits were delivered by the females treated with unfractionated Clophen A50. The fractions containing congeners with two to four *ortho* chlorines or di- and tricyclic compounds did not significantly induce EROD in either adults or kits. Clophen A50 reduced hepatic and pulmonary vitamin A contents in adult mink, while renal vitamin A was unaffected. Responses to the fractions containing the non- and mono-*ortho*-chlorinated congeners were similar to those obtianed with Clophen A50. Their effects were, however, less pronounced, particularly with respect to the hepatic vitamin A reduction. The fractions containing congeners with two to four *ortho* chlorines and the di- and tricyclic compounds had no significant effects on tissue vitamin A contents. Thymocyte number was significantly reduced in kits exposed to the fractions containing non- or mono-*ortho*-chlorinated congeners. Thymocyte number was also lower in kits exposed to the synthetic mixture of non-*orto*-chlorinated congeners than in control kits, but the difference was not statistically significant. To sum up, the non- and mono-*ortho*-chlorinated congeners in Clophen A50 enhanced EROD activities in adults and kits, reduced vitamin A concentrations in adults, and reduced thymocyte numbers in kits. Effects of the synthetic mixture of 3,3',4,4'-tetra-,3,3',4,4',5-penta- and 3,3',4,4',5,5'-hexachlorobiphenyl were similar to those of the fraction from Clophen A50 containing non-*ortho*-chlorinated congeners, and it is probable that the three coplanar congeners in the synthetic mixture, together with certain mono-*ortho*-chlorinated congeners, were largely responsible for the effects of Clophen A50 observed in this study.

Pharmacology & Toxicology 69, 421-426, 1991. 3 tables, 4 refs. Authors' abstract.

Effect of iodine on reproductive performance of female mink

R.J.Aulerich, R.K. Ringer, G.R. Hartsough

Unexpected early kit losses on mink ranches have aroused suspicion concerning the possible toxic effects of excessive dietary iodine on mink reproduction and kit survival.
Iodine is a major constituent of many disinfectants, some of which are recommended for control of the spread of Aleutian disease and for sanitizing mink nest boxes, cages and equipment. Injudicious use of such products, especially during the mink's reproductive period, could result in exposure of mink to iodine, which may have adverse effects on their reproductive performance.

When mink are compared with other species in sensitivity to supplemental dietary iodine, they appear to be among the more sensitive species. Two hundred fifty to 1000 ppm iodine fed to rabbits for 2 to 5 days during the latter portion of gestation caused increased mortality in newborns, while 2500 ppm dietary iodine resulted in only a slight reduction in feed intake and reduced weaning weights in hamsters and had no toxic effects on swine.
Because of the apparent sensitivity of mink to iodine, as shown by the consequences of adding supplemental iodine to the diet, ranchers should be aware of the potential implications of iodine toxicity. From the results of this study, it would appear that the use of iodine-containing disinfectants during the whelping period at the recommended level has no detrimental effects on reproductive performance. It is hoped that the further investigations of the effects of dietary iodine on mink will provide greater knowledge and insight on this subject.

Research report from the Michigan State University Agricultural Experiment Station, East Lansing, p. 73-78, 1991. 3 tables, 8 refs. Part of authors' text.

Cadmium, lead and mercury in hair from Danish otters *lutra lutra*

A.B. Madsen, C.F. Mason

Hair samples from 52 speciments of otters, found dead in Denmark between 1979 and 1986 inclusive, were analyzed for cadmium, lead and mercury. Mean concentrations (dry weight) were 0.77 mg Cd kg^{-1}, 1.28 mg Pb kg^{-1} and 2.38 mg Hg kg^{-1}, all lower than for a sample of otters from Great Britain. Current concentrations of these metals in Danish otters are unlikely to have toxicological significance.

Natura Jutlandica, Vol. 22 (3), p. 81-84, 1987. 1 table, 10 refs. Authors' abstract.

Metabolic rate and evaporative water loss at different ambient temperatures in two species of fox: the red fox (*Vulpes vulpes*) and the arctic fox (*Alopex lagopus*)

J.J. Klir, J.E. Heath

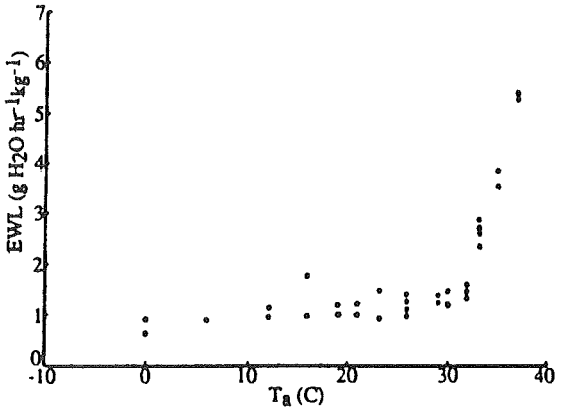


Fig. 3. Evaporative water loss (EWL) vs ambient temperature (T_a) in the red fox (*Vulpes vulpes*)

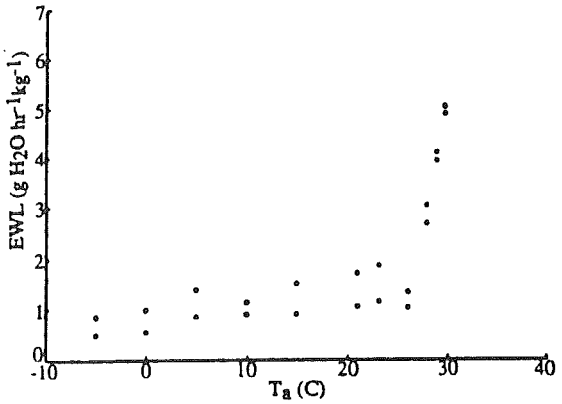


Fig. 4. Evaporative water loss (EWL) vs ambient temperature (T_a) in the arctic fox (*Alopex lagopus*)

1. Resting metabolic rate (RMR) and evaporative water loss (EWL) of adult red and arctic foxes were determined over ambient temperature (T_a) ranges of -13-37°C and -5-30°C as

oxygen consumption and amount of water in expired air using an open flow system.
2. The average RMR was 2.60±0.14 W/kg for the winter red fox, 2.59±0.14 W/kg for the summer red fox, and 2.35±0.11 W/kg for the winter arctic fox.
3. The rate of increase of RMR was significant ($P<0.05$) only for T_a range above 27°C. The slopes for this T_a range were 0.152 for the winter red fox, and 0.283 for the winter arctic fox.
4. The upper critical temperature (T_{uc}) of the red fox is probably between 30 and 32°C. The T_{uc} of the arctic fox is probably between 26 and 28°C. The lower critical temperatures (T_{lc}) were not reached.
5. A strong linear relationship between the EWL and T_a was found for T_a range above 27°C. The slopes for this T_a range were 0.523 for the winter red fox, and 1.025 for the winter arctic fox.
6. Probably, there are neither significant intraspecific seasonal nor interspecific differences in the RMR and EWL. The two species seem to differ only in their critical temperatures.

Comp. Biochem. Physiol. Vol. 101A, No. 4, pp. 705-707, 1992. 3 tables, 4 figs., 12 refs. Authors' abstract.

Physiological responses of red foxes (*Vulpes vulpes*) to surgery

T.J. Kreeger, U.S. Seal, J.R. Tester, M. Callahan, M. Beckel

Radio transmitters were surgically implanted into the abdomens of red foxes (*Vulpes vulpes*). Blood samples were taken before, immediately after, and 8 hr after surgery and analyzed for hormonal, biochemical, electrolyte and hematologic changes. Samples were taken at the same times from control foxes. Adrenocorticotropin increased after surgery ($P<0.05$), but returned to pre-surgery values after 8 hr. Cortisol increased and remained elevated in the surgery group relative to pre-surgery values or to control values ($P<0.05$); Triiodothyronine and tryroxine both decreased from post-surgery values 8 hr later ($P<0.05$). Creatine kinase, total bilirubin and aspartate aminotransferase increased after 8 hr in both surgery and control groups ($P<0.05$). Carbon dioxide increased under anesthesia in both groups, but returned to initial values after 8 hr ($P<0.05$). The white blood cell count increased after 8 hr only in the surgery group ($P<0.05$). There were no differences between the groups for any value obtained from the initial blood sample. These data indicate that abdominal surgery results in prolonged adrenocortical activity and decreased thyroid hormone levels, but otherwise has minimal systemic effects in red foxes.

