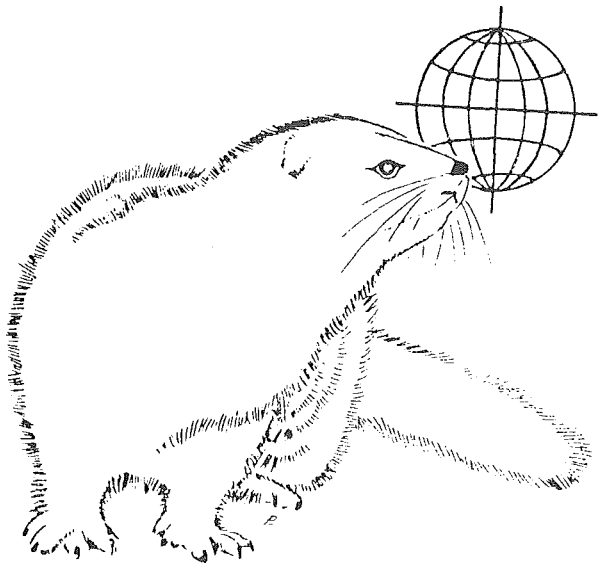

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Titles of other publications - not abstracted

Minks: rearing techniques and profitability. *Y. Guegan, J. Rougeot. ITAVI; Paris (France); 1987; 235 p. 23 tables. In FREN. Code 12-14-M.*

Topical questions of animal protection in today's animal management. *Schriftenreihe der Schaumann-Stiftung zur Förderung der Agrarwissenschaften, Huelsenberger Gespräche (Germany, F.R.), 1986, p. 180-188. 11 references. In GERM. Code 12-14-M-F-O.*

Fur winning from ethical point of view. *G.M. Teutsch. VET (Germany, F.R.); 1989, Vol. 4(6), 17-19. 2 ill., 12 references. In GERM. Code 10-12-14-M-F-O.*

4. Genetics

5. Reproduction

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7. Veterinary

Titles of other publicatons - not abstracted

Immunoprophylaxis of haemorrhagic pneumonia in minks (*Lutreola vison*). *R. Harnach. Veterinarstvi; 38, 12, 547-548. 1988. In CZECH. Code 9-M.*

Diagnosis of botulism in mink by the reversed indirect blood coagulation method. *H.S. Ma, Z.W. Chen. Maopi Dongwu Siyang; No. 4, 15-16. 1988. In CHIN. Code 8-9-M.*

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Fifty people have already applied for membership in INTERNATIONAL FUR ANIMAL SCIENTIFIC ASSOCIATION (IFASA). This is a beginning for building up an international association, however, we also need YOU as member.

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Please remember that a membership in IFASA is open for persons who are, or have been engaged in any activity connected with fur animals or the fur industry. We therefore welcome scientists, advisers, farmers and other people in the fur industry and related companies.

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We all have to take care of this opportunity to establish the international association. There is a gerat need for it, especially these days.

Welcome as a member - to day.

Prof. Einar J. Einarsson
President of IFASA

Notes

SCIENTIFUR

Vol. 14, No. 3

August 1990

At a meeting in Frankfurt on May 6th, the European Fur Breeders Associations' Consultative Committee (EFBACC) has given its full support of IFASA and the continued publication of SCIENTIFUR. We therefore thank the following Fur Breeders Associations for their support and welcome them on the list of official sponsors of IFASA:

B.E.F.F.A., Belgium, F.B.A., England, Irish Fur Breeders Association, Norwegian Fur Breeders Association, Danish Fur Breeders Association, Finnish Fur Breeders Association, Association Italiana Alevatori Visone, Spanish Fur Breeders Association, Zentralverband Deutscher Pelztierzüchter e.V., Syndicat Francais des Eleveurs de Visons, Dutch Fur Breeders Association, Swedish Fur Breeders Association.

To this list it is a pleasure for me to add the Japanese Mink Breeders Association and the Korean Fur Products Association which were - together with a certain number of individual memberships - obtained during my very fruitful and exciting journey to these countries in May-June of this year.

In this column, I would like to thank professor Keiji Kondo, Hokkaido University, Japan and Mr. Deog OH Chang, president of the Korean Fur Products Association for the initiative and for sponsoring this possibility to meet and get new members of the INTERNATIONAL FUR PRODUCTION FAMILY.

As will be seen from the present issue of SCIENTIFUR, 7 original reports covering more than fifty percent of the pages indicate that SCIENTIFUR is slowly going to be THE journal where original reports are published. Therefore, at present and hopefully also in the future, no other journal in the entire world can give so much original scientific information about Fur Animals as SCIENTIFUR. The fact that we are at the same time bringing abstracts from scientific and technical reports published in more than 150 other journals worldwide guarantees the subscribers that they are kept fully informed.

The day when the economic situation of IFASA and SCIENTIFUR allows us to print SCIENTIFUR in a more professional way, will be one of the happiest days in the life of your present editor.

This was the positive development and the optimistic thoughts of your editor.

The negative side is the absence of blue apply cards for individual membership of IFASA and advertising from the many serious international suppliers regarding Fur Animal Production. We are therefore waiting for much more response.

We are also full of hope and wishes for the new domocracies in Eastern Europe, and we hope that colleagues and organizations there will in a very near future be in a position to participate fully in the activities of THE INTERNATIONAL FUR ANIMAL FAMILY.

Hopefully my friend Bruce and you readers will forgive me for bringing Bruce's whole message in my notes, but the message from Bruce is so important that it must be seen by everybody who opens this issue of SCIENTIFUR. Thank you Bruce for your kind words and for your understanding.

Fur Trade Topics

Bruce W. Smith

YOUR OPPORTUNITY TO SUPPORT FUR RESEARCH

From time to time, FUR RANCHER publishes technical material on fur animal science from the excellent English-language journal, Scientifur, published in Denmark. That quarterly publication is a project of the International Fur Animal Scientific association.

Membership in the organization, including four issues of Scientifur every year, now is available to mink and fox farmers and their suppliers in North America. For persons interested in the nutritional and animal health advancement of fur farming, membership is highly recommended.

Young mink and fox producers, in particular, can benefit greatly from IFASA membership and from reading Scientifur. One-year membership, including quarterly issues of Scientifur, costs $86 US. Applications for membership or requests for additional information should be addressed to the association at PO Box 13, DK-8830 Tjele, Denmrk.

Government, university, and private researchers from around the world report their scientific findings in Scientifur. Contained are original reports, abstracts of long articles, and reviews of newer printer materials. Gunnar Joergensen, known personally to many American and Canadian fur farmers, is the editor.

The International Fur Animal Scientific association, for which plans were laid at the International Fur Animal Scientific Congress held in Canada and the US in 1988, will host the next such scientific meeting in Oslo, Norway, in 1992.

To keep up with the technical aspects of fur animal research, membership in IFASA is strongly recommended. ■

A SHORT NOTE FROM Bruce W. Smith

July 24, 1990

Dear Friend Gunnar,

I take pleasure in enclosing an advance proof of my editorial which will appear in the August issue of Fur Rancher. I thought you would be interested, and hope that it does some good.

Kindest regards,

Bruce

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Best wishes to everybody for the rest of the year and for the future.

It is worth while realizing that everybody in the area of fur animal production is responsible for the future - and a future without international cooperation and communication is not realistic.

Your editor,

Gunnar Jørgensen

Original Report

Stimulation of Follicular Melanin Synthesis in Mink (Mustela vison) By Two Synthetic Analogues of α-MSH: [Nle^4,D-Phe^7]-α-MSH and Ac-[Nle^4,D-Phe^7]-α-MSH$_{4-11}$-NH$_2$

[1]*LeGrande C. Ellis, Kerry L. Openshaw, Nancy C. Page*
[2]*Mac E. Hadley &* [3]*Brian C. Wilkes, Victor J. Hruby*

Abstract

Hair replacement during the spring molt was observed in commercially raised mink to proceed from the head caudally to the tail with the hair being replaced randomly in a given area of the pelt over a six week period of time. Two synthetic α-MSH analogues, [Nle^4,D-Phe^7]-α-MSH (compound I) and Ac-[Nle^4,D-Phe^7]-α-MSH$_{4-11}$-NH$_2$ (compound II) were administered to pastel, opaline or pearl mink by either intramuscular injections for 1 or 7 days or with osmotic minipumps during the spring molt to ascertain if these two compounds at equimolar concentrations would affect hair pigmentation. No readily noticeable increase in pigmentation was observed when pastel mink were injected intramuscularly with from 13.7 to 27.4 μg/day for compound I or from 18.4 to 36.8 μg/day for compound II or with osmotic minipumps with a 10^{-3} or 10^{-4} M stock solution with a release rate of 1.8 or 18 mg/day of compound I or 2.4 or 24 μg/day of compound II over a 12-day period. However, 33 μg/day for compound I or 44 μg/day for compound II constantly released over a 7-day time period increased pigmentation in the guard hairs in either the lancet or the shaft regions depending on whether that part of the hair was developing inside of the follicle at the time of α-MSH administration. When 54.8 μg/day of compound I and 73.6 μg/day of compound II were injected intramuscularly for 7 days, 2-3 mm segments (bars) of black pigmentation were noticed in those vibrissae of pastel mink that were developing at the time of α-MSH administration. In the opaline and pearl strains both compounds infused with osmotic minipumps at the highest concentration (33 and 44 μg/day, respectively) increased the number of pigmented cells and the density of the pigment within these cells present in the affected areas of the guard hairs. This treatment also changed the histologic appearance of the medulla cells of the opaline and pearl guard hairs. The underfur exhibited some microscopic color change of the pastel strain.

Introduction

Mink, in culture, have resulted from the fusion of several subspecies (*Shakelford, 1949*). Wild mink are dark brown in color, but today there are more than forty genetically distinct color-phases that range from white to blue to black (*Smith, 1982*). The dark or standard mink strain has resulted, not from a mutation, but from intensive selective breeding for a pelage with short, dark

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guard hairs of uniform length with a sheen and a dense, dark underfur (*Ellis et al., 1981; 1982*). This selective breeding has resulted in a number of reproductive and pelt priming problems, one of which is the presence of dark leather in the inguinal region of the male at the time of pelting that at one time was thought to be due to urinary incontinence and hence the name "wet belly". This pigmentation of the skin is known to be due to prolongation of the synthesis of melanin by the hair follicle in the shaft region of the guard hairs until the hair stops growing (*Ellis et al., 1981; 1982; Openshaw, 1984*). Normally there is little pigment in mink skin, except at the time of hair growth and replacement, and this pigmentation is primarily associated with hair renewal. Melanin synthesis in the hair follicle normally stops before hair growth ceases so that the hairs have no pigment at the basilar portion (shaft) that remanins beneath the epidermis. This results in a light colored skin at pelting time.

Very little is known concerning the control of pigment synthesis by hair follicles except that it occurs during hair growth (*Ryder, 1973; Openshaw, 1984; Cunningham et al., 1988*). Moreover, the pituitary is required for hair replacement and pigment synthesis (*Rust et al., 1965*); and circulating α-MSH levels rise during both the spring and fall molts (*Groesbeck, 1981; Ellis et al., 1982; McMullen, 1983*) as do also α-MSH receptors in developing guard hairs and underfur (*Cunningham and Ellis, 1988*).

Recently highly active α-MSH analogues have been synthesized and evaluated for potency as melanogenic agents (*Sawyer et al., 1980; 1982a,b; Knittel et al., 1983*). The present investigation was undertaken, therefore, to ascertain if follicular melanogenesis for hair pigmentation in mink could be stimulated by two specific biologically potent, synthetic, fragment analogues of α-MSH.

Materials and methods

In all studies, adult breeder males, (1-3 years of age, average weight 2.2 Kg - range 1.8-2.4 kg) were obtained from the Utah Fur Breeders Agricultural Cooperative in Midvale, Utah. They were housed in cages (32 x 50 x 80 cm) in a small animal room facing windows on the South with natural photoperiod. Feed was obtained from the Utah Fur Breeders Agricultural Cooperative from batches to be delivered to its members. Feed and water were given ad libitum, while room temperature was maintained at 60-70° F.

In the first study, pastel mink (four/group) were injected intramuscularly with 0.1, 0.2, 0.4 ml of a 10^{-4} M stock solution of either [Nle^4,D-Phe^7]-α-MSH (compound I - 13.7, 27.4 or 54.8 μg daily, respectively) or Ac-[Nle^4,D-Phe^7]-α-MSH$_{4-11}$-NH$_2$ (compound II - 18.4, 36.8 or 73.6 μg daily, respectively) in saline for 1 or 7 days. Additional pastel mink (four/group) were implanted with osmotic minipumps (Alza Corp., Palo Alto, CA) either Model 1702 (167 μl capacity with an estimated delivery rate of 0.55 μl/hr and a linear delivery time of 12 days containing either 10^{-4} or 10^{-3} M α-MSH in saline) or Model 2001 with a 200 μl capacity and a linear pumping rate of 1.0 μl/hr and a linear delivery time of 7 days containing either 10^{-3} or 10^{-4} M α-MSH in saline - see table 1 for detailed protocol and hormone dosages). Four additional opaline and four pearl mink were implanted with osmotic minipumps (Model 2001) containing 10^{-3} M of either compound I (33 μg/day) or compound II (44 μg/day) in saline.

The osmotic minipumps were surgically implanted in the mink after they were anesthetized with 10% acepromazine maleate (Fort Dodge Labs., Inc., Fort Dodge, Iowa) in ketamine HCl (0.4 mg/kg body wt. - Bristol Labs., Syracuse, NY). After shaving off the hair from a square cm area from the dorsal surface behind the shoulder blades, the area was disinfected with antiseptic soap and a tincture of iodine. A midline incision of approximately 1-2 cm was made with a scalpel, and a pocket was made in the subdermal connective tissue with a hemostat into which the minipump was inserted. The incision was closed with wound clips (Clay Adams, Parsippany, NJ), and each mink was injected Sub. Q. with 60.000 units of penicillin G procain (John D. Copanos, Inc., Baltimore, MD) to maintain asepsis.

Two areas on the back in the lumbar area were denuded: one by plucking and the second area by shaving first with an electric clipper and then with antiseptic soap and a safety razor blade. All mink were observed weekly for visual changes in pigmentation of the hair over the entire pelt during hair replacement. Samples of the newly grown hair in both the shaved and plucked areas were taken after four weeks and placed on a microscopic slide, covered with a cover glass held to the slide on the edges with transparent tape (3M, St. Paul, MN), and were observed microscopically for changes in pigmentation and structural changes in individual hairs.

Results

Visual examination of the pelage of both the treated and control animals and visual comparison of the amount of hair present in the plucked and shaved area indicated that the hair started to shed around April 1. New hair first appeared around the nose, eyes and then paws and proceeded caudally from the head to the tail. For a given area

Table I. Protocol for the Administration of [Nle^4,D-Phe^7]-α-MSH and Ac[Nle^4,D-Phe^7]-α-MSH$_{4-11}$-NH$_2$ into pastel, opaline and pearl mink.