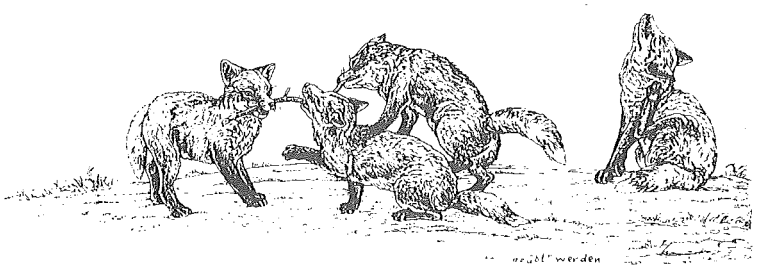
Journal of Wildlife Diseases, 26 (2), pp. 219-224, 1990. 1 table, 29 refs. Authors' abstract.

Feeding levels. Trials on the effect of feeding during implantation on whelping results and kit performance during lactation

R. Sandø Lund

From 26 Mar. to 9 Apr., 198 mated mink females were fed a restricted diet (170 kcal), and 141 females were fed ad lib., (250 kcal). In the 2 groups resp., the incidence of females which failed to give birth to a litter was 10.1 and 11.5%, litter size averaged 6.33 and 5.91 at birth and 6.01 and 6.55 at weaning, and the number of kits produced per mated female averaged 5.40 and 4.89. In a 2nd trial, 5 groups, each of 112 females were fed ad lib. or diets restricted by 5, 10, 20 or 30% from 26 Mar. to 10 Apr., and 3 groups, each of 330 females, received diets restricted by 0, 8 or 14%. There were no significant differences between the groups in the percentage of females producing a litter or in litter size at birth or weaning. It was concluded that the flushing of mink females during implantation does not improve their reproductive performance.

Dansk Pelsdyravl, 55 (3), p. 143, 1992. In DANH. 3 tables. CAB-abstract.



Original Report

Dual infection with Aleutian Disease Virus and Distemper Virus in mink

J.M. Nieto, M.L. Peña, S. Vázquex, R-F. Antonio, M.I. Quiroga

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Facultad de Veterinaria. E-27002 Lugo, Spain

Summary

Our study describes the histopathological, immunocytochemical findings and the criteria for morphologic and immunohistochemical diagnosis of a dual natural infection caused by Aleutian Disease Virus and Distemper Virus in mink. Lesions of progressive Aleutian disease were histologically identified in 2 mink with a clinical history of acute respiratory distress, thickness and hyperkeratosis of the foot pads. Besides those lesions intersititial pneumonia and inclusion bodies in epithelial cells were found. The Avidin-Biotin peroxidase technique using a monoclonal antiserum against the Distemper Virus nucleocapsid identified a systemic Distemper infection.

Introduction

Aleutian Disease (AD) of mink is a chronic viral infection caused by a Parvovirus (*Porter et al., 1968; Bloom et al., 1975*) which is responsible for important economic losses in mink farms (*Porter et al., 1980*).

The AD virus is present in the saliva, faeces and urine of infected animals (*Kenyon et al., 1963; Gorham et al., 1964*) and is horizontally transmitted to other mink through contaminated feed and utensils (*Gorham et al., 1964*) or vertically via the transplacental route (*Osburn, 1973; Porter et al., 1977*).

The infection by the AD virus is generally characterized by a marked hypergammaglobulinemia and systemic plasmacytosis, accompanied by different lesions caused by circulating immunocomplexes such as glomerulonephritis, arteritis and uveitis (*Müller-Peddinghaus et al., 1983; Hadlow, 1982*). The neonatal infection develops a different form of disease with interstitial pneumonia, and presence of inclusion bodies in type II pneumocytes (*Alexandersen, 1985; Larsen et al., 1984*).

Distemper in mink is caused by a *Morbillivirus* (DV) which is transmitted by aerosoles. DV in a first infection phase infects the tonsils and the bronchial and retropharyngeal lymph nodes and later is transported by blood macrophages to

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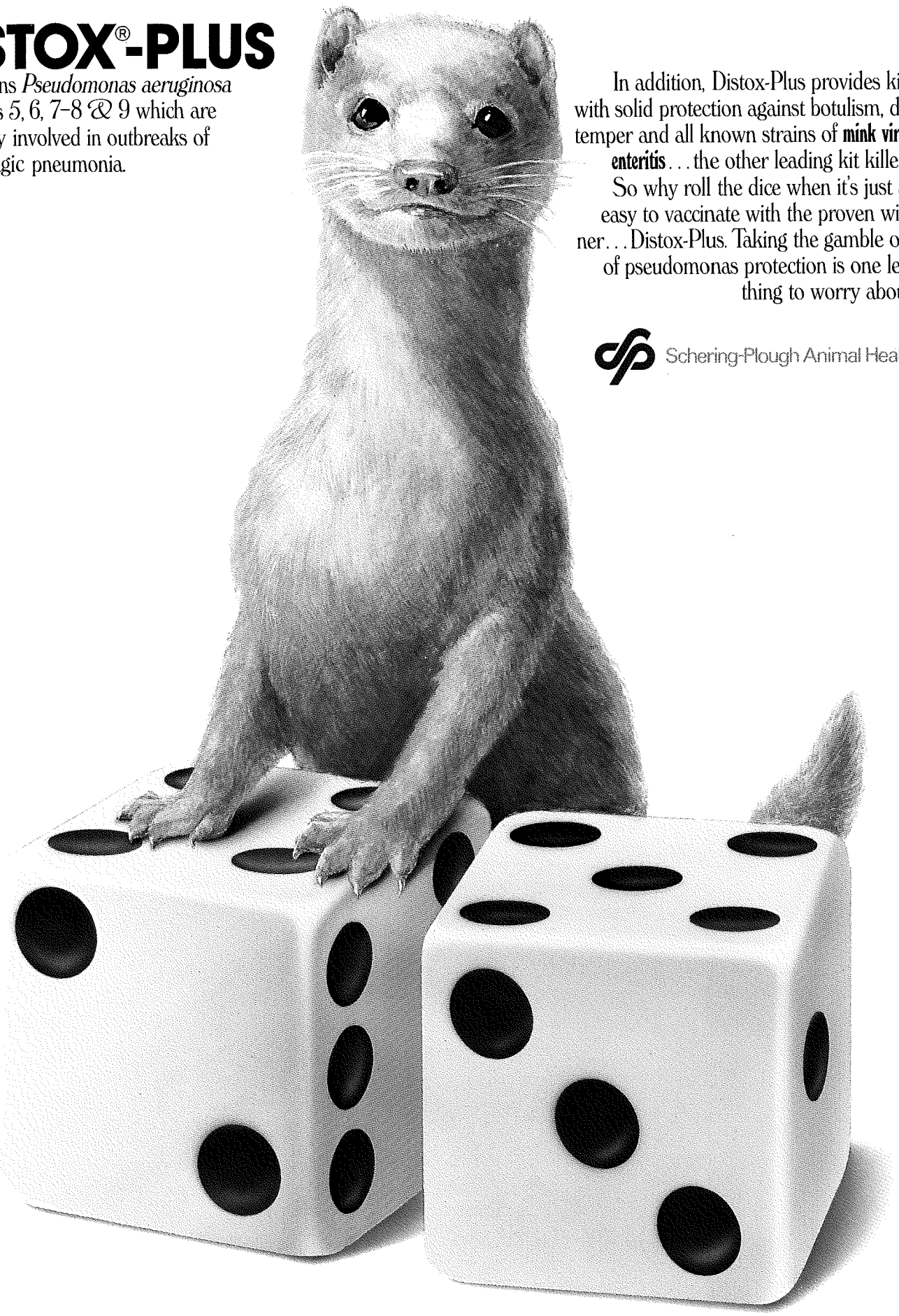

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other lymphoid organs, bone marrow, epithelial cells and nervous system (*Appel, 1969*). The chronic form of DV infection is characterized by demyelinizating encephalitis (*Vandevelede et al., 1982; Blakemore et al., 1989*).

Distemper virus in mink was first described in 1930 (*Appel, 1969*) and later confirmed by several authors (*Bindrich et al., 1957; Blixenkrone-Møller, 1989*).

Dual infections, nonprogressive-AD/DV, have been observed by Hansen on Danish farms (*Gorham, 1976*) with a high number of deaths due to distemper. The same author (1976) describes the difficulty of immunizing AD-infected mink against the DV due to the depression of the immune system caused by the AD virus and to the fact that mortality in unvaccinated AD mink is higher than in healthy animals.

In spite of that, dual infections in AD-infected mink are well known. There are no references about the morphopathology of them. Our study describes the histopathological, immunocytochemical findings and the criteria for morphologic diagnosis of a dual natural infection - progressive AD and Distemper - observed in 2 mink during a distemper epizootic in 1987 in the mink farms in NW Spain.