Group	Molar Conc. of α-MSH Analogues	Number of Animals	Mink color Phase	Method of Administration	Duration of Treatment	Dosage (mg/day)
[Nle^4,D-Phe^7]-α-MSH						
Control	Saline	4	Pastel	0.1 ml IM	1 day	0
Treated	10^{-4} M	4	Pastel	0.1 ml IM	1 day	13.7
Treated	10^{-4} M	4	Pastel	0.2 ml IM	1 day	27.4
Treated	10^{-4} M	4	Pastel	0.4 ml IM	1 day	54.8
Treated	10^{-4} M	4	Pastel	0.1 ml IM	7 days	13.7
Treated	10^{-4} M	4	Pastel	0.2 ml IM	7 days	27.4
Treated	10^{-4} M	4	Pastel	0.4 ml IM	7 days	54.8
Control	Saline	4	Pastel	1702 minipump	12 days	0
Treated	10^{-3} M	4	Pastel	1702 minipump	12 days	18
Treated	10^{-4} M	4	Pastel	1702 minipump	12 days	1.8
Treated	10^{-3} M	4	Pastel	2001 minipump	7 days	33
Control	Saline	4	Opaline	2001 minipump	7 days	0
Treated	10^{-3} M	4	Opaline	2001 minipump	7 days	33
Control	Saline	4	Pearl	2001 minipump	7 days	0
Treated	10^{-3} M	4	Pearl	2001 minipump	7 days	33
Ac-[Nle^4,D-Phe^7]-α-MSH$_{4-11}$-NH$_2$						
Control	Saline	4	Pastel	0.1 ml IM	1 day	0
Treated	10^{-4} M	4	Pastel	0.1 ml IM	1 day	18.4
Treated	10^{-4} M	4	Pastel	0.2 ml IM	1 day	36.8
Treated	10^{-4} M	4	Pastel	0.4 ml IM	1 day	73.6
Treated	10^{-4} M	4	Pastel	0.1 ml IM	7 days	18.4
Treated	10^{-4} M	4	Pastel	0.2 ml IM	7 days	36.8
Treated	10^{-4} M	4	Pastel	0.4 ml IM	7 days	73.6
Control	Saline	4	Pastel	1702 minipump	12 days	0
Treated	10^{-3} M	4	Pastel	1702 minipump	12 days	24
Treated	10^{-4} M	4	Pastel	1702 minipump	12 days	2.4
Treated	10^{-3} M	4	Pastel	2001 minipump	7 days	44
Control	Saline	4	Opaline	2001 minipump	7 days	0
Treated	10^{-3} M	4	Opaline	2001 minipump	7 days	44
Control	Saline	4	Pearl	2001 minipump	7 days	0
Treated	10^{-3} M	4	Pearl	2001 minipump	7 days	44

the hair loss and replacement was random with some hair being lost early, some intermediate and the rest later over about a six week period of time so that the animals exhibited good hair coverage at all times with no alopecia. The effect of the exogenous α-MSH analogues on pigmentation of specific parts of the hair (i.e. tip, lancet or shaft regions) could readily be documented in those hairs that were shaved since it took approximately one week for that part of the hair that was developing in the follicle at the onset of α-MSH treatment to grow up through the sheath to protrude above the epidermis (fig. 1a). The cut surface of the hair documented the stage of development of the hair at the time of α-MSH treatment as the changes in pigmentation always occurred below the sheared end of the hair. None of the pastel mink treated with the 10^{-4} M solutions of either of the two analogues, whether injected or infused with the minipumps, exhibited any noticeable pigmentation of the fur visually or microscopically in either the plucked or shaved areas. There were, however, some 2-3 mm black segments of several of the vibrissae (visual observations only) of the pastel mink that received either 54.8 or 73.6 μg/day of compound I or 11, respectively, due to increased melanin synthesis during vibrissae replacement. Non-affected guard hairs exhibited a higher density or frequency of pigment bearing cells in the inner medulla than in the intermediate cortex or the outer cuticle areas of the lancet region of the hair. Also, the shaft region of the guard hairs was non-pigmented. Administration of either compound I or II (33 or 44 μg/day, respectively, 10^{-3} M with model 2001 minipumps) at the time the shaft developed initiated pigmentation of the medullary cells of guard hairs (Fig. 1b). The tips of the new guard hairs that appeared in the shaved area also appeared visually slightly darker. The affected hairs showed an increase in pigment density within the cells of the medulla in either the lancet (fig. 1a) or shaft region (fig. 1b) of the medullary area. No noticeable difference was observed between compound I and compound II on pigmentation.

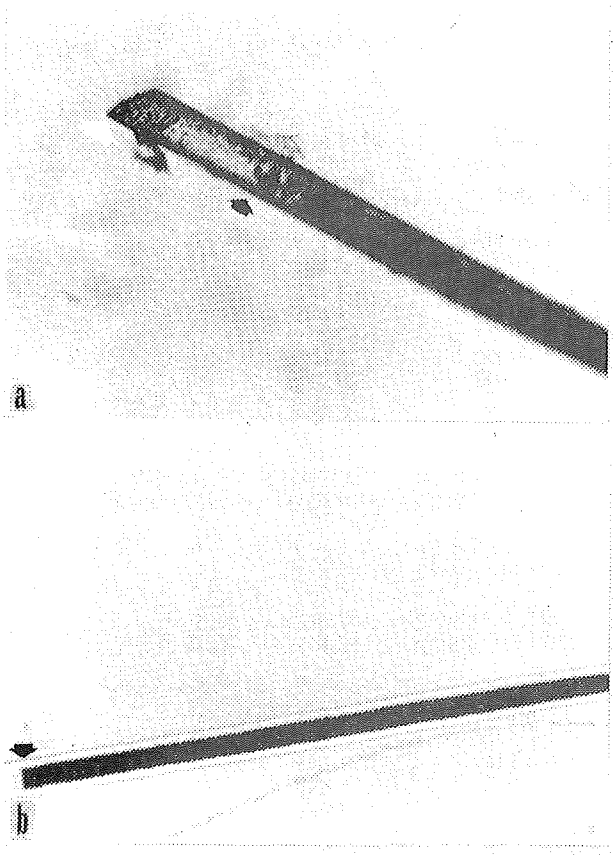

Figure 1. Pigment changes in guard hairs from a pastel mink given 44 μg/day of Compound II (Ac-[Nle^4,D-Phe^7]-α-MSH$_{4-11}$-NH$_2$ 10^{-3} M in saline by osmotic minipump - Model 2001): a) sheared end of the lancet region of a guard hair (white arrow) showing the onset of increased pigmentation of the medullary area (black arrow); and b) initiation of pigmentation of medullary cells of the non pigmented shaft region of a pastel guard hair.

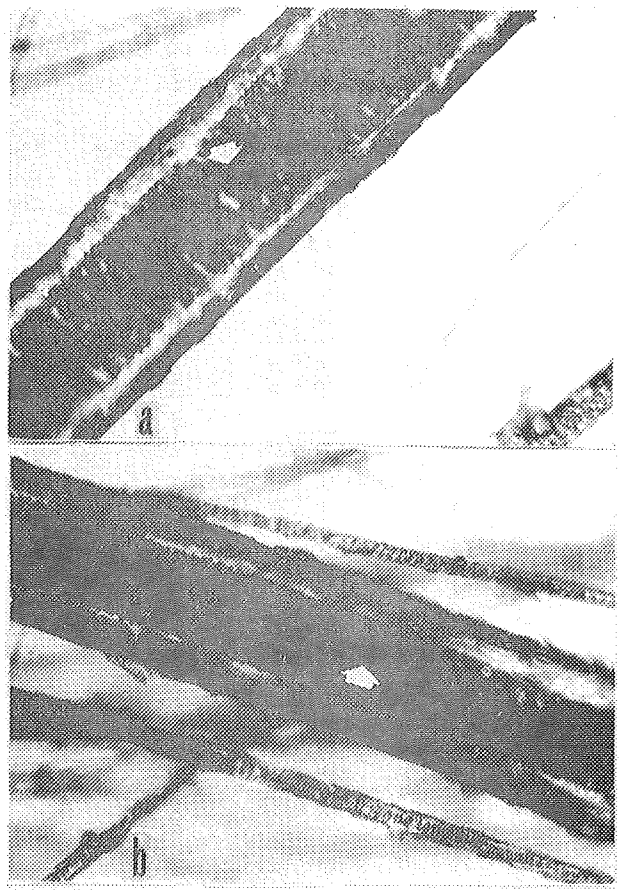

Figure 2. Lancet region of guard hairs from opaline mink that received 44 μg/day of Compound II (Ac-[Nle^4,D-Phe^7]-α-MSH$_{4-11}$-NH$_2$ 10^{-3} M in saline by osmotic minipump - Model 2001): a) normal hair showing occasional pigment bearing cells in the medullary area (white arrow); and b) hair after treatment showing an increased number of pigment bearing cells (white arrow).

Non-affected opaline and pearl guard hairs were non-pigmented except for occasional lightly pigmented cells that were randomly located in the medulla. The darker hue of the guard hairs of both strains was due to these occasional randomly located pigment bearing cells (fig. 2a and 3a). The color difference between the opaline and pearl strains was due to the more bluish appearing pigment of the pearl pigment bearing cells compared to the blacker pigment present in the opaline strain. Microscopically there was an increase in the number of pigment bearing cells of the medullary area of the hairs along with an increase in the density of pigmentation of those pigment bearing cells (fig. 3).

The unaffected underfur of all three strains of the mink exhibited less pigmentation than did their respective guard hairs. There was no visible or microscopic increase in pigmentation of the underfur was observed microscopically or visually after α-MSH analogue treatment (data not shown).

Discussion

The data from this investigation showed that pigmentation of hair of mink during the annual spring molt can be increased to varying degrees by two synthetic α-MSH analogues (compounds I and II) when given continuously at a rate of 33 or 44 μg/day (10^{-3} M stock solution), respectively, for 7 days. This dosage appears to be the

threshold level since preliminary observations with 330 or 440 μg/day of the two compounds (10^{-2} M stock solution) indicate that the response is dosedependent.

It is now known that different fur colors in mink and other mammals are due to the size and distribution of the melanin containing granules (melanosomes) in the individual hairs (*Russel, 1949; Joergensen, 1985*) and the amount of melanin present (*Billingham and Silvers, 1960; Ryder, 1973; Jørgensen, 1985*). Dark mink have a heavy accumulation of rod-shaped melanosomes while pastels also have a small amount of rounder granules. Pearl and opaline mink have very few melanosomes that are located primarily in the medulla of the hair, with most of the pigmentation appearing in the tips of the lancet portion of the hairs, whereas, pastels have many more melanosomes containing more pigment that are localized mostly in the medulla, but with some in the cortes. The lancet tips contain more melanosomes and more of the oxidized pigment making them appear black. Thus, pastel mink have dark tips and brown pigment in the lower lancet of the guard hairs and brown underfur. Pearls and opaline had small amounts of dark pigment in the tips of their, otherwise, white lancets and underfur, while opalines had black tipped and pearls a more bluish tipped lancets. Dark mink hairs contain many melanosomes that are found in the medulla, and cortex. With heavy selection for dark pigmented hair over the last two decades, the melanosomes are now found even in the cuticle of dark mink (*Ellis et al., 1989*) so that now the entire lancet and shaft is densely pigmented to just above the bulb. Other work in our laboratory shows that there are no differences in the circulating levels of α-MSH between the darks, pastels and opalines (*Groesbeck, 1981; McMullen and Ellis, 1988*). Similarly, there are no differences in α-MSH receptors on the developing hair fibers that could account for the differences in pigmentation (*Cunningham et al., 1988*). Nevertheless, mink circulating α-MSH levels do increase at the time of both the fall and spring molts (*Groesbeck, 1981; McMullen and Ellis, 1988*) as do also follicular α-MSH receptors (*Cunningham et al., 1988*) indicative of a functional role for α-MSH in pigment synthesis during hair replacement. Thus, control of hair color is genetic and it involves the number and size of the melanosomes, the amount of pigment and its state of oxidation, and the distribution of melanosomes within the developing hair. α-MSH did visibly increase the amount of pigment present in some melanosomes, but did not appear to effect the size or distribution of the melanosomes within the hair. This observation is consistent with those of other workers (*Geshwind, 1966; Geshwind and Huseby, 1966; Snell, 1972; Weatherhead and Logan, 1981; Pawelek and Korner, 1982*) who observed that α-MSH increased the pigmentation of the hair of several species. It is conceivable that higher dosages of the hormone might have affected the distribution of the melanosomes within the hair and further increased pigmentation. The pulsatile release of α-MSH could also be more effective than continuous release in affecting fur pigmentation as was used in this investigation.

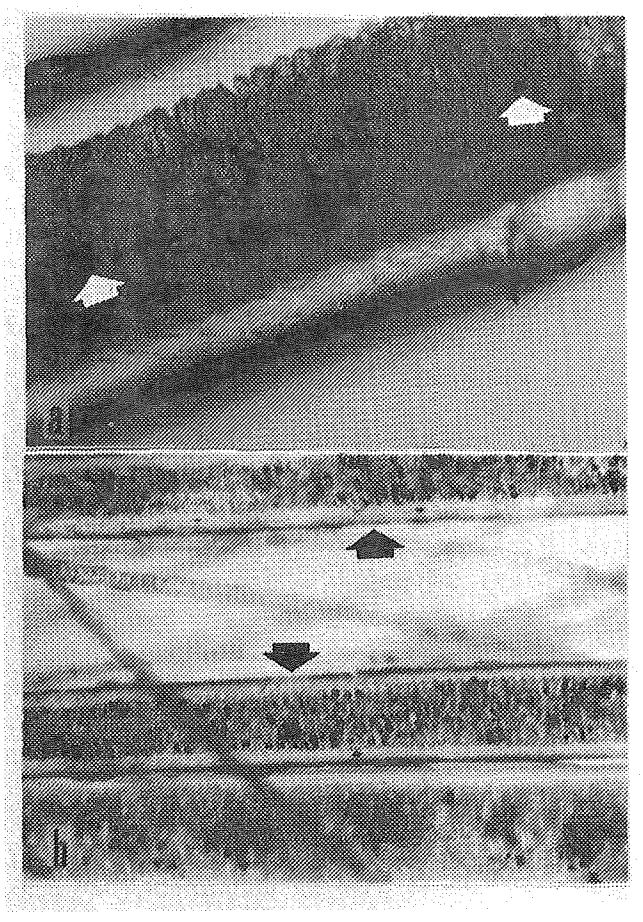

Figure 3. Lancet regions of guard hairs from pearl mink given 44 μg/day of CompoundII(Ac-[Nle^4,D-Phe^7]-α-MSH$_{4-11}$-NH$_2$ 10^{-3} M in saline by osmotic minipump - Model 2001): a) normal hair showing occasional pigment bearing cells in the medullary region; and b) two hairs after treatment (arrows) showing an increased number of pigment bearing cells.

Acknowledgements

We thank Mr. Stanford J. Benson and Mr. Corry L. Timpson for their technical assistance with part of the research. This work was sponsored in part by the following grants: Mink Farmers Research Foundation; Utah Agricultural Experiment Station Project No. 454, journal manuscript no. 3161; and U.S. Public Health Service Grant AM-17420 (NIH).

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Original Report

An attempt to evaluate the relationship between the keeping system and behaviour in young silver foxes.

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Summary

The behaviour of 912 young foxes 6-8 week old was observed taking into account various environmental factors. Their agonistic behaviour resembled reactions of the adult animals. The important factors influencing the behaviour of foxes turned out to be the keeping system (pavilions versus free-standing cages and the number of animals in one cage).

Introduction

Free standing cages and pavilions are frequently used in fox keeping systems in Poland. However, the effects of keeping conditions on the welfare of farm foxes are unknown. The aim of this study was to evaluate the influence of various environmental and breeding factors on young fox behaviour, which is a good indicator of their ability to adapt.

Material and method

The observations were carried out in silver fox farm Witkowizna in June 1988. 912 foxes 6-8 week old were submitted to a special test eliciting their agonistic behaviour. The stimulus was the observer, who approached each cage at such a pace that the maximum time of coming up to the wire was 5 sec. The proper pace rate was established in preliminary observations. Moments of the reactions of the animals were measured with a stop watch. All types of fox behaviour were also recorded.

The farm and breeding conditions which were taken into account while dividing fox population: 1) Keeping systems-freestanding cages or pavilions, 2) The number of foxes in one cage (1.2 or 4 in this study), 3) The sex of animals, 4) Date of birth (early, middle, late).

The number of foxes in these groups is shown in table 1.

Results

Behaviour of foxes

6-8 week old silver foxes had already well developed agonistic behaviour including many forms typical of adult animals, like cut-off acts and defensive postures (*Kaleta, 1983*). However, the difference between the frequencies of their occurrence was rather big (see table 2). We also ascertained the difference between the behaviour of foxes kept in pavilions and free-standing cages. It may be seen particularly when analysing motor pattern of reaction. In "pavilion" foxes withdrawal and immobilizing were more frequent, whereas foxes in "free-standing cages" various forms of flight reaction prevailed. Also the attempts to attack the observer occurred only in "pavilion" foxes.

Table 1. The division of examined material into groups according to various criteria.

Population of foxes (Total)		912			
Criteria: Keeping system		Pavilions 522		Free-standing cages 390	
Sex		Males 274	Females 248	Males 221	Females 169
Date of birth[x]:					
Early - 22.02-24.03		3	0	3	4
Middle - 25.03-22.04		154	153	171	141
Late - 23.04-23.05		74	63	3	0
Number of foxes per cage:	1	336		2	
	2	186		368	
	3	0		0	
	4	0		20	

[x] Only reliable data were taken into account.

Table 2. The types of young fox agonistic behaviour (selection).

Behaviour	Free-standing cages				Total		Pavilions				
	1	2	3	4			1	2	3	4	5
Cut-off	5	2	5	2	7	44	2	1	41	28	16
Freezing	0	0	0	0	0	2	0	1	1	0	0
Defensive	23	15	21	17	38	39	5	2	32	21	18
Aggression	0	0	0	0	0	3	1	0	2	1	2
Approaching	0	1	1	0	1	3	0	0	3	1	2
Withdrawal	19	39	37	21	60	233	40	27	166	128	105
Flight	86	37	68	54	140	88	20	15	53	39	49
Panicky flight	33	11	27	17	51	27	6	4	17	13	14
Stereotyped movement	0	0	0	0	0	4	0	0	4	1	3

1-means reaction of the first animal; 2-second animal
3-means males; 4-females (in free-standing cages group)
3-means single foxes; 4-males; 5-females (in pavilion group)

The "pavilion" group consisted of dyads (pair of animals in one cage) and single foxes. The single animals showed more evasive (cut-off) and stress (urination and defecation) reactions than their neighbours (dyads).

There was a lack of consistency in reactions of foxes in pairs. However, dyads in pavilions revealed more consistency as regards withdrawal (14% of dyads) than in free-standing cages (5%). On the contrary, foxes in "free-standing cages" revealed more consistency in escape reactions (27% of dyads) than "pavilion" animals (14%).

The comparison between males and females showed that the difference was more visible in pavilions (single foxes). It is interesting that during experiment a greater number of acts such as cut-off, immobilizing and withdrawal was elicited in males.

As shown in table 1 there were practically no foxes born early in the examined population. The comparison between the animals which were born late and in the middle period in pavilions turned out to be inconclusive.

Time of motor reaction in foxes (table 3)
In a typical cage with a dyad the difference in time of reaction between fox responding to stimulus as first and as second was highly significant. Thus, there was a clear tendency towards reaction diversity in dyads. Simultaneously, however, they were related with each other. Calculated correlation coefficient was $r_1 = 0.506$ in pavilion group and $r_2 = 0.374$ in free-standing cages (both highly significant p 0.01).

Table 3. Time of motor reaction in various examined groups of foxes.

Group	Number of foxes	Time (mean) (sec.)	Standard deviation	Variation coefficient (%)	Value of t (t-test)
P-Total	522	3.14	1.193	38.0	0.94
Fs-Total	390	3.058	1.449	47.4	
FP	93	3.060	1.150	37.6	4.05^{xx}
FFs	193	2.438	1.350	51.3	
SP	93	4.011	1.141	28.4	1.96^{x}
SFs	193	3.689	1.379	37.4	
MaP	274	3.212	1.219	37.9	1.47
MaFs	221	3.036	1.423	46.8	
FeP	248	3.060	1.163	38.0	0.27
FeFs	169	3.095	1.493	48.2	
FP	93	see above			5.65^{xx}
SP	93	" "			
MaP	see above	see above			1.45
FeP					
SiP	336	2.910	1.109	38.0	1.145
FP	93	3.060	see above		
SiP	see above	" "			8.38^{xx}
SP					
FFs	" "	" "			9.4^{xx}
SFs					
MaFs	" "	" "			0.398
FeFs					

P-pavilion, Fs-free-standing cage, F-responding as first to stimulus, S-responding as second, Ma-males, Fe-females, Si-single; x-significant (p 0.05), xx-highly significant (p 0.01).
Arrows indicate relations between groups.

There was a highly significant difference between time of reaction of pavilion foxes and foxes in "free-standing cages". In this case "free-standing cage" animals responded more quickly than in pavilions.

Discussion

The obtained data showed that foxes in free-standing cages usually fled quickly while animals in pavilions let the observer approach more closely, showing signs of another type of defensive behaviour. This difference was probably evoked by compulsory adaptation of foxes in pavilions where the aisle is narrow. Thus, farm workers approached animals more frequently and because of pavilion design their presence was more disturbing for foxes than in the case of free-standing cages.

The similar experiments of Plochocka (1988) show that the narrow aisles in free-standing cages evoke distinctly clearer adaptation behaviour in farm foxes than the wide ones.

Conclusions

1) The young foxes, 6-8 weeks of age, revealed almost fully developed agonistic behaviour.
2) The effect of the keeping system (pavilions or free-standing cages) and the number of animals in one cage on the behaviour of foxes was observed. On the other hand, influence of animal sex was less clear. 3) The signs of various forms of adaptation to farm conditions were observed in dyads kept in pavilions and in free-standing cages. 4) The symptoms of intense stress were observed in single foxes kept in pavilions.

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Original Report

The escape distance in young farm silver foxes

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Summary

The escape distance of 534 silver foxes was measured. The correlation coefficient between the aisle breadth and young fox escape distance was high. Particulary the effect of narrow aisle on the behaviour of the foxes was recorded.

Introduction

Our previous study shows that under farm conditions there is correlation between adult silver fox escape distance and aisle breadth (*Kaleta, Lewandowska, 1987*). The aim of this study was to ascertain whether this relationship may be found in weaned young foxes.

Material and method

The investigations were carried out in the state farm Witkowizna in the summer of 1987. 534 silver foxes of both sexes approximately 2 months of age were observed. The foxes examined were kept in pairs in free-standing cages. The procedure of escape distance measurement was as follows. Approaching perpendicularly to the cage the distances were measured when first signs of animal reaction were observed. The standard measuring tape was used and the distances between observer and cage wire were taken at the observers waist level. In this case agonistic behaviour of foxes was not recorded.

Results and discussion

The estimated correlation coefficient between aisle breadth and mean fox escape distance was high. For the first fox responding to observer in cage its value was 0.86, for the second - 0.80 (both highly significant). More detailed data concerning this relationship are shown in table 1 and 2.

Although the above mentioned coefficients are approximated the standard deviation in second fox was generally greater than in the first one (see table 1). Thus, the escape distance in the second fox in cage was rather more varied. This particularly concerned the case of wider aisles between the rows of cages. The calculated Spearman's correlation between the mean escape distance of the first and the second fox revealed their significant resemblance when narrower aisles were observed (see table 1). The difference between escape distances in first and second foxes in each pair taking into account various aisle breadths is shown in table 2. These data also suggest that reactions of the second fox were less regular.

Hence, the escape distance may probably be seen as the indicator of the adaptation of young foxes to farm conditions as was recorded in normal, adult animals (*Kaleta, Lewandowska, 1987*). As concerns the reaction of pairs of foxes, evidently, the observer presence provoked stress in both animals more simultaneously in the case of the narrow aisle than in the wide one.

Table 1. The escape distance of young foxes kept in pairs.

Aisle breadth (m)	No. of foxes	Escape distance of first fox (mean) (m)	SD[z)]	Escape distance of second fox (mean) (m)	SD	Spearman's correlation between both distances
1.4	158	1.03	0,37	0.79	0.52	0.375[xx]
1.68	150	1.09	0.64	0.99	0.47	0.302[xx]
1.78-1.9[y)]	32	1.12	0.42	0.69	0.58	0.425
1.91-2.1	28	1.27	0.55	0.83	0.70	0.167
2.4-2.6	14	1.91	0.49	1.40	0.73	0.0625
3.1-3.36	28	1.94	0.73	1.38	0.91	0.593[x]
3.5	16	1.405	0.99	1.24	0.27	0.196
3.65	50	1.97	0.95	1.32	1.02	0.450[x]
3.85	56	1.97	1.17	1.63	1.40	0.275

x-correlation significant (p 0.05); xx-highly significant (p 0.01)
y-because of small number of foxes in some "aisle breadth" groups; the results were combined; z-standard deviation.

Table 2. The difference between mean escape distances taking into account various aisle breadth, separately for first and second fox (test t).

Aisle breadth (m)	1.4	1.68	1.78	1.9	2.4	3.3	3.5	3.6	3.8
1.4		xx	Ns	xx	xx	xx	Ns	xx	xx
1.68	xx		Ns	Ns	xx	xx	Ns	xx	xx
1.78	Ns	x		Ns	xx	xx	Ns	xx	xx
1.9	xx	Ns	Ns		x	x	Ns	xx	xx
2.4	xx	Ns	x	Ns		Ns	xx	Ns	Ns
3.3	xx	xx	xx	Ns	Ns		xx	Ns	Ns
3.5	xx	x	xx	Ns	Ns	Ns		xx	xx
3.6	xx	xx	x	Ns	Ns	Ns	Ns		Ns
3.8	xx	xx	xx	xx	Ns	Ns	Ns	Ns	

Above diagonal line-first fox, below-second fox; Ns-non-significant; x-difference significant; xx-highly significant.

Conclusions

1) The interrelationship between the aisle breadth and young fox escape distance was observed. 2) In foxes kept in pairs in free-standing cages there was a tendency towards unifications of escape distances when the aisle breadth was narrow. 3) The above mentioned facts may be seen as the evidence of adaptation to farm conditions in 2 months old silver foxes.

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Original report

Stereotypies in adult ranch mink

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Abstract

Stereotyped and normal behaviour were quantified from April to June 1989 among 187 adult male and female ranch mink. It was shown that mink at the most devote 3% of the day to stereotyped behaviour. The frequency of stereotypies is markedly increased until feeding time in the middle of the day and declines to very low levels in the afternoon. Environmental disturbances such as human proximity, transfer to other farm section, and delivery have strong inhibiting effects on the performance of stereotypies. The relation between stereotypies and experienced stress is discussed, and it is suggested that chronic intermittent stress (e.g. stress induced by daily fresh food deprivation) is a prerequisite to the occurrence of stereotypies, but that additional conditions involving low level external stimulation are important.

Introduction

Repetitive stereotyped movement patterns are a type of conflict behaviour occurring among animals in barren environments. There is no clear definition of stereotypies, but the following three characteristics are the most commonly cited: (1) relatively invariant movement patterns, (2) which are performed repeatedly, and (3) which appear without any clear-cut function (*Broom, 1983; Cronin, 1985; Dantzer and Mormede, 1983; Keiper, 1969; Kiley-Worthington, 1977; Ödberg, 1978, 1981, 1986, 1987, 1989; Rushen, 1984; Sambraus, 1985; Wiepkema et al., 1985*). It is generally suggested that the occurrence of stereotypies in modern intensive husbandry is a result of the animals inadequate adaptation to the systems offered, and that stereotypies, therefore, may be regarded as indicators of a state of chronic stress induced by the management systems. This suggestion is supported by a few experimental studies indicating that the development of stereotypies may be manipulated by "feeding stress" (*Rushen, 1985*), by changing environment size or enrichment (*Keiper, 1969; Ödberg, 1987*), and that both acute and chronic stress increase apomorphine-induced stereotypies in laboratory rodents (*Antelman et al., 1980; Cabib et al., 1984*). However, lack of correlation or even negative correlations between stress and stereotypies have also been demonstrated (*Barnett et al., 1984; Barnett et al., 1985; Wiepkema, 1987*). Thus, it must be emphasized that no clear correlations have been established between the occurrence of stereotypies and physiological stress parameters (*Ödberg, 1989*). The findings of negative correlations have even lead to the assumption that stereotypies may in fact have a homeostatic or coping function by reducing deleterious effects of stress; an assumption which is supported by other findings of stress-reducing effects mediated by behavioural responses (*Delius, 1967, 1970; Heller, 1985; Weis, 1971a, 1971b*). It may be that the apparent contradictory two lines of interpretations are in fact both valid, in that the earlier stages of stereotypy development could be positively related to experienced stress, while later

occurrence of stereotypies involves emancipation of the stereotypies from the original stressful situation so that no or negative correlations to stress parametes are observed.

The aim of the present study was to begin intense investigations of causal and functional aspects of stereotypies using farmed mink as experimental animals. Firstly, we wished to quantify the occurrence of different types of stereotypies in adult male and female mink under conventional danish farm conditions. Secondly, it was the purpose to investigate possible relationships between stereotypies and the occurrence of other types of behaviour, specific farm routines, or "biological" events such as pregnancy. Thirdly, we intended subsequently to split a great number of animals in two groups according to the individual levels of stereotypies observed. These high or low stereotyping animals were planned to serve as material for additional analyses of causes, functions, and heredity of stereotypies in future experiments. Stereotypies in mink have previously been followed as minor part of a dutch welfare study (*Jonge et al., 1985*).

Materials and methods

The animals in this study were a total of 187 one to four years old ranch mink housed individually in conventional danish wire cages measuring 30 x 45 x 90 cm and supplied with nest boxes. Both sexes were represented by two colourtypes in the following order: 53 females/11 males of the colourtype pastel, and 102 females/21 males of the colourtype scanblack, giving a total of 64 pastel, 123 scanblack, 155 females, and 32 males.

Individual scanning observations were made on three consecutive days (Tuesday-Thursday) in each of the weeks 13, 14, 15, 16, 17, 20, 23, and 24 in 1989 (experimental weeks 1, 2, 3, 4, 5, 8, 11 and 12). In this way, observations started one week after mating which took place in the beginning of March and ended six weeks after delivery which took place in the beginning of May. A total of six doublescannings (two observers) were performed on each observation day with three doublescannings in the morning (9.00-11.00 h) before feeding time and with three doublescannings in the afternoon (13.00-15.00 h) after feeding time. Thus, each animal were subjected to a total of 288 observations throughout the observation period. During the observations, one of the following behavioural parameters were recorded:

In nest box.
Inactive in cage.
Nonstereotyped activity in cage, all activities not otherwise recorded.
Eating.
Scent marking; abdominal rubbing against the wire floor.
Curious: standing at the front of the cage intensively watching the observer.
Pendling: stereotyped to and from movement of the whole body.
Horizontal: stereotyped side to side movement of the anterior body.
Vertical: stereotyped up and down movement of the anterior body.
Mixed stereotypy: Mixed horizontal and vertical stereotyped movement.
Biting: Stereotyped intensive biting in the wire mesh.
Scratching: Stereotyped intensive scratching in the wire mesh.
Nipple stereotypy: Stereotyped circular movement with the head around or nearby the drinking nipple.

The diurnal distribution of activity outside the nestbox and retreat to the box was studied for six of the scanblack females by 24 h video tape recordings through 5 days in the middle of the observation period.