Material and methods

Two female mink of the standard variety, 7 and 8 months old respectively, were sent for diagnosis with a clinical history of acute respiratory disease and thickness and hyperkeratosis of the foot pads. The animals came from an AD-infected farm diagnosed by the counter immune electrophoresis test and were vaccinated against DV according a routine health programme. When the animals were sent to our Service an episode of epizootic distemper was diagnosed in a mink farm in the NW of Spain were the farm was situated (*Nieto et al., 1992*). After the necropsy, the samples of lung, trachea, stomach, intestine, spleen, lymph nodes, liver, kidney, and brain were fixed in 10 per cent buffered formalin. The samples were embedded in paraplast according to the usual standard histopathological techniques. The 4 micron-thick sections were stained by the Hematoxylin-Eosin, Giemsa and Silver-methenamine techniques. The immunolabelling of the samples was done by the Avidin-Biotin Peroxidase complex (ABC) (*Hsu et al., 1981*) using a monoclonal antiserum (*Orvell et al., 1985*) against the DV nucleocapsid.

Results

Necropsy findings. At the necropsy the animals were thin and showed mucopurulent secretions from the nose and hyperkeratosis of the foot pads. The kidneys were small and presented multiple whitish foci; the surface of the liver was irregular and the lungs had a homogenous pale pinkish colour with an elastic consistency.

Microscopic findings. Focal accumulations of plasma cells in the interstitium of the kidney (fig. 1), in portal spaces and hepatic parenchyma next to plasmacytosis of the lymph nodes and spleen were histologically observed; bile duct proliferation was also observed. The renal glomeruli presented a diffuse glomerulonephritis with deposits of argentophilic material in one case, and proliferation of mesangial cells (fig. 1) in the other. The brain showed lesions of focal encephalomalacia and perivascular lymphocytic infiltrations. Occasionally, eosinophilic inclusion bodies were seen in the epithelium of the renal pelvis and urinary bladder and trachea of one animal. The lungs of both mink presented interstitial pneumonia lesions, with enlargement of the interalveolar wall and free alveolar macrophages.

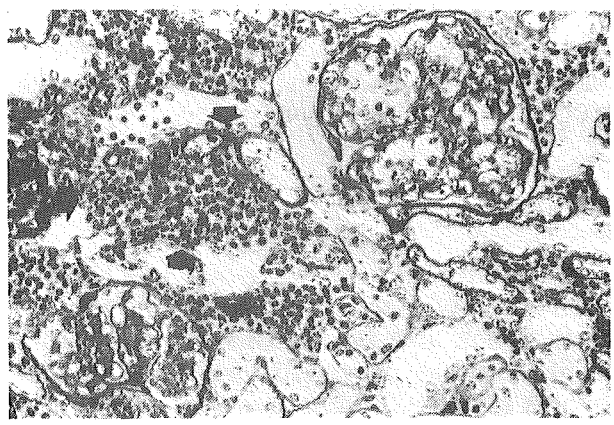

Fig. 1. Interstitial plasmacytosis (arrows) and diffuse glomerulonephritis with proliferation of mesangial cells. Silver methenamine 200X.

Immunohistochemical findings. Our immunoperoxidase technique was positive, staining virus antigen in the epithelium of the stomach, small intestine (fig. 2), renal pelvis, urinary bladder

(fig. 3), ependymal cells, neurons, epithelium of the respiratory tract and macrophages.

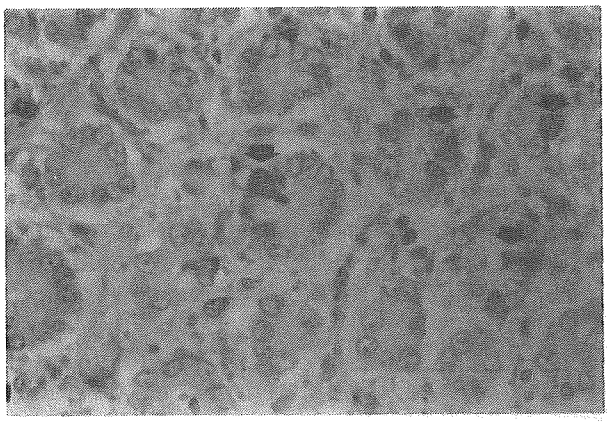

Fig. 2. Small intestine. Positive staining for DV antigen of the epithelial cells using the ABC technique (arrows) 400X.

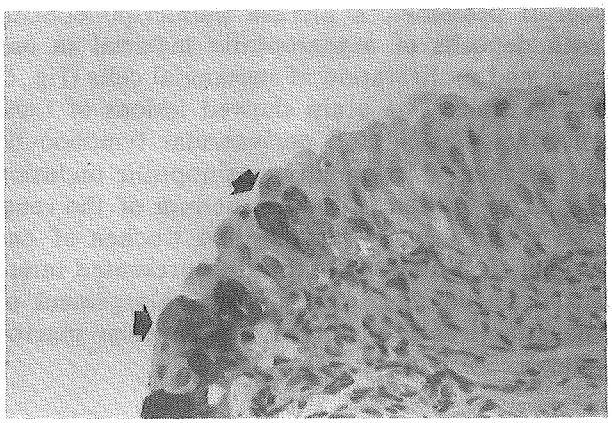

Fig. 3. Urinary bladder. Positive staining for DV antigen of the transitional epithelium using the ABC technique (arrows) 400X.

Discussion

The diagnosis of progressive-AD was based on observation of systemic plasmacytosis, bile duct proliferation and glomerulonephritis, according to observations previously described by other authors (*Müller-Peddinghaus et al., 1983; Nieto et al., 1991; Porter et al., 1980; Trautwein, 1964*). Necrotic arteritis were not seen in the mink studied. The appearence of this lesion determines an acute clinical course with death of the animals generally by internal hemhorragies (*Müller-Peddinghaus et al., 1983*).

The identification of the lesions in the respiratory tract allows us to do a differential diagnosis between the interstitial pneumonia caused by distemper and those caused by other agents, although its interpretation is sometimes difficult using routine techniques (*Fairchild et al., 1967; Ducatelle et al. 1980*). The neonatal infection by the AD virus produces an interstitial pneumonia with inclusion bodies in pneumocytes type II (*Larsen et al., 1984*). However, the age of the animals sent to our service, 7 and 8 months respectively, and the existence of characteristic lesions of progressive AD allowed us to quickly reject this possibility. In our study small, refringent eosinophilic inclusions were identified occasionally in some epithelia in one animal, but their nature was not definitely determined until we performed the immunolabel of the DV.

The final diagnosis of the infection by DV was done by immunolabelling with a monoclonal antiserum. The appearance of positive reactions in numerous localities of both animals allowed us to identify distemper as a systemic form.

Vaccination against DV infection is a habitual practice in mink farms and, because of that, it is not frequent. In the cases we have cited, the infection was developed in vaccinated mink and could be explained as consequence of the modification of the immune system in mink caused by AD (*Gorham, 1976; Hansen et al., 1976*).

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Virus infections in mink (greasy kits)

Vilhjálmur Svansson

New doctor in the family. We congratulate Dr. Vilhjálmur Svansson with the new title and wish him good luck in the future.

Chapter 1:
Introduction: Review on the occurrence of viruses in mink

A short review is given on the presently known virus infections of mink. The family relationships among these viruses are described and their morphological characteristics, stability, habitat and importance in other species.

Chapter 2:
Electron microscopic investigations of faecal samples collected from mink farms with "greasy kits"

The syndrome "greasy kits" of mink is described. The publications dealing with possible infectious agents, histopathological findings and possible predisposing factors are dealt with. Virus-like particles were demonstrated by electron microscopic investigations of faecal samples from herds with outbreaks of "greasy kits". The morphological structures of the particles indicated that they belonged to 3 different virus families: reoviridae, caliciviridae and coronaviridae.

Chapter 3:
Characterization of mink reovirus (MRV) isolated from "greasy kits"

From a faecal example which by EM examinations was shown to contain reovirus-like particles a cytopathogenic agent was isolated in a rhesus monkey kidney cell line (MA-104 cells). This isolate reacted in immunofluorescencse test (IFA) with various polychlonal reovirus antibodies. In addition, reactivity was demonstrated between a reovirus serotype 3 specific monoclonal antibody and the isolate. SDS-PAGE analysis demonstrated the presence of 10 ds RNA segments. Pretreatment with trypsin before inoculation of MA-104 cells and the employment of trypsin before inoculation of MA-104 cells and the employment of trypsin in the maintenance medium improved the virus yield with about 3-4 log units. Virus cultivated in a medium containing trypsin had a specific gravity of 1.40 - 1.41 g/ml. Based on the serological and physical-chemical examinations the virus was considered to belong to the genus reovirus within the reoviridae family.