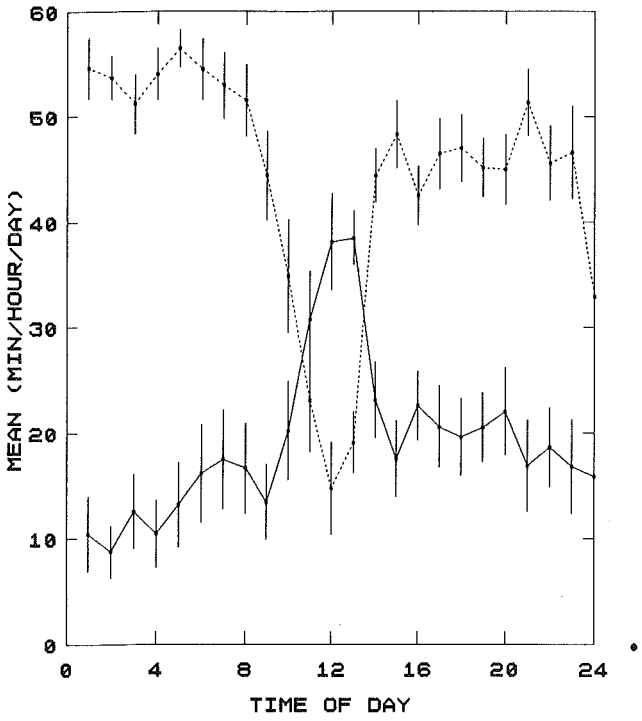
Prior to the observations in week 16 (experimental week 4), all animals were transferred from the mating section to otherwise identical housing conditions in the delivery section of the farm. Intercorrelations between behavioural parameters were calculated, and relations to colourtype, sex, age, time, feeding, delivery, and transfer from mating section to delivery section were estimated. Four animals died during the experimental period reducing the total number of scannings from 53856 to 52626.

Results

Figure 1 illustrates the results of 24 h video tape recordings. It clearly appears that the main activity period lies rather sharply between 9.00 h and 15.00 h, and that is exactly the period during which scanning observations were performed. The distribution of behavioural elements based on scannings, therefore, seems to be representative for the animals main activity period.

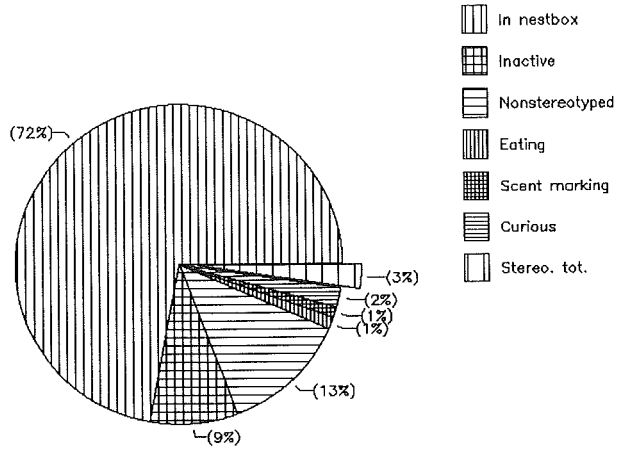
Figure 2 (left) shows the frequency of each behavioural element recorded throughout the experiment, in that the observed seven stereotyped elements are shown together. It appears that recordings of animals *in nest box* and recordings of *inactive* in the cages represent 72% and 9%, respectively, of all 52626 scannings. Stereotyped element represent together only 3% of the recordings.

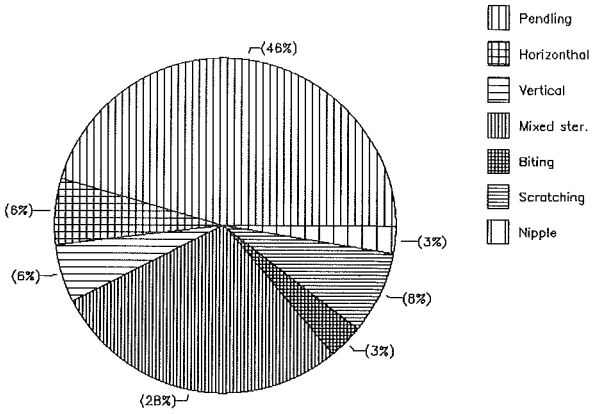
Figure 2 (right) shows the frequencies of recorded stereotyped elements *pendling* (46%) and *mixed stereotypy* (28%) as the most commonly



observed stereotypies. Based on all scannings, *pendling* is thus recorded in 1.4% and *mixed stereotypy* in 0.8% of all scannings. Figure 2 (below) illustrates the distribution of stereotypies in scanblack females which are later shown to be the most stereotyping animals. It appears that the occurrence of stereotypies is randomly distributed.

Figure 1 Diurnal variation in mean time spent with activity in the cage (solid line) and retreat to the nest box (dashed line).





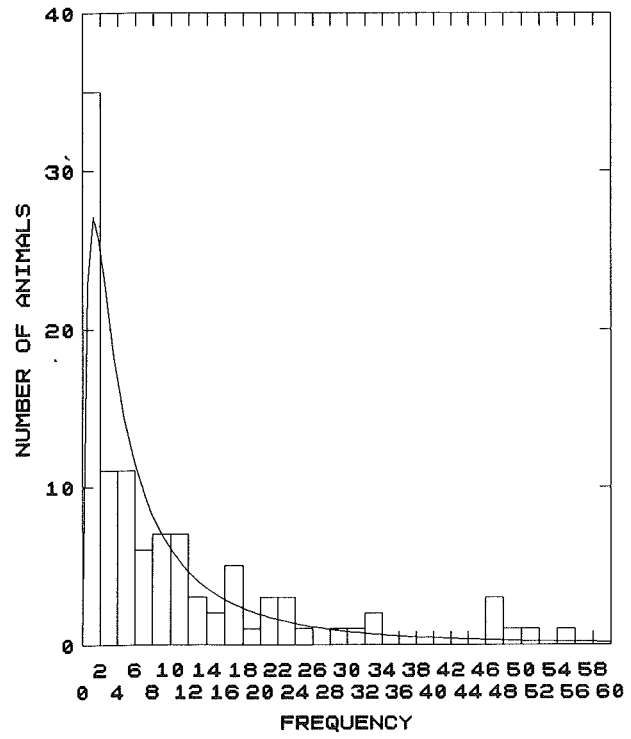


Figure 2. Frequencies (%) of recorded behavioural elements (left), freguencies of stereotypies (right), and frequency distribution of stereotypies among scanblack females with the lognormal distribution curve inserted (below); P = 0.082, Kolmogorov-Smirnov two-sample test (Siegel, 1956).

Table 1. Influences of colourtype, sex, and age on behavioural elements. Data presented as number of animals recorded for each element and in parentheses mean observations/animal/scanning x 100. * P < 0.05; ** P < 0.01; *** P < 0.001.

ELEMENT	PASTEL n=64	SCANBL. n=123	FEMALE n=155	MALE n=32	AGE 1 YEAR n=110	AGE >1 YEAR n=77
In nestbox	64 (77.0)	123 (66.7)***	155 (69.8)	32 (71.2)*	110 (66.9)	77 (75.0)***
Inactive	64 (7.2)	123 (9.0)*	155 (8.7)	32 (8.0)	110 (9.2)	77 (7.4)**
Nonstereotyped	64 (8.7)	123 (14.2)***	155 (12.5)	32 (11.8)	110 (13.9)	77 (10.0)***
Eating	56 (1.1)	115 (1.5)**	140 (1.3)	31 (1.4)	102 (1.4)	69 (1.2)
Scent marking	46 (0.8)	102 (1.5)	126 (1.3)	22 (1.0)	95 (0.7)	53 (0.6)
Curious	63 (2.1)	118 (1.9)	149 (1.8)	32 (2.6)	109 (1.9)	72 (2.0)
Pendling	18 (1.3)	75** (2.5)*	86 (2.4)	7* (0.9)	61 (2.4)	32 (2.0)
Horizontal	3 (0.7)	32*** (0.9)	32 (0.9)	3 (0.3)	25 (0.9)	10 (0.7)
Vertical	2 (0.7)	24** (1.0)	23 (0.8)	3 (2.7)	17 (1.3)	9 (0.5)
Mixed ster.	10 (1.6)	51** (2.3)	54 (2.2)	7 (2.3)	44 (2.6)	17* (0.9)
Biting	26 (0.8)	45 (0.6)	61 (0.7)	10 (0.7)	48 (0.6)	23 (0.8)
Scratching	16 (0.7)	38 (0.7)	39 (0.5)	15* (1.1)***	37 (0.7)	17 (0.6)
Nipple	0 (0.0)	15** (0.8)	14 (0.9)	1 (0.3)	12 (0.7)	3 (1.3)

Table 1 shows influences of colourtype, sex, and age on the behavioural elements observed. Data are presented as number of animals recorded for each behavioural element during the whole experiment and as mean observation/-animal/scanning x 100. The two sets of data were treated statistically with X^2-tests and Mann-Whitney U-tests (*Siegel, 1956*), respectively. The statistical evaluations reveal significant differences between colourtypes with respect to observations of the elements in *nest box, inactive, non-stereotyped* activity, and with respect to the stereotypies *pendling, horizonthal, vertical,* and *nipple.* The overall picture being more activity and more frequent stereotypies among scanblack mink. Significant differences are revealed between females and males with respect to *in nest box, pendling,* and *scratching;* the males spent more time *in nest box*, fewer males show *pendling*, but *scratching* is recorded much more oftenly for males. The most pronounced difference between 1-year and older animals is higher *non-stereotyped* activity and more *mixed stereotypy* among the younger animals.

Table 2 and Figure 3 shows behavioural results from each of the eight observation weeks. Statistical analyses over weeks reveal significant differences for all behavioural elements recorded. The most dramatic changes occur in observation week 4 and 8 with marked decreases in *non-stereotyped* activity and in several of the stereotyped elements. These changes could be related to transfer of the animals from the mating section of the farm to the delivery section just before observation in week 4, and to delivery which took place for all females between observation week 5 and 8. Recordings of *non-stereotyped* activity and recordings of the element in *nest box* are generally inversely related, and the most pronounced differences occur in the weeks after delivery. In experimental week 8 (approximately 2 weeks after delivery), *non-stereotyped* activity outside the nest box is markedly reduced, while the element *in nest box* is frequently recorded. Experimental week 12 (approximately 6 weeks after delivery) shows the opposite pattern with relatively few recordings *in nest box* and a very high *nonstereotyped* activity in the cage; at the

Table 2. Number of animals recorded for each behavioural element during the 8-weeks observation period. Figures in parentheses represent mean observations/animal/scanning x 100. * P < 0.05; ** P < 0.01; *** P < 0.001.

ELEMENT	OBSERVATION WEEK 1	2	3	4	5	8	11	12
				n=187				
In nestbox	187 (72.2)	187 (75.0)	187 (69.3)	185 (75.4)	186 (71.1)	187 (78.2)	187 (78.6)	186 (51.5)***
Inactive	75 (7.2)	48 (7.5)	109 (12.2)	106 (20.1)	124 (10.1)	142 (12.6)	104 (9.8)	175*** (25.3)***
Nonstereotyped	173 (15.0)	174 (14.7)	178 (15.4)	169 (9.7)	176 (14.1)	162 (9.2)	176 (13.1)	174 (17.4)***
Eating	68 (3.6)	74 (3.9)	55 (4.3)	87 (3.5)	77 (4.0)	69 (3.5)	41 (3.0)	34*** (3.2)***
Scent marking	42 (3.6)	40 (3.6)	67 (5.5)	52 (4.0)	76 (4.8)	31 (3.2)	35 (3.7)	29*** (3.4)***
Curious	134 (6.4)	124 (5.6)	85 (4.7)	58 (4.0)	61 (4.5)	40 (3.8)	43 (3.3)	47*** (3.3)***
Pendling	56 (6.1)	51 (6.6)	37 (7.1)	18 (5.4)	38 (6.4)	14 (3.6)	20 (7.6)	38*** (6.9)***
Horizontal	21 (5.3)	3 (3.7)	5 (3.9)	5 (3.9)	6 (5.6)	3 (3.8)	4 (4.2)	6*** (3.2)***
Vertical	12 (4.7)	6 (4.2)	7 (5.2)	3 (5.6)	7 (3.6)	3 (7.4)	6 (3.2)	4 (4.9)***
Mixed ster.	24 (9.4)	22 (8.1)	25 (8.2)	18 (4.8)	33 (6.0)	20 (4.9)	11 (5.3)	12* (3.2)***
Biting	39 (3.9)	29 (3.6)	21 (4.2)	1 (2.8)	12 (3.0)	3 (2.8)	3 (2.8)	0*** (0.0)***
Scratching	22 (4.4)	16 (3.3)	13 (3.6)	4 (2.8)	7 (5.2)	10 (2.8)	5 (2.8)	6** (2.8)**
Nipple	3 (5.6)	2 (2.8)	1 (2.8)	3 (4.6)	6 (4.2)	3 (2.8)	1 (5.6)	5 (4.4)*

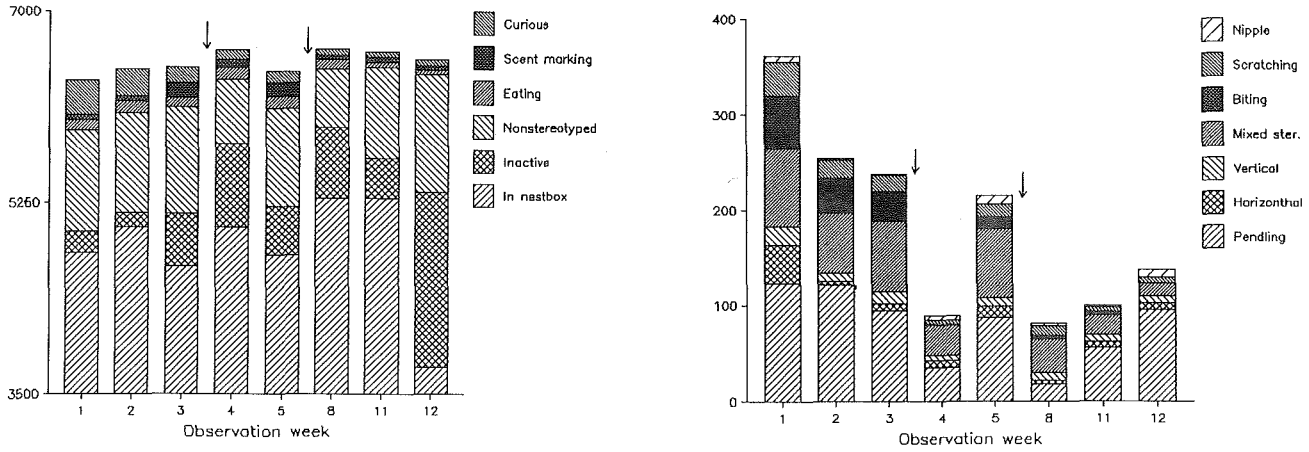


Figure 3. Changes in normal behaviour (left) and stereotypies (right) during the observation weeks. Data presented as total recordings. Arrows indicate transfer between week 3 and 4, and delivery between week 5 and 8.

same time, *inactive* is markedly enhanced. The stereotyped elements *pendling, horizonthal, vertical, mixed,* and *nipple* follow normal activity in the cage, except in the last observation week, when the high activity level is not followed by comparable increments in stereotyped elements.

ELEMENT	OBSERVATION DAY 1	2 n=187	3
In nestbox	187 (68.8)	187 (75)	187 (73.9)**
Inactive	183 (11.5)	170 (8.4)	176 (7.0)***
Nonstereotyped	186 (12.5)	185 (12.5)	186 (12.5)
Eating	98 (1.9)	122 (2.1)	136* (2.0)
Scent Marking	103 (1.9)	89 (2.1)	96 (2.1)
Curious	152 (2.9)	142 (2.3)	140 (2.2)***
Pendling	62 (3.0)	65 (3.3)	73 (3.3)**
Horizontal	14 (1.7)	17 (2.1)	18 (1.8)
Vertical	11 (1.9)	12 (2.1)	17 (2.1)
Mixed ster.	38 (2.7)	43 (3.3)	43 (3.8)***
Biting	33 (1.5)	36 (1.4)	37 (1.5)
Scratching	25 (1.5)	27 (1.6)	26 (1.4)
Nipple	4 (1.6)	8 (1.9)	12 (1.5)

Biting and *scratching* show a steadily decrease during the eight observation weeks, and the same holds true for the nonstereotyped element *curious*.

Table 3 and Figure 4 illustrate behavioural results obtained on the three observations days, and it

Table 3. Number of animals recorded for each behavioural element during the 3 days observation period. Figures in parentheses represent mean observations/animals/-scanning x 100. * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$.

appears that the elements *in nest box, inactive, curious, pendling,* and *mixed stereotypy* differ significantly from day 1 to 3. *Curious* and *inactive* decrease during the week, while *in nestbox*, and the two stereotyped elements increase significantly.

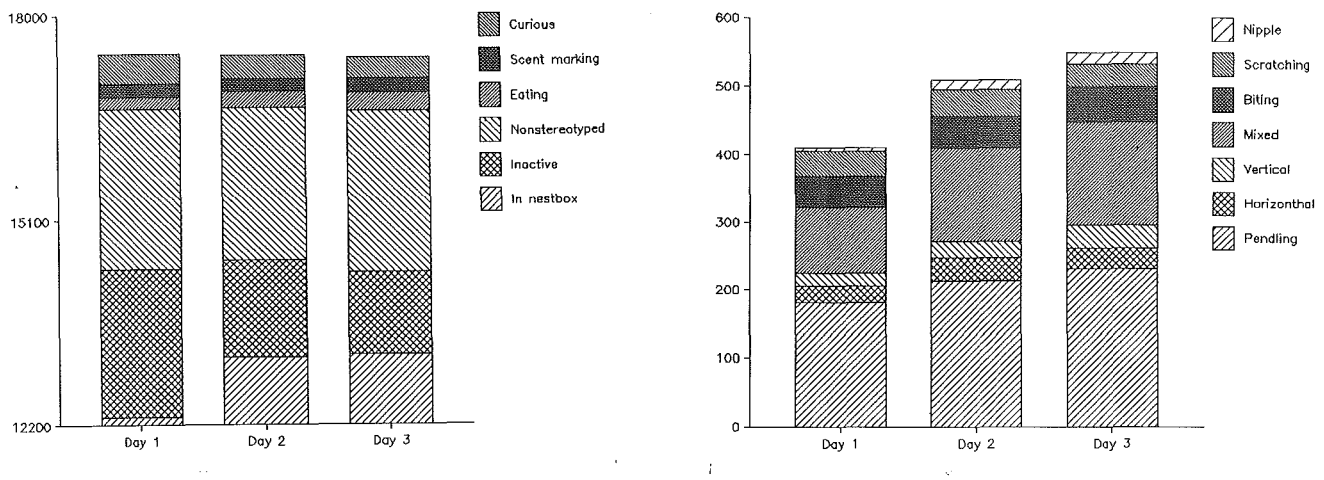


Figure 4. Changes in normal behaviour (left) and stereotypies (right) during observation days.

Results of individual scanning sessions are presented in Table 4 and Figure 5. Significant changes are revealed for all behavioural elements recorded with the most apparent shift occurring between scanning 3 and scanning 4 (i.e. the two scanning sessions separated by feeding). *Non-stereotyped* activity is high and rather constant until feeding, then reduced to a lower but still stable level. Stereotyped elements show a similar pattern, but in contrast to normal activity, most of the stereotyped elements reveal a steadily increase until feeding and a more pronounced decrease after feeding. The elements *biting* and *scratching* differ from other stereotyped elements, in that no increase until feeding is revealed.

Table 4. Number of animals recorded for each behavioural element during the 3 observation days and during the 6 scannings. Figures in parentheses represent mean observations/animal/scanning x 100. * P < 0.05; ** P < 0.01; *** P < 0.001.

ELEMENT	OBSERVATION DAY 1	2 n=187	3	SCANNINGS 1	2	3 n=187	4	5	6
In nestbox	187 (68.8)	187 (75)	187 (73.9)**	187 (70.2)	187 (70.2)	187 (66.0)	187 (74.5)	187 (74.5)	187 (74.5)**
Inactive	183 (11.5)	170 (8.4)	176 (7.0)***	134 (6.8)	156 (7.9)	157 (7.7)	175 (12.8)	176 (10.9)	178 (12.1)***
Nonstereotyped	186 (12.5)	185 (12.5)	186 (12.5)	184 (17.0)	178 (15.8)	182 (17.4)	176 (8.3)	179 (9.8)	180 (9.8)***
Eating	98 (1.9)	122 (2.1)	136* (2.0)	64 (2.8)	45 (2.8)	51 (2.3)	76 (3.4)	95 (3.2)	110*** (3.6)***
Scent Marking	103 (1.9)	89 (2.1)	96 (2.1)	53 (3.0)	78 (3.4)	75 (4.0)	41 (2.8)	57 (3.0)	52** (2.8)***
Curious	152 (2.9)	142 (2.3)	140 (2.2)***	121 (4.2)	100 (3.6)	105 (3.6)	84 (3.4)	103 (3.6)	84 (3.2)***
Pendling	62 (3.0)	65 (3.3)	73 (3.3)**	48 (4.5)	59 (5.7)	66 (8.3)	23 (3.0)	17 (2.8)	25*** (3.4)***
Horizontal	14 (1.7)	17 (2.1)	18 (1.8)	7 (2.8)	17 (3.4)	23 (3.2)	3 (2.1)	5 (2.1)	5* (2.1)***
Vertical	11 (1.9)	12 (2.1)	17 (2.1)	9 (3.0)	12 (3.6)	13 (4.7)	1 (2.1)	4 (2.1)	7** (2.8)***
Mixed ster.	38 (2.7)	43 (3.3)	43 (3.8)***	33 (4.3)	39 (6.0)	50 (7.4)	8 (2.8)	11 (2.1)	6*** (2.1)***
Biting	33 (1.5)	36 (1.4)	37 (1.5)	37 (2.8)	29 (3.0)	22 (2.3)	3 (2.1)	9 (2.1)	10*** (2.6)
Scratching	25 (1.5)	27 (1.6)	26 (1.4)	21 (3.0)	17 (2.3)	19 (3.0)	6 (2.8)	9 (2.3)	13** (2.3)***
Nipple	4 (1.6)	8 (1.9)	12 (1.5)	2 (3.2)	5 (3.8)	10 (2.8)	0 (0.0)	4 (2.8)	3* (4.3)***

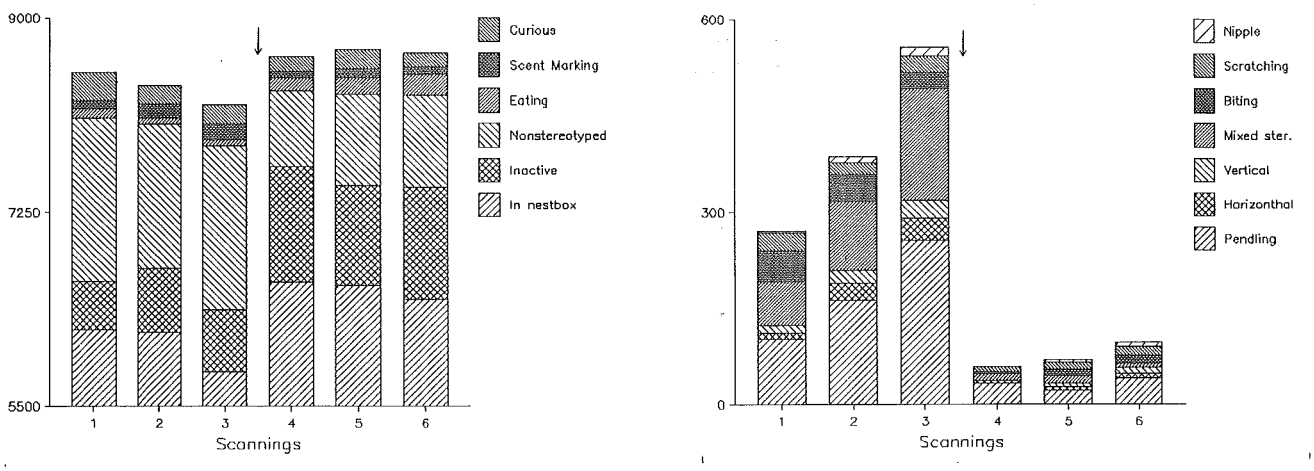


Figure 5. Changes in normal behaviour (left) and stereotypes (right) during scanning sessions. Arrow indicates feeding time.

Correlation coefficients (Spearman Rank Correlation Coefficient, *Siegel, 1956*) between the recorded behavioural elements based on animals performing the elements are shown in Table 5 with probabilities enumerated below the coefficients. In addition to the obvious negative correlations between the element *in nest box* and all elements recorded in cage, several interesting correlations are revealed. *Biting* and *scratching* occur independently of all other observed elements; other stereotyped elements are positive interrelated, negative correlate to *curious* and positively correlated to *scent marking* and to the stereotyped elements *pendling*, *horizontal*, and *mixed stereotypy*.

Discussion

From the present results, it appears that the main activity period of farmed mink is rather sharply concentrated between 9.00 h and 15.00 h, at least when the animals are fed in the middle of the day. That the activity period is in fact regulated by the time of feeding can not be deduced from the present results, but such a dependency has previously been demonstrated (*e.g. Jonge et al., 1985*). During the daytime, mink devote approximately 3% of their total time to stereotypies, and the occurrence of stereotypies is randomly distributed among the animals. The frequency of stereotypies could of course change for a whole

Table 5. Correlation coefficients between recorded elements.

	I. nest.	Inact.	Nonst.	Eat.	S. mark	Cur.	Pend.	Hor.	Ver.	Mix.	Bit.	Scrtc.
Inactive	-.67											
	.0001											
Nonstereotyped	-.78	.28										
	.0001	.0001										
Eating	-.4	.21	.21									
	.0001	.0036	.004									
Scent marking	-.6	.3	.54	.34								
	.0001	.0001	.0001	.0001								
Curious	0	0	-.01	-.13	-.2							
	.99	.97	.88	.07	.006							
Pendling	-.59	.17	.55	.33	.52	-.28						
	.0001	.02	.0001	.0001	.0001	.0001						
Horizonthal	-.41	.1	.32	.2	.36	-.18	.55					
	.0001	.17	.0001	.006	.0001	.02	.0001					
Vertical	-.21	-.02	.25	.01	.16	.07	.15	.2				
	.003	.75	.0006	.88	.03	.33	.04	.005				
Mixed ster.	-.44	.09	.36	.37	.42	-.19	.63	.28	.23			
	.0001	.22	.0001	.0001	.0001	.009	.0001	.0001	.002			
Biting	-.01	-.01	.03	-.08	-.08	.05	-.12	-.06	0	-.12		
	.085	.94	.68	.3	.29	.48	.09	.45	.95	.11		
Scratching	-.05	.02	.06	.02	.05	.07	-.01	-.02	.05	-.06	.05	
	.53	.83	.42	.8	.53	.37	.18	.77	.46	.41	.5	
Nipple	-.28	.14	.28	.12	.21	.05	.04	.11	.27	.05	.13	.03
	.0001	.06	.0001	.09	.004	.53	.57	.13	.0001	.52	.08	.73

diurnal period, but this would require a marked shift in the relations between stereotypies and other activity from daytime to the dark hours. In the above cited study by Jonge et al., 24-h videotape recordings revealed average time spent with stereotypies between 2% and 3%, but calculated in relation to the time the animals were awake, the dutch animals reached as much as 15% of the time spent stereotyping. If a comparable calculation is done here by excluding the fractions of *in nest box* and *inactive*, stereotypies represent exactly 15.8% of the total recordings of active behavioural elements during the daytime. The frequencies of stereotypies obtained in the pre sent study, therefore, very much resemble those obtained by Jonge et al. (1985).

There seems to be an overall positive correlation between levels of stereotypies and level of normal activity; scanblack mink showing higher levels than pastel mink, females revealing higher levels than males, and animals less than 1 year having higher normal activity levels and slightly higher levels of stereotypies than older animals. Concerning the specific stereotyped elements, it appears that only scanblack mink show *nipple*, that males are recorded more frequently for *vertical* than females, and that *mixed stereotypy* is particularly more frequent among the youngest animals. The general picture of positive correlation between normal activity and stereotypies is slightly blurred when the changes within days are studied in more details. During the hours until feeding, stereotypies show high and increasing levels; but after feeding, the stereotypies decline abruptly. Normal activity reveals no increase until feeding, and the decrease after feeding is not so pronounced. This differential effect of feeding time on stereotypies and normal activity may contribute to elucidate some of the factors eliciting stereotypies in mink. Although food was available almost ad libitum, indicated also by the spread-out eating activity, fresh food distribution clearly affects the animals. Perhaps the increment in stereotyped behaviour until feeding reflects "expectancy" of fresh food distribution, and that the stereotyped activity is related to non-rewarded appetitive behaviour for the consummatory act of eating. In the present study, eating activity occurs throughout the day in all scanning sessions, but it is possible that the principal food consumption is concentrated to the period after presentation of fresh food. If the increased frequency of stereotyped behaviour is in fact related to fresh food deprivation, the occurrence and perhaps development of stereotypies could be explained in agreement with Rushen (1985) and Jonge et al. (1985) as a behavioural result of "feeding stress". Of course, the validity of this interpretation has to await further experiments including changes in feeding time and in amount of food distributed combined with additional physiological stress measures.

The behavioural changes between the three observation days (Tuesday-Thursday) are mainly characterized by a fall in the element *curious* and increases in the stereotyped elements *pendling* and *mixed*. It is tempting to explain the changes in *curious* with an adaptation to the presence of human observers during the three continuous observation days. In this way, the high frequency of *curious* on the first observation day would be a consequence of the preceding four days (Fri-

day-Monday) non-disturbance period. The changes in stereotyped elements could be explained in a similar manner; when disturbed by the observers, the frequency of stereotypies falls but the animals adapt to humans proximity and the stereotypies return to original levels. The overall negative correlation between *curious* and stereotyped elements support such an effect of slight disturbance on the occurrence of stereotypies, and additional support is lend by the behavioural changes revealed here over individual observation weeks. Marked, but transient reductions in stereotypy levels are observed subsequent to transfer of the animals from one farm section to another and in response to delivery. Similar "disturbance effects" are not revealed to the same extend for normal activity, so disturbances or other environmental changes may in fact have a general inhibiting effect on developed stereotypies; a suggestion which agrees with the findings of Keiper (1969) and Ödberg (1987).

If stereotypies are facilitated by "feeding stress" as proposed above, it appears illogical at first sight if other potentially stressing conditions such as humans sudden proximity, transfer of the animals, or delivery should have the opposite effects. It is important here, however, to distinguish between the kind of stress experienced by the animals in the different situations. "Feeding stress" is an expected repeated event which probably situates the animals in a state of chronic intermittent stress just like other deprivating situations to which animals can not respond adequately. The other stressing situations, however, have the nature of acute stress. They are totally new transient situations to which the animals can react properly by showing approach, avoidance or other types of adequate responses depending on the situation. Behavioural responses to chronic intermittent stress have been shown to differ both quantitatively and qualitatively from acute stress responses (*Heller, 1985; Heller and Jeppesen, 1985*), so in this respect, the differential effect on stereotypies have not been shown to develop in response to chronic intermittent stress per se (*Ödberg, 1989*), some additional facilitating factors must be important. Lack of external stimulation inducing alternative activities could be obviously relevant in a restricted cage milieu, and the present study show, in fact, that environmental stimulation even in the form of acute stress reduces the performance of stereotypies.