Chapter 4:
Characterization of mink calicivirus (MCV) isolated from "greasy kits"

By EM investigations of faecal samples from mink kit 42-46 nm particles were demonstrated, that had a characteristic calicivirus structure. Virus isolations were attempted with positive results in mink lung cells when faecal samples containing calicivirus-like particles were inoculated. The cytopathic effects obtained looked like the ones described for other members of the caliciviridae. The cell culture cultivated virus was 37-40 nm in diam. Further investigations of the isolated virus showed a specific gravity of 1.370 - 1.375 g/ml in CsCl-gradients for complete particles, 67 kD size of a structural polypeptide and at least 3 non-structural polypeptides. Based on these morphological and physochemical observations the virus isolate was considered to be a mink calicivirus (MCV). A serum sample from a rabbit immunized with feline calicivirus (FCV) showed reactivity with MCV in IFA and Western blots. No reactivity was demonstrated with FCV in Western blots and MCV-ELISA when tested against mink calicivirus positive serum samples.

Chapter 5:
Preliminary attempts to infect mink: Neonatal mink kits were inoculated with faecal suspensions containing mink reovirus (MRV) and mink calicivirus (MCV)

Four litters of 2-day old mink were inoculated with supernatants from faecal suspensions containing reovirus-like and calicivirus-like particles. The kits in one of the litters had pronounced enteric symptoms and were severely greasy. In faecal samples from the kits co-infections were found with two different PAGE-types of serotype 3 reovirus and of calicivirus. In another inoculated litter the excretion of reovirus with faeces was followed. The virus excretion with faeces lasted 15 days. Maximum virus titer ($>10^{12}TCID_{50}$ per g faeces) was demonstrated on the eight day after inoculation.

Chapter 6:
Experimental infection of neonatal mink kits with mink reovirus (MRV)

Two-day old mink kits, inoculated with serotype 3 reovirus from mink, developed in general mild diarrhea. Faeces became yellowish coloured and had a creamy consistency. The diarrhea lasted for about a week. A mild degree of greasiness was noted in connection with the enteric symptoms. The kits of one of the inoculated litters developed clinical greasiness in connection with diarrhea which was more severe than in the other litters. Histological examination of the intestine from inoculated kits showed only weak changes. Viral antigen wad demonstrated in a few epithetical cells in the upper half of the intestinal villi. Reovirus was isolated from day 1 after inoculation and for the following 2-3 weeks. Depending on the inoculation dose and the level of reovirus antibodies in serum samples from the dams, differences were demonstrated in the development of reovirus antibodies in serum samples from inoculated mink kits and their dams. From the results obtained it was concluded that serotype 3 infections in general probably had milder clinical manifestations in neonatal infections.

Chapter 7:
Experimental infection of neonatal mink kits with mink calicicirus (MCV)

Mink kits either 2-3 or 7-8 days old born of MCV serum positive dams were inoculated with cell culture cultivated mink calicivirus. No clinical symptoms were observed in the kits that were inoculated when 2-3 days old. Two separate periods of diarrhea were observed in the kits inoculated when one week old. In these kits marked histopathological changes were demonstrated in sections of the intestine. Fusion and shortening of intestinal villi were also observed. No increase in calicivirus specific antibodies were shown in the inoculated kits. Calicivirus was not isolated from faeces and viral antigen was not demonstrated in sections from the intestinal tract of kits with diarrhea. Thus calicivirus ethiology of the clinical symptoms and the histopathogenic changes of the intestine could not be confirmed.

Chapter 8:
Examinations of the occurrence of reovirus in mink: Viral isolation, characterization and serological investigations

Reovirus was found with high prevalence in herds with outbreaks of "greasy kits". Faecal samples were examined by means of EM and reovirus isolation in MA-104 cells.
The isolation method was found more sensitive then EM. Out of 70 faecal samples 4 were found positive by EM examination and 20 by viral isolation.
In herds where faecal samples were collected from both healthy and "greasy kits" there was a tendency to higher prevalencve of reovirus in affected kits.
Nine dams and their litters were observed in the lactation period. In serum and colostrum samples from 8 out of 9 of the dams, reovirus specific antibodies could be demonstrated. Maternal protection against reovirus seemed to be of short duration, since reovirus could be isolated from their offspring on day 16 post partum.
When faecal samples from 2 herds with outbreak of mink enteritis virus (MEV) were examined by viral isolation, 16 out of 28 sample were reovirus positive. It was concluded that clinical symptoms often are more severe when reovirus infections occur simultaneously or secondary to infections with MEV.
High prevalence of reovirus antibodies were found in mink older than 7 months in 4 different herds. The majority of the mink seemed to contract reovirus infections in the first year of life.
All known mammalian serotypes of reovirus could be isolated from mink. Eighteen out of 22

reovirus isolates from 13 herds belonged to serotype 3. By SDS-PAGE analyse of genomic dsRNA from these 18 serotype 3 isolates, 4 different electrophoresis types (PAGE-types) were demonstrated. Three serotype 2 isolates were shown to have identical PAGE-type. A serotype 1 isolate had different PAGE-type from serotype 2 and 3 isolates. Some of the PAGE-types were widely spread among Danish mink herds.

Chapter 9:
Summarized discussion and conclusion on reovirus and calicivirus in mink

A review is given on the described prevalence and pathological importance of reovirus and calicivirus infections in mink. Possible causalities of various gastroenterial affections are discussed. Further, the importance of co-infections in the neonatal period with reovirus and calicivirus to provoke the syndromes "greasy kits" is discussed.

Chapter 10:
Sero-epidemiological investigations on the prevalence of morbillivirus antibodies in blood samples from different marine mammals

Blood samples from populations of seals and whales living in the North-Atlantic Ocean were tested for the presence of morbillivirus antibodies by various serological methods. The routes of PDV infection and changes in pathology are discussed. From serological studies on seal populations carried out by us and others, we propose a spread of PDV infections from seals on the east coast of North America in 1981, eventually leading to an outbreak among mink herds in Denmark in 1989.

Chapter 11:
Experimental infection of harbor seal (*Phoca vitulina*) with canine distemper virus

In an attempt to elucidate some of the routes of infection, young seals of the harbor seal were inoculated with a distemper virus strain that was virulent for dogs and mink. The inoculated seals showed clinical symptoms which to some degree were similar to the ones that are observed in distemper virus infections of sensitive species of carnivores. Viral replication in lymphoid tissues was observed and followed by an extended period of immunosuppression. In inoculated seals distemper virus antigen could not be demonstrated in surface epithelial cells. An increase in distemper specific antibodies could be demonstrated in the inoculated seals by means of various serological methods. No spread of infection to contact seals and mink was demonstrated. Changes in the haemagglutinin protein were demonstrated with a panel of anti-canine distemper virus and anti-phocid distemper virus monoclonal antibodies. From our investigations it was concluded that the harbor seal is apparently not especially sensitive for infections with distemper virus. Maybe a number of passages of virus are required before the virus is adapted to the harbor seal.

Chapter 12:
Examination of the humoral antibody response in seal and mink after natural and experimental infections with canine distemper virus and phocid distemper virus

Serum samples from seal and mink infected with canine or phocid distemper virus were examined employing various serological methods. Inhibition ELISA was employed with various monoclonal peroxidase marked anti-canine/phocid distemper virus antibodies. The results of these ELISA tests indicate that it was possible to distinguish between antibodies produced by infections with PDV/PDV-like virus and by CDV. In the same way it seemed possible to distinguish between positive serum samples against PDV and PDV-like virus.
An examination of a much larger number of serum samples would, however, be necessary to support this impression.

Thesis. Royal Vet. and Agric. Univ. Denmark. In DANH. Su. ENGL. 21 tables, 38 ill., 275 refs. Author's summary.

Emergence, natural history, and variation of canine, mink, and feline parvovirus

Colin R. Parrish

During 1978 a new parvovirus of dogs was recognized simultaneously as the cause of new diseases of dogs throughout the world, and within 2 years had spread into and infected almost every population of domestic and wild dogs which has been examined. This review examines the emergence of canine parvovirus, the evidence concerning the previous emergence of mink

enteritis virus as the cause of a new disease in mink in the 1940s, and the mechanisms which determine the host ranges and other specific properties of the viruses of cats, mink and dogs. It is concluded that these parvoviruses present a unique opportunity for understanding the natural evolution and variation of viruses and for determining the ways in which viruses can gain new host range and other functions. It is suggested that mink enteritis virus and canine parvovirus emerged by 2 different mechanisms as pathogens of the members of Mustelidae and Canidae which had previously been resistant to infection of disease.

Advances in virus research, Vol. 38, 403-450, 1990. CAB-abstract.