The above considerations concerning stereotypies and their possible relations to experienced stress are rather speculative. As stated by Ödberg (1987), it is very difficult to separate original causal factors and merely modulating factors when the ontogeny of stereotypies has not been followed, and especially when the stereotypies have not been manipulated experimentally or correlated to physiological measures.
Concerning interrelations between specific behavioural parameters, the present study shows that *scent marking* and *eating* are positively correlated with the stereotyped elements and negatively correlated with *curious*. This could mean that *scent marking* and *eating* at least partially are provoked by the same factors as stereotyped behaviour, and that the two elements, therefore, are stimulated under conditions of chronic intermittent stress in a low stimulating milieu as proposed above. If this interpretation is valid, parts of the observed *scent marking* and *eating* elements could be considered as non-functional conflict behaviour. In the study by Jonge et al. (1985) sham-feeding behaviour is frequently observed and categorized as a stereotypy. Sham-feeding resembles normal eating, except that no food is taken during the behaviour. The present study does not distinguish between functional eating and sham-feeding, and it is possible, therefore, that the positive correlations obtained here between *eating* and stereotyped elements could be the result of correlations between sham-feeding and stereotypies.

Although the stereotyped elements recorded in the present study all meet the major criteria of stereotypies, there could be some problems especially concerning the element *pendling*, defined here as stereotyped to and from movement of the whole body. This element follows normal activity in the cage, just like other stereotyped elements, but due to the oblong construction of the cages, any high level motor activity would very easily look stereotyped. It is possible, therefore, that some *pendling* recordings do not reflect actual performances of a stereotypy, and that such recordings should, in fact, have been categorized as *nonstereotyped activity*. This is of particular importance since *pendling* is the most commonly recorded stereotypy in the present study representing 43% of all stereotypies. The problem with *pendling* adds to an overestimation of the actual stereotypy frequencies. Such an overestimation could be counteracted by the scanning observation method employed in the present study, since the scannings involved short-time observations of the animals, and any longer-lasting and more complex types of stereotypies are therefore not included in the present results. The 24 h video recordings as well as preliminary intense ad libitum observations, however, did not confirm the existence of such stereotypies. It is our opinion, therefore, that the present quantification of stereotypies reflecting 3% total occurrence and 15-16% of the active behaviour are maximum estimates.

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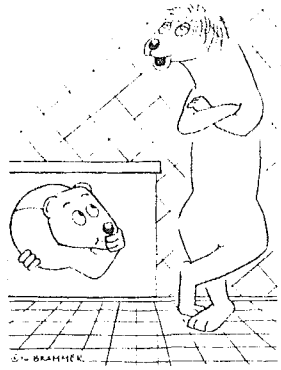

Beautiful Fur Animals – and their colour genetics

By Norodd Nes, Einar J. Einarsson and Outi Lohi
with contribution from S. Jarosz and R. Scheelje

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Beautiful Fur Animals – and their colour genetics is intended as a reference book for fur farmers and fur merchants and a textbook or manual of studies about qualitative genetics.

The book is a result of an age-long collaboration between the authors Norodd Nes and Einar Einarsson from Norway and Outi Lohi from Finland/Denmark. Stanislaw Jarosz from Poland and Reinhard Scheelje from West Germany have both contributed to the chapters concerning nutria and chinchilla.

The authors have done a great deal of research into qualitative genetics of fur bearing animals. They have also worked closely with practical fur breeding. The book is therefore written especially for people in praxis but it will also be a useful textbook and inspiration for additional reading into qualitative genetics or fur animals in general for most levels.

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Original report

Effects of play balls on peltbiting, behaviour and level of stress in ranch mink.

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Abstract

Mink cages were provisioned with two plastic balls and the effects of these on behaviour, stress physiology and pelt damages were recorded. Mink spent some time manipulating balls during the first weeks after their introduction. This behaviour almost ceased within one month, but at that time general activity and curiosity were still increased and time spent in nest still decreased by the balls. Pelt damages and stress parameters were not affected by the balls. Female mink were more stress sensitive than males. Mink presumed to bite the pelt of their cage mates had higher levels of eosinophil leucocytes, indicative of higher levels of long term stress.

Introduction

Animals kept in restrictive environments frequently display normal behaviour with a greater or a smaller frequency compared to animals living in nature and sometimes they develop abnormal behaviour. This may lead to an economic loss which can be prevented by keeping the animals in less restrictive housing conditions.

Pigs not allowed to root in the soil increase social contacts leading to a higher frequency of aggression and tailbiting. A regular supply of fresh straw or soil can reduce damage considerably (*e.g. Buré, 1985; Meyer et al., 1984*).

Peltbiting in mink undoubtedly depend on various genetic and environmental conditions. In this work it was examined whether failing possibility of occupation, as it was seen in pigs, had some relevance. Since it was not in advance obvious which object mink should accept for occupation it was examined whether they would have something to do with play balls, and whether this, if occasion should arise would, influence their behaviour, stress level and incidence of peltbiting.

Materials and methods

The investigations were carried out in the fall of 1989. The animal material consisted of 197 demi (pastel x pearl) and 192 standard yearlings. All animals were kept two by two (a male and a female) under conventional farm conditions in standard wire cages in a two rowed shed at a private farm. The cages belonging to the standard yearlings were numbered from 1 to 96. Each colourtype were equally divided into a control and an experimental group. Animals from each group were alternately arranged sectionwise (1 section = 6 cages) just following weaning. Cages belonging to the experimental groups were supplied with two play balls each early in the morning on the 17th of October. Balls were made of red hard plastic, 4.5 cm in diameter.

All animals were killed the 27th-28th of November and graded for peltbiting on the 13rd of December. The behaviour of the standard yearlings was observed between 10 a.m. and 3 p.m. the day before and the 1st, 2nd, 3rd and 27th day after play balls were given. On day 6 and 7 after play balls were given blood samples were collected for later determination of the individual eosinophil leucocyte and cortisol levels. Blood samples were collected in cages numerical order. On the 23rd of October between 9 a.m. and 12 a.m. blood samples were collected from males in cages 1-96 and later in the afternoon between 1 p.m. and 3 p.m. from females in cages 1-36. The 24th of October between 10 a.m. and 12 a.m. from females in cages 37-96. If the duration of collecting a blood sample lasted more than a minute or more a note was taken. A litter size index, expressing the reproductive potential of the animal, was also recorded.

The behaviour data were collected according to the one-zero-method (*Lehner, 1979*): Over a period of 30 seconds it was noticed in 3 cages in a row for each animal if one or more of the following behaviour elements had taken place. Cage no. 1 - 3 were the first to be observed and the observations were continued in cages numerical order three cages at a time. Each cage was observed 6 times per observer per day. One observer did the observations on day 1-3 and two observers did the observations on day 13 and 27 after the play balls were given. Thus, the average individual score for every behaviour elements is based on 42 observations, each with a duration of 30 seconds. The following elements of behaviour were observed: Nest: in the nestbox. Curious: looking at the observer from a position close to the frontdoor. Stereotype: performing stereotyped behaviour (including pendling, see Bildsøe et al., 1990). Ball play: pushing to the ball with paw or nose. Social play: all kinds of non-aggressive social interaction. Including neckbiting, dragging around wiht the cage mate and play fights with "Play face" (*Poole, 1978*) and bites which are not carried through. Aggression: behaviour which causes the cage mate to displace, escape or scream. Mostly bites without "play face". Marking: all kinds of marking behaviour: rubbing the belly, the sides or the anal region against the floor and the sides of the cage. Active: all kinds of activities in the cage besides the above mentioned. Passive: sleeping or awake and inactive in the cage.

Results

Effects of play balls, sex and colourtype.
The use of play balls did not influence the frequency of peltbiting. Approximately 11% of the standard yearlings from the experimental group and about 17% from the control group showed different degrees of peltbiting. Approximately 54% of the demi yearlings from the experimental group and about 29% from the control group showed peltbiting (table 1). The demi groups showed more peltbiting compared to the standard groups ($P < 0.001$, x^2-test, two-tailed). The distribution of neck bite and body bite between males and females was not by a mere coincidence ($P < 0.01$, x^2-test, two-tailed). Females had a relatively higher frequency of neck bites and a lower frequency of body bites compared to males.

Table 1. Number of animals in experiment and number of animals with pelt bites distributed according to colour type, sex and presence or absence of ball.

	STANDARD			DEMI			STANDARD + DEMI
	MALE	FEMALE	TOTAL	MALE	FEMALE	TOTAL	
WITH BALL							
NO. OF ANIMALS	48	48	96	54	49	103	199
ANIMALS WITH BITES							
IN NECK	1	0	1	5	19	24	
ON BODY	8	2	10	9	11	20	
TOTAL	9	2	11	14	30	54	65
WITHOUT BALL							
NO. OF ANIMALS	48	48	96	45	49	94	200
ANIMALS WITH BITES							
IN NECK	4	4	8	5	19	24	
ON BODY	4	5	9	3	2	5	
TOTAL	8	9	17	8	21	29	46

Table 2. Percentage observations of specified behavioural elements and mean levels of cortisol and eosinophil leucocytes distributed according to sex and presence or absence of play balls. Standard mink. Number of animals shown in brackets. Behavioural data means of day 1-27.

	SEX				BALL			
	MALE	(N)	FEMALE	(N)	WITHOUT	(N)	WITH	(N)
BEHAVIOUR (% OBSERVATIONS)								
NEST	80.6	(96)	80.7	(96)	82.4	(96)	*78.9	(96)
CURIOUS	6.8	--	7.5	--	6.4	--	*7.9	--
STEREOTYPE	3.6	--	*5.9	--	4.4	--	5.1	--
BALL-PLAY	3.1	--	2.7	--	.0	--	5.8	--
SOCIAL PLAY	3.3	--	3.1	--	3.4	--	3.0	--
AGGRESSION	.6	--	.4	--	.6	--	.4	--
MARKING	.3	--	.2	--	.3	--	.2	--
ACTIVE	28.3	--	30.3	--	26.0	--	*32.6	--
PASSIVE	.9	--	.7	--	.7	--	.9	--
CORTISOL (NMOL/L)	34.1	(90)	*62.0	(90)	46.8	(90)	49.3	(90)
EOSINOLHILS/MM^3	219.2	(68)	222.7	(70)	205.6	(72)	236.3	(66)

(* P < 0.01, ANOVA / Mann Whitney U-test, two-tailed)

Play balls did not have any effects on the physiological parameters (eosinophils, cortisol) either, but they did influence behaviour (table 2). Data from day 1, 2, 3, 13 and 27 were subjected to an analysis of variance to test whether day, sex or play ball had any significant influence on behaviour. Animals in the experimental group spent less time in "nest" and were more "curious" and "active". The frequency of "stereotype" was greater in females compared to males, and significantly greater in females in the experimental group compared to females in the control group (7.1% and 4.8%, respectively; $P < 0.05$). Females had the highest level of cortisol. Except "marking" all elements of behaviour showed significant ($P < 0.001$) variations across the 5 observation days. Fig. 1 illustrates this aspect for those elements of behaviour which were significantly influenced by the presence of play balls. The effect of play balls on "nest" and "active" existed all days of observation. "Curious" was only influenced the last two observation days (interaction ball x day, $P = 0.006$).

On the day before play balls were given there was no significant differences between the experimental and the control group as far as behaviour was concerned.

Characterisation of bitten minks and their potential biters

For all estimated parameters a comparison was

Table 3. Eosinophil levels in animals which have no pelt bites and whose cage mates have bites, and in animals which have pelt bites and whose cage mates do not have. Data distributed according to sex. Number of animals shown in brackets.

	ANIMALS WITH NO PELTBITES, BUT LIVING TOGETHER WITH AN ANIMAL WITH BITES		ANIMALS WHICH HAVE PELTBITES, AND LIVES TOGETHER WITH AN ANIMAL WITHOUT BITES	
MALES	(8)	201.8	(9)	190.4
FEMALES	(13)	268.4	(7)	135.9*
BOTH SEXES	(21)	243.0	(16)	166.6**

(* P = 0.06, ** P = 0.03: Mann-Whitney U test, two-tailed).

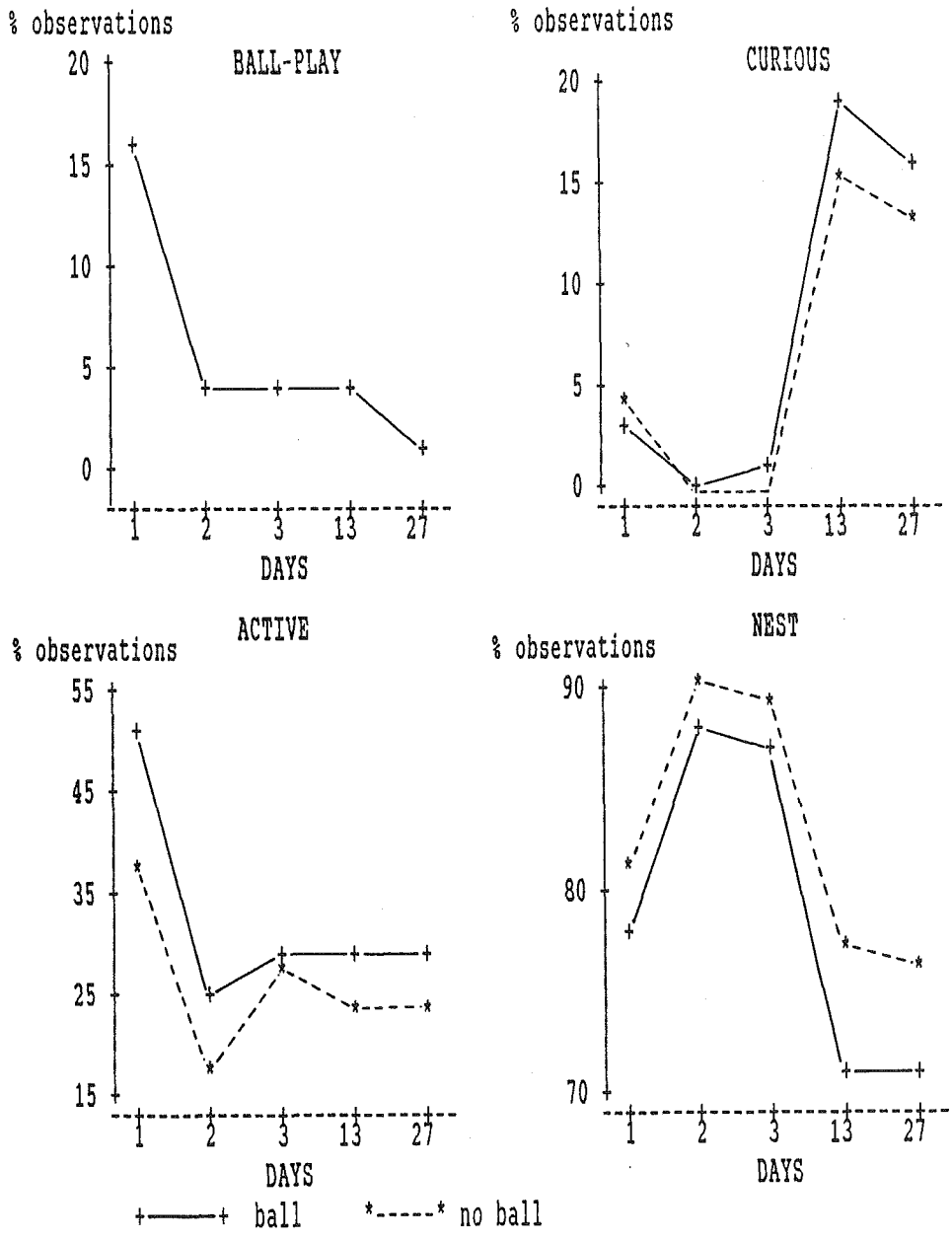

Fig. 1. Effect of day of observation and presence (+) or absence (-) of ball on frequency of four behaviour elements.

made between animals with bite marks and their cage mate (potential biters). The only parameter showing significant difference between those two groups was the eosinophil leococyte level which was lowest among animals with bite marks (table 3). As far as males were concerned potential biters had a tendency to be less curious (P = 0.06) and more aggressive (P = 0.06).

Effects of collecting blood samples in cage numerical order

As far as males were concerned there were no effects on any of the physiological parameters (eosinophils, cortisol) in relation to the order in which blood samples were collected. In females the cortisol level was higher on day 1 compared to day 2 and the level significantly increased during day 2. The eosinophil leucocyte level was significantly lower on day 1 compared to day 2 and significantly increasing during day 2 (table 4). An effect of the duration of the individual blood samples was also present. Samples which took more than 1 minute to collect had a significantly higher cortisol level compared with the rest of the samples (97.2 respectively 55.8 nmol/l, P = 0.0022).

Table 4. Effect of sex and of collecting blood samples in cage numerical order on cortisol and eosinophils. Blood samples were collected on two consecutive days. All samples from males were drawn in cage numerical order on day 1. Samples from females were drawn in cage numerical order at the end of day 1 and on day 2. The effect of sampling order is illustrated by mean scores for day 1 and 2, and by the correlation between individual scores and cage number, and by the slope resulting from a linear regression of these data. Slope is expressed as % change in relation to mean, in order to allow comparison between cortisol and eosinophil slopes.

	SAMPLING ORDER			MANN-WHITNEY TEST	
	MALES	FEMALES		P,sex	
	DAY 1	DAY 1	DAY 2		P,day
	CAGE 1-96	CAGE 1-36	CAGE 37-96		
CORTISOL					
NO. OF ANIMALS	91	32	57		
MEAN (nmol/l)	34.1	87.1	47.7	0.0001	0.0001
TIME EFFECT,					
slope (% per cage)	0.05	-1.96	0.84*		
correlation	0.06	-0.15	0.27*		
EOSINOPHILS					
NO. OF ANIMALS	68	12	58		
MEAN (no./mm^3)	218.2	140.7	239.2	0.89	0.005
TIME EFFECT					
slope (% per bur)	0.49	-2.43	1.60**		
correlation	0.04	-0.23	0.40**		

(* P<0.05 / ** P<0.01; slope: OLS-method; correlation: Spearman Rank).

Correlation between data

A clear pattern of correlation existed within the set of behaviour data: Elements performed out in the cage were all more or less positively correlated, and significantly positive correlated to "active" and significantly negative correlated to "nest" (table 5). If the correlation analysis was done on each sex separately the same pattern as stated above appeared. In addition there was a positive correlation between the same elements recorded for males and females ($P < 0.01$), except for the element "passive". "Ball play" was likewise significantly positive correlated between males and females, and within each sex significantly positive correlated to "active".

The physiological parameters and index for litter size were not mutually significantly correlated or correlated to any of the elements of behaviour. If data were separated out on each sex some of the tendencies stated in table 5 showed up to be sig-

Table 5. Coefficeints of correlation (Spearman Rank) between specified elements. Significant correlations ($P < 0.05$) underlined. Number of animals in analysis shown in brackets.

	ACT	MAR	STE	PAS	CUR	AGG	SOC	NES	EOS	COR	LIT
ACTIVE (192)		.23	.47	.25	.40	.17	.27	-.85	-.10	.05	-.03
MARKING (192)			.17	.11	-.09	.20	.25	-.23	-.14	-.01	-.05
STEREOTYPE (192)				.13	-.06	.08	.11	-.54	-.08	.06	-.07
PASSIVE (192)					.06	.11	.09	-.29	-.12	.07	-.01
CURIOUS (192)						-.05	.13	-.35	-.06	-.07	-.05
AGGRESSIVE (192)							.19	-.25	.15	-.03	.03
SOCIAL PLAY (192)								-.30	-.03	-.05	.13
NEST (192)									.11	-.04	-.05
EOSINOPHILS (138)										-.11	-.01
CORTISOL (180)											-.09
LITTER SIZE INDEX (143)											

nificant. Female eosinophil leucocyte level was significantly positive correlated with female "aggression" (0.35). Male eosinophil leucocyte level with male "nest" (0.50). Female "ball play" with female cortisol level (0.32). Litter size index was negatively correlated to each of the non social elements and positively correlated to the two social elements, especially to social play. An analysis of the correlation between litter size index and the combined social respectively non social elements confirmed the existence of this tendency. Although still insignificant litter size index correlated positively to social elements (0.08) and negatively to non social elements (-0.08).

Discussion

The variations in cortisol and eosinophil levels in relation to the order in which blood samples were collected could be due to normal day by day variations and independent of the experiment. This interpretation is contradicted by the fact that the variations in the cortisol and eosinophil levels do not follow the same pattern on the two separate days. The recorded variations are in complete accordance with previous findings on variations in cortisol and eosinophil levels due to prolonged and acute stress (*e.g. Heller and Jeppesen, 1985*), which make it likely that the recorded variations in eosinophils and cortisol in this study are due to stress.

The level of cortisol was high and the level of eosinophils was low in blood samples taken from females on the first day. This may be due to an acute stress caused by the disturbance related to the collection of blood samples, which do not usually take place at a private farm. The low number of circulating eosinophils in females on day 1 are expected since the collection of blood samples from their male cage mates and with that the stress of the females started hours before the blood samples were drawn from the females (*Zarrow et al., 1964*). The number of circulating eosinophils in females on day 2 was higher compared to the number in females on day 1 and increasing during the period of collection as expected a day or so following acute stress and during repeated stress (*Heller and Jeppesen, 1985*). The level of cortisol was "normal" early in the morning on day 2, due to the previous rest period and the short half life of cortisol and increasing during the day due to the renewed disturbance.

The differences observed between sexes with respect to cortisol levels and adrenocortical reactivity are in agreement with the general experience from experiments with rodents, which show that androgen inhibits reaction to stressors (*e.g. Kitay, 1963*).

Bleedings lasting more than a minute were few and randomly distributed and did not, therefore, influence the previous or coming considerations. The control and the experimental group were alternately arranged sectionwice and the results concerning effects of play balls cannot, therefore, be affected by the stress reaction caused by the sampling order. The relatively few animals which were the basis for comparison of eosinophil levels in bitten and potential biters were also randomly distributed in respect to sampling order and the result obtained, therefore, not influenced by the order.

The use of play balls in the daytime decreases distinctly during the observation period and almost came to an end on day 27. It is remarkable that, in spite of the failing reaction to the balls, some behaviour elements were still affected by the balls at that time. The presented increased frequency of "active" and "curious" and decreased frequency of "nest" may be taken as an indication of improved well being (*Jeppesen, 1988*). The higher frequency of "stereotype" in females with a play ball and the positive correlation between "ball play" and cortisol level in females could be due to a general increase in activity caused by the play balls. It seems most unlikely that the increased level of cortisol and number of stereotypes should be an expression of experienced harmful stress, since animals could freely choose if they wanted to use the play balls.

The shown variations in behaviour in relation to day of observation were partly due to presence of the observer (*see Bildsøe et al., 1990*). Low levels of "curious" on day 1, 2 and 3 were most likely due to habituation to the observer who was also present before day 1. The high levels of "curious" on day 13 and 27 were in keeping with that argumentation due to the preceding periods without observer and to the presence of an extra observer. Similar considerations explain the variation in frequency of "nest". The variation in "active" is at moment difficult to explain. It seems certain, however, that variation could not be due to presence of play balls since the control and the experimental group show parallel variations.

Animals with peltbites had low levels of eosinophils; the potential biters had high levels. Since it was shown previously (*Heller and Jeppesen, 1985*) and is supported by the findings of the present study, that high levels of eosinophils may express experienced long term stress, then we cannot avoid suggesting that bitten animals are the least stressed in a couple and that potential biters are the most stressed. This means that the damaging peltbites observed on the skin after pelting cannot be a result of normal ritualised aggression and social play, since this is normally directed from dominating/unstressed animals toward submis-

sive/stressed animals. It has to be so that damaging peltbites are caused by the unritualized defence aggression occasionally performed by submissive or stressed animals in situations where the motivation for flight is high but flight not possible. This interpretation is supported by the fact that also in swine it is the most stressed animal that perform damages (*Buré, 1985*). At first the lack of correlation between bite marks and all recorded elements of behaviour was difficult to understand; it is much more easy if peltbiting is due to the above mentioned unritualized and only occasionally occurring defence aggression. The failing correlation may in fact be taken as support for the suggestion that pelt damages are caused by subordinate or long term stressed animals, since correlation between peltbites and the normal and far most frequent behaviour is not to be expected in that situation.

The highly negative correlation between "nest" and all recorded elements of behaviour may be explained solely by an individually different use of the nests and be suggestive, therefore, of a different level of general activity among animals. The positive correlation between "active" and all elements of behaviour performed out in the cage could be due to the fact that animals spending a lot of time out in the cage have greater opportunity to show a variety of different elements of behaviour. Another explanation could be the existence of a true causally based correlation between elements.

The existence of significantly positive correlations between almost all elements of behaviour showed by males and the same elements showed by females is remarkable. Concerning social elements correlation between males' and females' performance of same element are obvious, but the result suggests that also for all the others elements there must exist a casual relationship responsible for the result.

The correlation between eosinophils and "aggression" in females and eosinophils and "nest" in males can not be related to any data in this investigation or to data from the literature. The exciting indication that a high frequency of social behaviour are positively correlated to the index for litter size already in the autumn need a further investigation. If planned so that social elements are the only ones to be looked for it will show whether data can be collected fast enough to use behaviour to predict potential fertility in farm practice.

The highest frequency of peltbiting was found among the demi yearlings. This is in accordance with a previous findings that crosses between pure lines exhibited a higher frequency of peltbiting compared to pure lines. This phenomenon could be caused by an expected higher level of activity in crosses between pure lines, or by the fact that livegrading just before pelting reduce peltbites (*Falkenberg, 1990*) and crosses are seldom sorted. In this investigation neither the standard yearlings nor the demi yearlings were graded before pelting. The difference in frequency of peltbites between the two colourtypes must therefore be due to a genetic difference in behaviour.

Females had a higher frequency of neckbites and a lower frequency of body bites compared to males. This may mean that the instinctive tendency of the males to perform neck biting as part of the sexual behaviour influence the orientation of the damaging pelt bites. Whether the sexual motivation of the males means anything for frequency of peltbiting can not be assessed by the result of the present study.

Even though play balls influenced behaviour they did not reduce the frequency of peltbiting. This may be due to the fact that they were small distinct stimuli easy to monopolize and that they increased the activity of the animals and with that the risk of creating more competition and social stress in the pair. It may be noticed that the objects effective in reducing tailbiting in swine were natural stimuli, soil or straw, and that they were spread out over all of the enclosure of the animals. The effects of giving "toys" such as car tyres and chains were limited also in swine. The failing influence of play balls on frequency of peltbites could be caused also by the facts that the reported changes in behaviour were too minimal to have any effect.

The most important reason for the failing effect of the play balls in this experiment may have been, however, that they were provided at the wrong time. Since livegrading shortly before pelting is very effective in reducing peltbite (*Falkenberg, 1990*), any effort exerted to reduce peltbites should be practised most effectively at that time. The effect of the livegrading on peltbites may depend on its properties as acute stressor and with that its effectiveness in reducing activity in general (*Bildsøe et al., 1990*). The aim of further investigations on causes of pelt bites should be to test this hypothesis and to find practical means to reduce activity effectively shortly before pelting.

Acknowledgement

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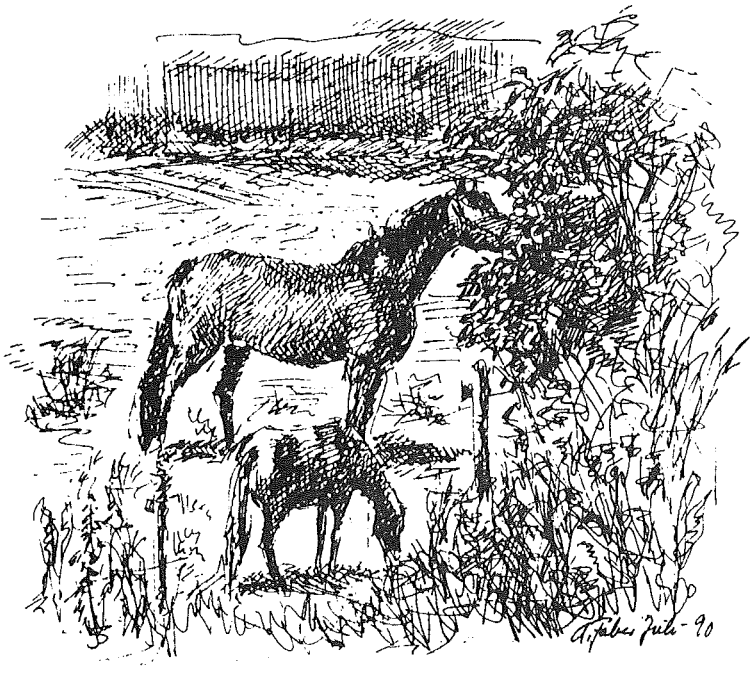

Original Report

Activity pattern of lactating mink and the effect of water trays or wire netting cylinder in mink cages

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Summary

Either water trays or wire netting cylinders were placed in conventional mink cages immediately before the mink were whelping. The activity of the females in the conventional as well as the enriched cages was recorded from the kits were approximately 4 weeks old and until the kits were weaned at the age of 8 weeks.

For all three experimental groups the activity of the females out in the cage increased as a function of time. The activity in the day hours seems to be controlled by feeding time. In the period between morning feeding and noon feeding, the females are most passive and placed either in the next box or in the entrance to the nest. After noon feeding the females maintain a relatively high level of activity out in the cages.

At the same time as the level of activity increased in general, the stereotypic behaviour accounted for an increasing part of this activity. Females with access to wire netting cylinders showed less stereotypic behaviour than females with water trays and females in control groups.

The use of water trays by the females was very low throughout the entire experimental period. Kits were not observed to lick liquid from the female's wet pelt. This possibility of securing extra liquid for the kits does probably not exist.

The weight development of females and kits with access to water trays does not differ from the weight development of mink in the two other groups.

Introduction

In the lactation period females have a great need for water. Part of the water is used for milk production. The increased metabolism results in a larger need for liquid for heat regulation and for segregation of breakdown products.

Stereotypic movements, without any clear-cut function, and pendling up and down the wall of the cage at a relatively high speed are supposed to be extremely energy-demanding.

These patterns of movement often occur in connection with the feeding situation. It may also be expected that at the end of the lactation period the presence of the kits motivates the females partly to be with the kits and partly to try to get away from the kits which may further the stereotypic activity.

The objective of this project was to illustrate the pattern of activity of the females during the last 4 weeks of the lactation period, which must be considered the most stressing period for the female. There was also a wish to investigate the importance of water trays as extra supply of liquid for the female, as well as the importance of a resting place where the female can be alone without the kits.

Material and methods

59 mink females of the colour type pastel were included in the experiment. Since weaning the mink had been living in conventional mink cages.