Coronavirus infection in mink (*Mustela vison*). Serological evidence of infection with a coronavirus related to transmissible gastroenteritis virus and porcine epidemic diarrhea virus

P. Have, V. Moving, V. Svansson, Å. Uttenthal, B. Bloch

Antibodies to a transmissible gastroenteritis virus (TGEV)-related coronavirus have been demonstrated in mink sera by indirect immunofluorescence, peroxidase-linked antibody assays and immunoblotting. This is the first serological evidence of a specific coronavirus infection in mink. The putative mink coronavirus (MCV) seems to be widespread in the Danish mink population with a prevalence approaching 100%. Analysis by immunoblotting has shown that MCV is closely related to TGEV by the spike (S), matrix (M), and nucleoprotein (N) polypeptides. Furthermore, antibodies to MCV also cross-reacted with N and M polypeptides of porcine epidemic diarrhea virus (PEDV). Thus MCV may occupy an intermediate position between the TGEV group of coronaviruses and PEDV. The possibility that MCV may be associated with syndromes of acute enteritis in preweaning mink is discussed.

Veterinary Microbiology, 31, 1-10, 1992. 3 tables, 3 figs., 18 refs. Authors' abstract.

Serological (Em2-ELISA) and parasitological examinations of fox populations for *Echinococcus multilocularis* infections

B. Gottstein, P. Deplazes, J. Eckert, B. Müller, E. Schott, O. Helle, P. Boujon, K. Wolff, A. Wandeler, U. Schwiete, H. Moegle

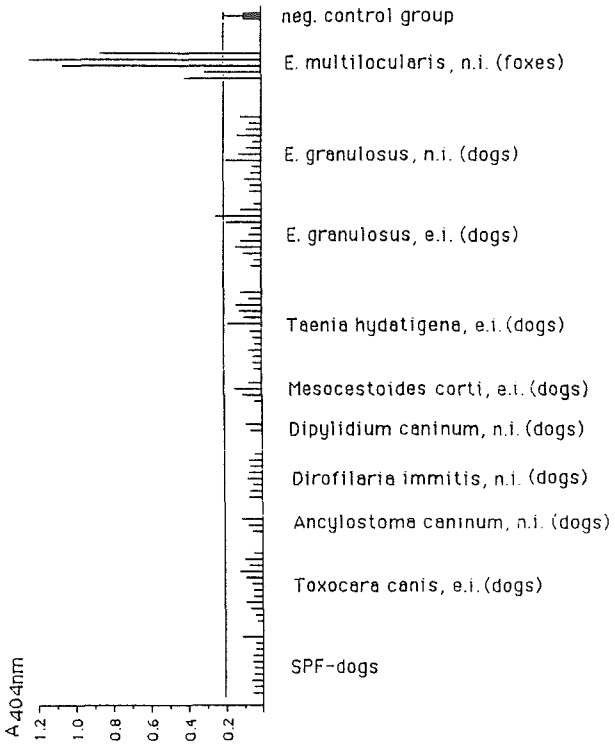

Fig. 1. Determination of anti-Em2 antibody concentrations by ELISA in serum from carnivores infected with various helminth species. The cut-off point is indicated on the far right side by the mean $A_{404\ nm}$ value plus 4 SD of serum of 60 dogs with no *E. multilocularis* infection, the cut-off line being further drawn to the left for easier interpretation of the figure. n.i.: natural infection; e.i.:experimental infection

Serum or body fluid samples of 1,006 foxes were investigated in an ELISA for antibodies against a highly sensitive and specific antigen (Em2-antigen) of *Echinococcus multilocularis*. Parasitological examinations of the intestines and simultaneous serological examinations were carried out in 505 foxes: A group of 98 blue foxes

(*Alopex lagopus*) from Norwegian fox farms did not contain intestinal stages of *E. multilocularis* and was clearly sero-negative in Em2-ELISA. On the other hand in red foxes (*Vulpes vulpes*) originating from European areas known to be endemic for *E. multilocularis* the following average prevalence rates were found: 244 foxes from Southern Germany, *E. multilocularis* prevalence 55% and sero-prevalence 60%; 139 foxes from Austria, *E. multilocularis* prevalence 4% and sero-prevalence 12%.Serological identification of individual foxes with or without intestinal *E. multilocularis* infection was not possible. Only serological (no parasitological) examination in 402 foxes originating from endemic areas in Switzerland resulted in a sero-prevalence rate of 37%. Sero-prevalence was only 6% and 4% in 54 and 26 other foxes, respectively, originating from Swiss and German areas where *E. multilocularis* has not yet been reported. Negative control Norwegian (farmed) silver foxes (n=43) were all sero-negative. The specificity of the Em2-ELISA was confirmed by negative Em2-serologies with sera from dogs infected with intestinal and tissue dwelling helminth species (with the exception of two from 24 dogs infected with *E. granulosus*). The results indicate that although a diagnosis of intestinal *E. multilocularis* infection in individual foxes is not feasible by serological examination, the Em2-ELISA might be of value for the identification and discrimination of fox populations with or without *E. multilocularis* infection, reflecting a relative parasite prevalence rate in such populations.

J. Vet. Med. B 38, 161-168, 1991. 2 tables, 1 fig., 22 refs. Authors summary.

Identification of Aleutian mink disease parvovirus transcripts in macrophages of infected adult mink

H. Kanno, J.B. Wolfinbarger, M.E. Bloom

We examined Aleutian mink disease parvovirus (ADV) mRNA expression in lymph nodes of adult mink infected with ADV by Northern (RNA) blot and in situ hybridization. In Northern blot analysis, ADV transcripts were deteced in the poly(A) RNA fraction extracted from mesenteric lymph nodes of two of five mink 10 days after intraperitoneal inoculation with the virulent Utah I strain of ADV. In strand-specific in situ hybridization, ADV DNA an dMRNA were detected in some macrophagelike cells located in the medullary sinus in mesenteric lymph node sections from two of six infected mink by using biotinylated probes. In suspensions of lymph node cells, about 30% of the cells phagocytic for latex particles contained ADV DNA and about 1% of these cells contained ADV mRNA. In peritoneal exudate cells, about 20% of the macrophagelike cells contained ADV DNA and about 2% of these cells contained ADV mRNA. These results indicated that some macrophages in ADV-infected mink contained ADV mRNA and were target cells in ADV infection.

Journal of Virology, Vol. 66, No. 9, 5305-5312, 1992. 5 figs., 35 refs. Authors' summary.

Glomerular lesions in Aleutian disease of mink (*Mustela vison*): A morphological and differential morphometrical study

J.M. Nieto, C. Alvarez, J.M. Flores, J. Romano

A morphological and morphometrical study has been carried out on glomerular lesions in mink with spontaneous Aleutian disease, using the WHO classification for Systemic Lupus Erytematous Nefritis. 154 renal samples from sick animals and 10 samples from uninfected mink were processed by routine histopathological techniques and metacrylate inclusions. The samples were studied quantitatively with an automatic image analyzer. 5 forms of glomerulonephritis (GN) were identified: mesangial glomerulonephritis (n=13), focal and segmental GN (n=10), diffuse GN (n=99), membranous GN 8n=12) and advanced sclerosing GN (n=10) and were associated with the degree of interstitial plasmocytosis. Glomerule morphometry was shown to be an excellent method for identifying the type of lesion, while it quantified the participation of various glomerular elements in the lesion.

Histology and histopathology 6 (2), 141-148, 1991. 4 tables, 5 figs., 26 refs. Authors' summary.

Extraglomerular lesions in kidneys of mink with encephalitozoonosis

Zhi-yong Zhou, Knut Nordstoga, Inge Bjerkås

Extraglomerular renal lesions were studied by light and electron microscopy in 13 farmed mink which showed cataractous eyes associated with spontaneous encephalitozoonosis. The extraglomerular renal lesions consisted of multiple renal systs, multifocal-to-coalescing interstitial nephritis and vasculitis. Tubular cysts of varying size were present in the corticomedullary junction and medulla. The inflammatory infiltrates were composed mostly of lymphocytes and plasma cells and usually accompanied an interstitial fibrosis. Vasculitis, perivasculitis and sclerotic arteries were frequently seen.

Acta vet. scand, 33, p. 33-41, 1992. 8 figs., 24 refs. Authors' abstract.

Brain and spinal cord lesions in encephalitozoonosis in mink

Inge Bjerkås

Central nervous system lesions were studied by light microscopy in 43 farmed mink, aged 5 months to 2 1/2 years, with spontaneous encephalitozoonosis and showing cataractous eye changes. Lesions were found in the brain and spinal cord of all animals examined but were generally mild and chronic. The lesions were consistent with those previously described in spontaneous encephalitozoonosis in other carnivores. Parasites in parasitophorous vacuoles and free or phagocytosed in necrotic and granulomatous lesions were demonstrated in animals aged 5 months to 1 year. The occurrence of arterial lesions of the polyarteritis nodosa type found in the youngest animals probably indicates fetal infection. In animals aged 1 1/2 and 2 1/2 years active lesions were usually lacking and the changes were characterized by arterial slerosis, sometimes with aneurysmal formations, small perivascular lympho-plasmacytic cuffings and focal gliosis.

Acta vet. scand. 31, p. 423-432, 1990. 1 table, 11 figs., 21 refs. Author's abstract.

Biochemical and physical properties of the prion protein from two strains of the transmissibel mink encephalopathy agent

Richard A. Bessen, Richard F. March

Transmissible mink encephalopathy (TME) has been transmitted to Syrian golden hamsters, and two strains of the causative agent, HYPER (HY) and DROWSY (DY), have been identified that have different biological properties. During scrapie, a TME-like disease, an endogenous cellular protein, the prion protein (PrP^{C}), is modified (to PrP^{Sc}) and accumulates in the brain. PrP^{Sc} is partially resistant to proteases and is claimed to be an essential component of the infectious agent. Purification and analysis of PrP from hamsters infected with the HY and DY TME agent strains revealed differences in properties of PrP^{TME} sedimentation in *N*-lauroylsarcosine, sensitivity to digestion with proteinase K, and migration in polyacrylamide gels. PrP^{C} and HY PrP^{TME} can be distinquished on the basis of their relative solubilities in detergent and protease sensitivities. PrP^{TME} from DY-infected brain tissue shared solubility characteristics of PrP from both uninfected and HY-infected tissue. Limited protease digestion of PrP^{TME} revealed strain-specific migration patterns upon polyacrylamide gel electrophoresis. Prolonged proteinase K treatment or N-linked deglycosylation of PrP^{TME} did not eliminate such differences but demonstrated the PrP^{TME} from DY-infected brain was more sensitive to protease digestion than HY PrP^{TME}. Antigenic mapping of PrP^{TME} with antibodies raised against synthetic peptides revealed strain-specific differences in immunoreactivity in a region of the amino-terminal end of PrP^{TME} containing amino acid residues 89 to 103. These findings indicate that PrP^{TME} from the two agent strains, although originating from the same host, differ in composition, conformation, or both. We conclude that PrP^{TME} from the HY and DY strains undergo different posttranslational modifications that could explain differences in the biochemical properties of PrP^{TME} from the two sources. Whether these strain-specific posttranslational events are directly responsible for the distinct biological properties of the HY and DY agent strains remains to be determined.

Journal of Virology, Vol. 66, No. 4, 2096-2101, 1992. 4 figs., 39 refs. Authors' summary.

Identification of two biologically distinct strains of transmissible mink encephalopathy in hamsters

Richard A. Bessen, Richard F. March

Experimental transmission of the Stetsonville, Wisconsin, U.S.A. source of transmissible mink encephalopathy (TME) to outbred Syrian golden hamsters resulted in two distinct syndromes, termed hyper (HY) and drowsy (DY), that diverge by the third hamster passage. The syndromes differed with respect to clinical signs, incubation period, brain titre, brain lesion profile and pathogenicity in mink. HY hamster TME had an incubation period of 65±1 days and was characterized by clinical signs of hyperaesthesia and cerebellar ataxia. Lethargy and the absence of hyperexcitability or cerebellar ataxia were representative of DY hamster TME which had an incubation period of 168±2 days. At end stage, HY and DY infected animals had brain titres of $10^{9.5}$ LD_{50}/g and $10^{7.4}$ LD_{50}/g of tissue, respectively, indicating that the replication kinetics of these two strains is different. Hamster TME passaged back into mink revealed that only DY retained mink pathogenicity. This suggests that the DY agent is the major mink pathogen in the Stetsonville TME source that is also pathogenic in hamsters after a long incubation period. The HY agent is likely to be a minor component of the original TME mink brain that replicates more rapidly than DY agent in hamsters, but alone is non-pathogenic in mink. The presence of the HY and DY strains of agent that retain their biological characteristics on repeated hamster passage in the Stetsonville TME source requires that the informational molecule encoding these transmissible agents has the capacity to account for this biological diversity.

Journal of genera Virology 73, 329-334, 1992. 2 tables, 2 figs., 36 refs. Authors' summary.

Sarcoptic mange in red foxes and other wild carnivores in Norway

Gunnar Holt, Carl Berg

The spread of sarcoptic mange throughout Norway from the time it was first reported (1976) until 1986 is described. During this time sporadic cases were seen in pine martens (*Martes martes*), badgers (*Meles meles*) and lynx (*Lynx lynx*). The fox population has declined drastically, with a corresponding increase in species preyed upon, particularly hares (*Lepus timidus*), and predators that compete with foxes, particularly pine martens.

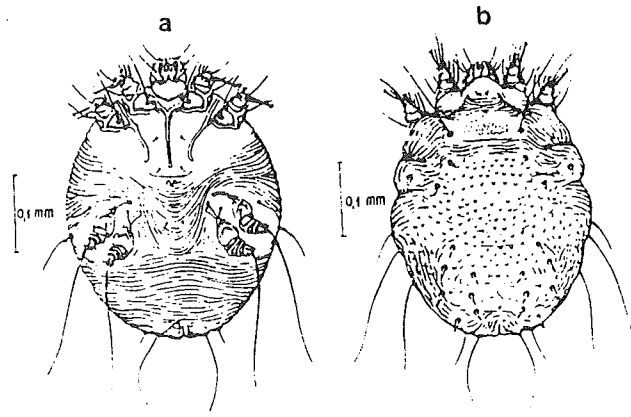

Fig. 1. Sarcoptes scabiei (♀) seen from the ventral (a) and dorsal (b) sides.

Norsk Veterinærtidsskrift, 102 (6), 427-432, 1990. 1 table, 2 figs., 12 refs. In NORW. CAB-abstract.

Rotaviral enteritis in a raccoon

A.N. Hamir, M. Morin, C.E. Rupprecht

A hand-reared raccoon (*Procyon lotor*) kit had severe diarrhea and died within 24 hr. Gross and histopathological findings were compatible with a diagnosis of viral enteritis. The immunoperoxidase test revealed rotavirus group A antigen in the intestinal mucosa. This is the first record of rotaviral enteritis in a raccoon.

Jorunal of Wildlife Diseases, 26 (2), 262-264, 1990. 2 figs., 4 refs. Authors' abstract.

Detection of IgM antibodies against canine distemper virus in dog and mink sera employing enzyme-linked immunosorbent assay (ELISA)

Merete Blixenkrone-Møller, Ib Rode Pedersen, Max J. Appel, Christian Griot

An enzyme-linked immunosorbent assay (ELISA) for the detection of IgM antibodies against canine distemper virus (CDV) in canine and mink serum is described. The diagnostic poten-

tial of this technique was evaluated by analyzing sera from natural or experimental infections in dog and mink and negative control sera. These results were compared with results obtained in the developed CDV IgG ELISA and in the virus neutralization test. The IgM test, which requires only a single serum specimen, is a useful method for diagnosing current or recent CDV infections in dog and mink.

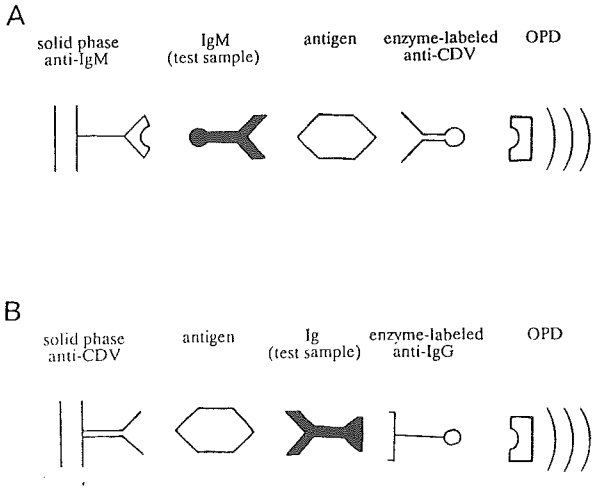

Fig. 1. Principles of ELISA for CDV IgM antibody detection (A) and CDV IgG antibody detection (B)

J Vet Diagn Invest 3, 3-9, 1991. 6 figs., 25 refs. Authors' abstract.

Antigenic relationships between field isolates of morbilliviruses from different carnivores

M. Blixenkrone-Møller, V. Svansson, M. Appel, J. Krogsrud, P. Have, C. Orvell

The antigenic relationships between PDV and isolates of morbilliviruses from distemper were investigated. Fourteen isolates, originating from terrestrial carnivores and harbour seals from 1985-1991 from Denmark, Norway, Greenland, and the U.S.A. were reacted in IFA and ELISA with monoclonal antibodies (MAbs) directed against four virion proteins (NP, P, F. and H). The MAbs comprised a newly completed panel of 36 anti-PDV MAbs and 39 previously developed anti-CDV MAbs. The antigenic make-up of the isolates separated them into the CDV prototype group and the PDV prototype group, having the antigenic characteristics of the reference vaccine strains of CDV and the Danish PDV isolate, respectively. The minor antigenic variations within the CDV group contrasted markedly to the differences encountered between the CDV and PDV group. The PDV group included isolates made in 1988 from diseased seals of Danish and Norwegian waters and isolates made in 1989 from distemper outbreaks in Danish mink farms. In contrast, the other distemper isolates investigated, including isolates from 1986 from a corresponding Danish mink farm, revealed the antigenic characteristics of CDV. Our results strongly indicate that PDV was recently transmitted from diseased seals to terrestrial carnivores causing distemper epizootics among farmed mink.

Arch Virol 123, 279-294, 1992. 2 tables, 4 figs., 39 refs. Authors' summary.

Histopathological, immunohistochemical and electron microscopic methods for the diagnosis of fox distemper infection

J.M. Nieto, L. Ferrer, S. Vidal, D. Fondevila, R. Fernández

Distemper virus (DV) is a Morbillivirus pathogenic for dogs, mink, foxes and others Mustelidae that produces different clinical diseases according to the strain of virus dose, susceptibility and immune response of the host (2, 3, 7). DV is highly transmissible and 20-80% of the infected animals die (1, 4)

DV - air-borne first multiplies in the lymphoid tissue and then spreads by the leukocytes 8-9 days post infectionem to the epithelial and nervous cells (1).

Several morphological methods are used for the identification of DV infections like histopathological demonstration of inclusion bodies or immunohistochemical identification of viral antigen (5, 8, 9).

The purpose of this study was to report the distribution of inclusion bodies and viral antigen in non vaccinated naturally infected foxes by means of histopathological, immunohistochemical and ultrastructural techniques.

Schweiz. Arch. Tierheilk. 132, 409-484, 1990. 1 table, 2 figs., 10 refs. Authors' summary.

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Morphological blood picture and acid-base balance in mink fed with oil offals and with chemically preserved feed additives

H. Bieguszewski

Morphological blood picture and acid-base balance parameters of 100 young mink, divided into five groups were tested. The control group of mink was fed the standard diet. In the meal dose of the first experimental group, 20% fresh meat-fish feeds were substituted with meat-fish feeds conserved with formalin. The second experimental group of mink was fed the diet with 50% meat feeds conserved with formic acid. To the meal dose of the third experimental group slaughter blood conserved with sodium benzoate and sulphuric acid was added (33% of meat-fish feeds). The fourth experimental group of mink was fed the standard diet and 3% oil offals were added.
Supplementation of mink feed with chemically preserved feed additives did not affect morphological blood indices.
Addition of conserved blood to the ration had an influence on the morphological indices of erythroblastic system. Decrease of bicarbonate and sum of blood base were noticed in the group with addition of oil offals. The experimental feeding did not have any unfavourable effect on grading of the tested mink.

In POLH, Su. ENGL, RUSS. pp 9-16, 2 tables, 30 refs. Author's summary.

The digestibility of nutrients and nitrogen retention in mink fed a diet with addition of oil offals and chemically preserved feeds

H. Bieguszewski, B. Glowinska, T. Pietryga, M. Urbanowski

The digestibility of nutrients and nitrogen retention in mink fed a diet with addition of oil offals and meat feed preserved with formalin and formic acid, as well as slaughter blood conserved with sodium benzoate and sulphuric acid were investigated.
The increase of digestibility coefficients of dry matter, organic matter and crude protein in mink fed a diet with addition of formalin and formic acid preserved feeds was found.
Decrease of nitrogen retention in mink given a diet with additon of formalin conserved feeds was shown.

In POLH, Su. ENGL, RUSS. pp. 17-22, 3 tables, 11 refs. Authors' summary.

Liver activity in polar foxes fed the diet with additon of conserved blood

H. Bieguszewski, J. Ornowski, R. Raja

The content of cholic acids in the blood of polar foxes fed a standard diet and a diet in which 40% of meat-fish fodder was substituted by nutria blood conserved with sulphuric acid and sodium benzoate or cooked blood, were tested.
In the control group of foxes and in the animals fed the diet with addition of conserved blood, the rate of blood purity from ^{131}I-rose bengal was also tested.
No statistically significant differences in cholic acids content and half period of blood purity from ^{131}I-rose bengal between control and experimental groups were found.

In POLH, Su. ENGL, RUSS. pp. 23-27, 2 tables, 6 refs. Authors' summary.

The weight gain and biochemical indices of blood plasma in mink, fed with oil offals and chemically preserved feed additives

H. Bieguszewski, M. Urbanowski, B. Glowinska

The weight gain during the growing period of mink fed chemically preserved feed additives and oil offals were tested. After forming of the winter fur, the blood from the experimental animals was taken in order to estimate some of the biochemical indices.
In the first period of the experiment, in mink fed the diet in which 20% fresh meat feeds were substituted with meat feeds conserved with formalin, a decrease in weight gain was noticed. The weight gain of mink fed the diet with 50% meat feeds conserved with formic acid was approximately the same as of mink fed the diet in which 33% fresh meat feeds were substituted with blood conserved with sodium benzoate and sulphuric acid. In the last period of the experiment a decrease of weight gain was noticed in males fed the diet with 3% oil offals.
Addition of formalin to the ration had an influence on the decrease of total protein content in mink blood plasma. The lower content of urea in blood plasma was observed in animals fed with different chemically preserved feed additives. Addition of chemical preservatives and oil offals did not have any influence on aminotransferase activity, the content of α-amino azote, creatinin and cholesterol of mink blood plasma.

In POLH, Su. ENGL, RUSS. pp. 29-35, 2 tables, 15 refs. Authors' summary.

The evaluation of usefulness of vaginal smear and omometric methods in Arctic fox females heat analysis

A. Frindt, R. Kijewski, M. Brzozowski, T. Kaleta

The experiments were carried out on one of the Central Poland farms in 1988. 31 one-year-old females were used. The experiments started when the difference in external reproductive organs was visible. 180 vaginal smears and 350 omometric measurements were taken.
The results obtained indicate the usefulness of both methods in determining the optimum heat date in the female.
The omometric method is preferable because it is less labour-consuming and easier to use under farm conditions.

In POLH, Su. ENGL, RUSS. pp 37-41, 2 tables. Authors' summary.

Effect of meat substitute mash supplemented to feed for polar foxes on their growth and coat quality

J. Gedymin, R. Cholewa, A. Piaszyk, R. Kasperek

The experiment was carried out on 180 polar foxes born on 26 and 27 May. On 7 and 8 July they were weaned and divided into 3 groups (60 animal in each group): the control group without any feed supplement, experimental group I with 20% supplement and experimental group II with 40% supplement of meat substitute mash. Starting on 15 July, every animal was weighed at one-month intervals and the changes in the coat were observed in 4 chosen animals in each group. From September the live weight of foxes in the experimental groups was higher than of those in the control group, and after slaughter it appeared that their pelts were longer. In the animals from group I the coat was better developed and obtained the highest price when compared with those from other groups. The cost of feeding in group I was lower than that in group

II. These findings would indicate that 20% supplement of meat substitute mash was most advantageous from the economic point of view in comparison with the result obtained in the remaining feeding variants.

In POLH, Su. ENGL, RUSS. pp. 44-48, 1 table, 8 refs. Authors' summary.

Some morphological and biochemical indices of blood, from ferrets fed a diet supplemented with meat feeds conserved with formic acid

H. Bieguszewski

Ferrets, 29 in number, fed a diet with meat-fish feeds conserved with formic acid were tested. The experimental group of ferrets (15 animals) was fed the diet in which 50% meat-fish feeds were substituted with meat feeds conserved with concentrated formic acid (1.5%). The control group of ferrets (14 animals) was fed the standard diet. Addition of conserved meat to the ration did not have any statistically significant influence on the following morphologial and biochemical indices of the blood: haemoglobin content, number of red blood cells, number of white blood cells, haematocrit index, content of total protein, urea, GOT and GPT activity and content of cholesterol. No statistically significant changes of acid-base parameters were noticed.
The experimental feeding did not have any unfavourable effect on weight gain and on grading of the tested ferrets.

In POLH, Su. ENGL, RUSS. pp. 49-55, 5 tables, 8 refs. Authors' summary.

Grading of blue fox

H. Kenttämies

Subjective scoring is not an exact method for evaluating the exterior traits of fur animals in varying farm conditions. However, a trained farmer is able to separate the best and poorest animals from medium ones. A comparison of scores obtained by grading live animals with that of pelts helps the farmer to estimate the production level of his farm, and to predict the economical return for the season within the framework of prevailing prices. In this study, the general appearance of live animals appeared to be a useful trait to evaluate. It can be judged by using various methods. General appearance reflected body size and fur quality, as well as size and quality of the pelt. Prevalence of severe fur defects diminished the scores for general appearance. However, scores for body size produced a closer association with pelt size, as compared to general appearance. Scores for underfur density proved to be an indicator of pelt quality. The grading of colour was greatly affected by lighting conditions. In sufficient daylight the judging of colour tended to succeed more reliably, as compared to the other traits.
The pelt price was mostly affected by auction. The animals with good appearance and pale or medium colour tended to achieve high prices as compared to low and medium scored dark coloured ones. Severe defects in fur or pelt reduced selling prices.

In ENGL, Su. POLH. pp. 57-64, 4 table, 15 refs. Author's conclusion.

The influence of feed chalk supplementation to blood meal conserved with sulphuric acid and sodium benzoate on morphological and biochemical indices of polar foxes (*Alopex lagopus*)

O.M. Lorek, H. Bieguszewski

The insufficient supply of meat feed, brings about the necessity of slaughter blood utilization for polar foxes (*Alopex lagopus*).
The aim of this report was to examine the influence of feed acidified with blood conserved with sulphuric acid and sodium benzoate as well as neutralization with feed chalk on morphological and biochemical blood indices. Young foxes, 96 in number, from weaning until pelting were tested. The animals were divided into three groups - 32 animals in each (the same number of males and females). In the meal dose of group II and III, 40% of the feed protein was substituted by conserved blood protein, and to the meal ration of the III group 3% of feed chalk was also added. Supplementation of fox feed with conserved blood and feed chalk did not affect most morphological blood indices, nor acid-base parameters. Conserved blood and feed chalk have an influence on the content of biochemical indices of blood plasma.

In POLH, Su. ENGL, RUSS. pp. 65-72, 3 tables, 11 refs. Authors' summary.

Influence of addition of feed preserved with formic acid in rations for ferrets on the chemical substructure and some physical parameters of their coat

M. Maciejewska, H. Bieguszewski, B. Glowinska

The experiment was carried out for 12 weeks on 10 growing ferrets divided into two groups, 5 animals in each group. The animals in the first, control group obtained standarized feed, while in the second, experimental group the feed preserved by addition of formic acid (in proportion of 1.5% of feed weight) was introduced as a substitute of part of the ration. The analysis of hair keratose fractions and evaluation of physical parameters were performed after 6 and 12 weeks of experimental feeding of the animals.
The keratose composition of the hair after the first period of experimental feeding ($\alpha:\beta:\gamma$ = 60:20:20) differed highly significantly from that in the control animals ($\alpha:\beta:\gamma$ = 45:25:30:).
After 12 weeks of feeding the ferrets with the addition of the preserved feed, the quantitative relations of keratose fractions still significantly differed from the values found in the control animals but were close to them. This finding would suggest that the animals rather slowly adapted to the changed feed. In addition, the authors observed thickening of the tops of the guard hair. In the first period of the experiment, the coat in the experimental animals had more impurities to increased amount of suint.

In POLH, Su. ENGL, RUSS. pp. 73-78, 2 tables, 6 refs. Authors' summary.

Introduction of preserved nutria blood to feed for polar foxes and chemical substructure and some physical features of their coat

Maciejewska, H. Bieguszewski, T. Pietryga

In the experiment there were 10 young polar foxes divided into 2 groups, the first being the control group. The animals obtained ad libitum feed containing 50% plant components and 50% animal components. In the rations of the animals in the experimental group, 20% of the animal component was substituted by nutria blood preserved with sulphuric acid and sodium benzoate. The coat samples for laboratory investigations were taken after 4 and 8 weeks of the experimental feeding. After 4 weeks, the relations of the keratose fractions were $\alpha:\beta:\gamma$ = 70:30:20 while in the samples from the control animals they were 50:30:20. The differences were statistically highly significant. After 8 weeks of giving experimental feed the contents of keratose fractions was close to those in the control animals, which would show adaptation of the animals with time to the new feed component.
Among the physical parameters only the content of suint was observed to increase significantly after addition of preserved nutria blood.

In POLH, Su. ENGL, RUSS. pp 79-84, 2 tables, 4 refs. Authors' summary.

Characteristics of species digestion patterns and enzyme adaptations to diet compositions in carnivorous fur bearing animals

W.M. Olejnik

Enzyme properties of the digestive tract in different animals and its participation in the digestion of proteins, fats and carbohydrates were compared.

In RUSS, Su. POLH. pp. 85-89, 1 fig., 4 refs. CAB-abstract.

Feeding experiments with mink and foxes fed acid preserved raw materials

I. Pölönen, T. Dahlman, J. Mäkelä

In Finland, acid preservation experiments have been carried out since 1960. Results of these experiments are summarized.

ENGL. Review pp. 92-98, Su. POLH. 3 tables, 15 refs. CAB-abstract.

Thyroid hormone levels in polar foxes fed a diet supplemented with preserved blood

R. Rajs, H. Bieguszewski

The thyroxine and triiodothyronine level in the blood plasma of growing polar foxes fed a diet with 20% cooked or chemically conserved slaughter blood was determined. The hormones were estimated by the radio-immunology method with an RIA kit. Lower concentrations of

thyroid hormones in the experimental foxes were found.

In POLH, Su. ENGL, RUSS. pp. 99-104, 3 tables, 13 refs. Authors' summary.

The level of vitamin B_{12} in polar foxes fed a diet supplemented with preserved blood

R. Rajs, H. Bieguszewski, J. Ornowski

Growing polar foxes were fed a diet with 20% cooked slaughterhouse blood or chemically conserved. The level of vitamin B_{12} in the blood plasma of polar foxes was determined by the radiocompetitive method. There was not found any negative influence of the experimental diet on the amount of vitamin B_{12} in the blood.

In POLH, Su. ENGL, RUSS. pp. 105-108, 2 tables, 12 refs. Authors' summary.

Artificial insemination in foxes

M. Valtonen

The extent and methods of artificial insemination applied on fox farms in Finland are presented.

ENGL. Review, pp. 109-114, Su. POLH. 2 tables, 6 refs. CAB-abstract.

Biometrical testing of size and body weight and of some internal organs in polar and common foxes

Z. Wolinski, A. Frindt

Different populations of foxes from Polish farms in the years 1950-1980 were tested.
The aim of this report was to examine the size and body weight and the size and weight of some internal organs in the animals as well as the relationship between testing characteristics.
The influence of breeding and husbandry conditions was noticed for only a few breeding characteristics.

In POLH, Su, ENGL, RUSS. pp. 115-119, 4 tables. Authors' summary.

The current status of physiological research in fur animals in Denmark

B.M. Damgaard

Research in fur animals in Denmark take place at both private and national institutes. Information regarding the physiological research in fur animals performed at the National Institute of Animal Science, Department of Research in Fur Animals is given.

ENGL. Review, pp. 123-127. 3 tables, 6 refs. CAB-abstract.

Review of nutritional experiments with fur bearing animals in Denmark

N. Glem-Hansen

Nutritional experiments with fur bearing animals in Denmark were first initiated at the National Institute of Animal Science in 1947. Much effort has been put into experiments concerning the protein requirement and determination of digestibility of feedstuffs. Results from these experiments are the basis for nutritional standards and diet composition in Denmark and, the some extent, the other Scandinavian countries. Nutritional experiments with fur bearing animals are at present carried out on two governmental experimental institutions, namely The National Institute of Animal Science and The Royal Veterinary and Agricultural University. These institutes are concentrating on basic studies, while two research farms owned by the Fur Industry implement the more applied part of the research and investigations. At present 19 fulltime scientists are employed in fur animal science of whom 9 especially work with nutritional aspects. The scientific activities are organized through committees covering the following scientific areas:

- Physiology, feeding and feedstuff evaluation
- Genetics and reproduction
- Hair and pelts - physiology and technology
- Ethology, environment and domestication
- Infectious diseases

Scandinavian scientists cooperate rather intensively through an association which arranges bi-

annual conferences. To a certain extent, the co-operation also includes inter-Nordic scientific projects. The above-mentioned association initiated the First International Scientific Congress in Fur Animal Production in Helsinki in 1976 and has been active in the arrangement of the pursuant three congresses in Copenhagen, Versailles and Toronto.

In ENGL, Su. POLH. pp. 129-137, 1 table, 22 refs. Author's abstract.

Fur animal reseach in Finland

Tapio Juokslahti

The main topics of research in fur bearing animals in Finland are presented.

ENGL Review, pp. 139-144, Su. POLH. CAB-abstract.

Fur animal research at the University Leipzig

R. Krieg

Research concerning mink, nutria and rabbits is described. The main problems of scientific work are described.

ENGL. Review, pp. 145-150, Su. POLH. 5 tables, 1 fig. CAB-abstract.

Ethology of muskrats (*Ondatra zibethica*) reared in cages

Frantisek Kukla

An observation on 28 muskrats kept in cages is described. The behaviour, especially feeding activity, in wild muskrats reared in cages for 2-3 years was observed. The high aggressiveness and low fertility in muskrats was noted.

ENGL. Review, pp. 151-155, Su. POLH. CAB-abstract.

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