Immediately before whelping, water trays (30 cm L x 20 cm W x 2 cm H) were placed in 16 of the cages approximately 15 cm below the cage ceiling. In 20 other cages wire netting cylinders (diam. 10 cm, length 30 cm) were suspended from the cage ceiling. No changes of the cages were made for the remaining 17 females.

The water trays were filled with water daily at 10.30 a.m. Apart from that the animals were taken care according to normal farm routine. The animals were fed at 1.00 p.m., and the following morning at 8-9 a.m. the feed remains were redistributed.

Individual scanning observations were carried out in each of the weeks 22, 23, 24, and 25 from 8.00 a.m. till 3.00 p.m. The observations started when the kits were approximately 4 weeks old (on May 25th, 1987), and ended when they were approximately 8 weeks old (on June 22nd, 1987).

The observer passed the cages 4 times per hour and noted down the ongoing activity of the mink.

The following elements of behaviour were recorded at Scan-sampling:

1) Mink in the nest box.
2) Mink lying in the nest box entrance.
3) Mink lying out on the wire netting floor of the cate.
4) Mink non-specifically active out in the cage.
4a) Mink pendling out in the cage.
4b) Mink performing stereotypic behaviour out in the cage.
4c) Mink on the water tray.
4d) Mink in the wire netting cylinder.
9) Kits in the nest box entrance.
10) One or more kits out in the cage.

The results of the behavioural observations have been calculated as number of observations where the position or behaviour in question was observed in per cent of total number of observations in the period in question, i.e. the per cent frequency of the position/ behaviour.

The elements of behaviour act.pendling, act.stereotype, act.wire netting cyl., and act.watertr. have been calculated as per cent of observations where the female has been active out in the cage.

The females were weighed on May 1st, and both females and kits were weighed, when the kits were 3 weeks old, and when the kits were weaned at the age of 7-8 weeks.

When calculating the weight development of the females throughout the experimental period, corrections have been made for time of birth according to the following formula: corrected weight = measured weight + (average number of days after birth - actual number of days after birth) * weight change per day.

Results

Figure 1 shows the recorded female weights corrected for time of birth as function of number of days after birth. It appears from the figure that there is no difference in weight development of the female groups, which is confirmed by an analysis of variation.

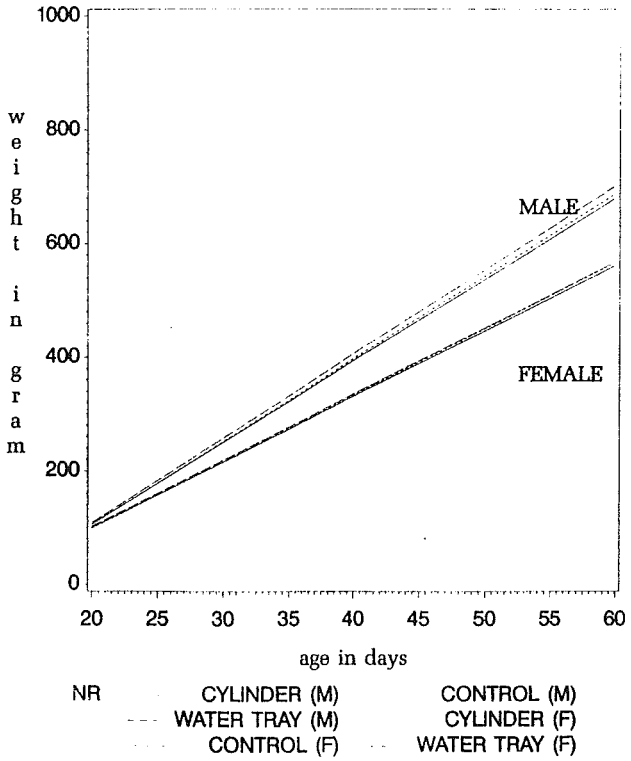

Figure 1. Weight development of female and male kits. (Weighed 21 and 52 days old).

Figure 2 shows the weight development of male and female kits as function of age. An analysis of variation shows that there is no difference between the weight development of the experimental groups.

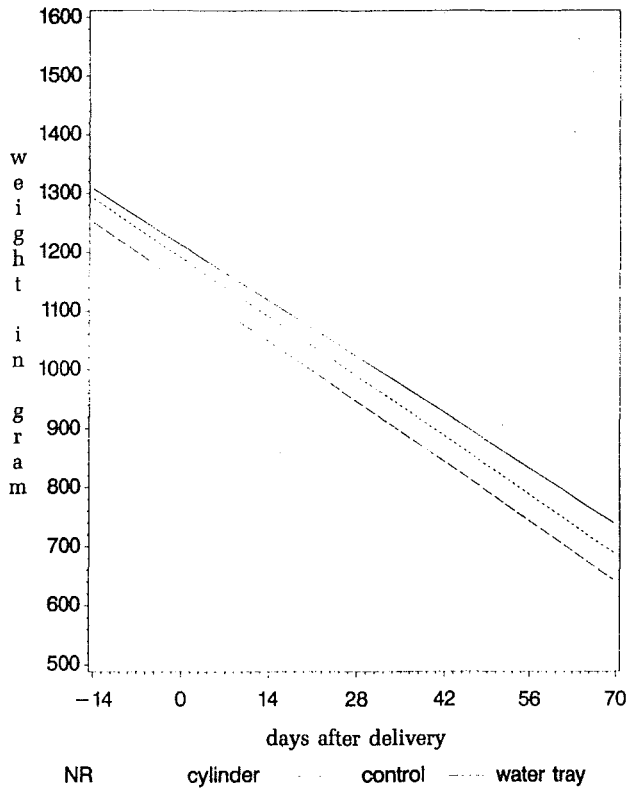

Figure 2.Weight development of females during the lactation period.

Table 1 shows position/behaviour of females in each of the three experimental groups distributed on the 4 weeks of observation and for the entire observation period. The results have been treated statistically with a nonparametric test Wilcoxon (SAS), $p<0.0001$ = ***, $p<0.005$ = **. For all elements of behaviour - apart from "in nest box entrance" in females with wire netting cylinders ($p=0.0512$) - there is a significant difference in frequency over the 4 weeks.

The activity of the females out in the cage increases from week to week. The position of the females out in the cage and the position of the kits out in the cage and in the nest box entrance increase significantly from week 23 to week 24.

The females use the nest box less in the 2 last weeks than in the 2 first weeks.

The element of behaviour act.pendling increases from week 22 to week 23 and remains at this level during the following weeks. The element of behaviour: act.stereotype increases from week 24 to week 25. Females with wire netting cylinders perform significantly less pendling ($p<0.05$) and stereotypic behaviour ($p<0.005$) than females in the control group and females with water trays.

Females with access to water trays use these less and less with time.

Females with access to wire netting cylinders use these regularly in the first three weeks, and then the use of the wire netting cylinders decreases.

The statistical test shows a difference between groups of females as regards position of the female in the nest box ($p=0.066$), in the nest box entrance ($p<0.005$) and lying out in the cage ($p<0.01$).

Table 2 shows position and behaviour of the females in periods 1 and 2, respectively. For period 1, the statistical analysis (Wilcoxon) shows a significant difference as regards position of the females lying out in the cage and in nest box. In period 2 there is a significant difference as regards position in nest box entrance, lying out in the cage as well as for the elements of behaviour act. pendling and act. stereotype. There is a tendency as regards kits in the nest box entrance $P = 0.0663$.

Table 3 shows the average position/behaviour of all females during the hours of the day in periods 1 and 2, respectively.

In the first period, the females are most active out in the cage at 8 a.m. when the feed is being redistributed and again at feeding at 1 p.m. and the rest of the day. In period 2 the same pattern is seen as in period 1, but around noon feeding the females are active and out one hour earlier than in period 1.

In general the nest box is used more in the morning and less in the afternoon in both periods.

In period 1, the kits are more out in the cage in the afternoon which is also seen in period 2, but the kits are also out in the morning, when the females are inactive in the nest boxes.

Discussion

For all three experimental groups the results showed a significant increase in active behaviour

Table 1. Per cent frequency of position/behaviour per week for females in control cages, females in cages with wire netting cylinder, and females in cages with water trays, respectively, as well as the per cent frequency for the entire experimental period.

Position/ behaviour	WEEKS OF OBSERVATION 22	23	24	25		22-25
CONTROL FEMALES						
in nest box	48	56	40	47	***	48.2
in nest box entr.	19	15	17	10	***	15.8
out in cage	32	28	41	41	***	35.9
lying out in cage	22	13	18	11	***	16,5
active out in cage	9	14	23	31	***	19.4
act. pendling	2	9	11	10	***	8.2
act. stereotype	2	9	4	17	***	7.9
inactive	90	85	76	68	***	80.5
kits out in cage	14	13	26	24	***	19.5
kits in nest entr.	0	0	2	12	***	3.5
WIRE NETT. CYLINDER						
in nest box	51	54	45	45	**	49.3
in nest box entr.	17	18	18	16	ns	17.6
out in cage	30	27	35	38	**	33.0
lying out in cage	19	8	12	6	***	11.9
active out in cage	11	18	24	32	***	21.1
act. pendling	1	5	6	7	**	4.7
act. stereotype	0	6	2	10	***	4.5
act. wire nett.cyl.	20	18	24	10	**	18.2
inactive	88	81	76	68	***	78.8
kits out in cage	11	8	26	22	***	17.2
kits in nest entr.	0	0	2	14	***	4.2
WATER TRAYS						
in nest box	53	61	45	45	***	51.8
in nest box entr.	17	14	14	13	**	14.8
out in cage	28	24	40	40	***	33.4
lying out in cage	16	8	20	5	***	13.0
active out in cage	12	15	20	35	***	20.3
act. pendling	3	7	10	12	***	8.0
act. stereotype	3	4	6	19	***	8.3
act. in water tr.	12	9	2	1	***	5.5
inactive	88	84	80	65	***	79.6
kits out in cage	12	5	33	22	***	18.6
kits in nest entr.	0	0	4	13	***	4.4

out in the cage as a function of time. This increase was corresponded by a decrease in the use of nest box, lying in the nest box opening, and lying out in the cage, respectively.

The reason for the increase in activity may be a rising temperature in the nest box because of crowding, and that the female in periods try to get away from the kits. The possible effect of the increasing temperature to the use of nest boxes by the females is maybe supported by the fact that in the afternoon the females were more out in the cage.

Investigations regarding the optimal age of weaning have shown that when the kits are weaned at the age of 8 or 10 weeks, the physiological stress level of the females is reduced. If the kits are weaned at the age of 6 weeks, no immediate reduction of the stress level is seen, but the weaning in itself seems to be stressing for the female at this time (*Jeppesen, Heller & Houbak, 1988*). At the end of the experimental period, the presence of the kits also cause increasing stress for the female which may result in increased activity by the females. The visual contact between neighbouring females has previously been shown

Table 2. Per cent frequency of position/-behaviour in the 2 first weeks of observation (period 1) and the 2 last weeks of observation (period 2) distributed on control females, females with wire netting cylinder and females with water trays.

1st period	Groups of females			
Position/ behaviour	Contr.	Wire nett. cylind.	Water trays	
in nest box	52	53	58	*
in nest box entr.	17	18	16	ns
out in cage	30	29	26	ns
lying out in cage	18	14	12	*
active out in cage	11	15	13	ns
act. pendling	5	3	5	ns
act. stereotype	5	3	4	ns
inactive	88	86	85	ns
kits out in cage	13	10	9	ns
kits in nest box entr.	0	0	0	ns

2nd period	Groups of females			
Position/ behaviour	Contr.	Wire nett. cylind.	Water trays	
in nest box	44	46	46	ns
in nest box entr.	14	17	13	*
out in cage	42	37	40	ns
lying out in cage	15	9	13	*
active out in cage	27	27	27	ns
act. pendling	10	6	11	*
act. stereotype	10	6	12	**
inactive	73	73	72	ns
kits out in cage	25	24	28	ns
kits in nest box entr.	7	8	9	(*)

to increase activity of lactating females (*Hoffmeyer & Møller, 1987*).

At the same time as the general activity increased, the elements of behaviour pendling and stereotypes amounted to an increasing part of this activity. When the kits were approximately 8 weeks old, the stereotypic behaviour occurred at the highest frequency.

Stereotypic behaviour in domestic animals is often seen as an indicator of poor adaptation to housing conditions. It has, however, not been possible to prove a significant correlation between frequency of stereotypic behaviour and physiological stress which has given rise to the assumption that the performance of stereotypic behaviour can be stress-reducing in itselv (*Wiepkema, 1985*).

Under production conditions, domestic animals are given limited space and their activity will therefore often be of a stereotypic nature, especially their running up and down in the cage (pendling). Later investigations (*Hansen, 1990*) have shown that the level of eosinophil leucocytes of the female is three times higher immediately before the time of birth than when the kits are weaned at the age of 8 weeks. Compared to the low activity level of pregnant females it is likely that there is a negative correlation between activity and level of eosinophil leucocytes of females. This assumption is supported by results obtained with mink kept in conventional mink cages with and without nest box, respectively. Mink deprived of the use of nest boxes were more active and had a significantly lower eosinophil level (*Hansen, 1989*).

A comparison between the three experimental groups showed no difference as regards activity out in the cage. The recording of this element of behaviour includes besides pendling and stereotypes also position on water tray and in wire netting cylinder. The difference found between female groups in the first two weeks (period 1) as regards the elements of behaviour "lying out in cage" and "active out in cage" is probably due to the fact that in period 1 females used the water trays partly as resting place and partly for active "bathing". They were therefore quickly empty of water and could again be used as resting place. Females with wire netting cylinders used these as resting place.

In the last two weeks (period 2) the "bathing possibility" was not used, and because of water in the trays the females were prevented from using the trays as resting place. Females with wire netting cylinder continued to use these as an alternative to "lying out in the cage" (table 2).

In period 2, females with wire netting cylinder differed from the other two experimental groups by a significantly lower frequency of the elements of behaviour "pendling" and "stereotypes". The results furthermore showed that there was no difference between groups as regards "activity/-inactivity" and "out in the cage". It is therefore reasonable to assume that the use of wire netting cylinders to some extent reduces the performance of the elements of behaviour "pendling" and "stereotypes".

A possible explanation may be that the narrow wire netting cylinder surrounding the body of the mink is regarded by the mink as a "safe" place, and at the same time the animal is placed up high in comparison with the neighbouring animals. This tendency to seek a high position as a resting place is also known from other carnivores (*Hansen, 1985*).

Table 3. Per cent frequency of position/behaviour of all females in periods 1 and 2, respectively distributed on hours of observation.

1st period	HOURS OF OBSERVATION IN THE 1ST PERIOD								
Position/ behaviour	8	9	10	11	12	13	14	15	
in nest box	70	58	62	53	57	50	42	42	***
in nest box entr.	6	19	18	30	23	15	17	11	***
out in cage	23	22	20	20	20	35	41	47	***
lying out in cage	5	11	11	13	12	17	23	29	***
active out in cage	18	12	10	7	8	18	18	18	***
act. pendling	7	7	2	3	3	4	5	3	ns
act. stereotype	8	10	1	2	3	3	4	1	**
act. wire nett.cyl.	16	25	10	20	7	23	29	15	ns
act. water tr.	11	18	18	0	16	11	2	6	ns
inactive	82	88	90	93	92	82	83	82	***
kits out in cage	6	7	9	11	9	10	16	20	***
kits in nest entr.	0	1	0	0	1	0	0	0	ns
2nd period	HOURS OF OBSERVATION IN THE 2ND PERIOD								
Position/ behaviour	8	9	10	11	12	13	14	15	
in nest box	43	51	55	48	48	34	47	35	***
in nest box entr.	9	19	23	27	12	9	9	16	***
out in cage	48	31	22	25	40	57	44	49	***
lying out in cage	6	11	10	8	8	19	14	20	***
active out in cage	42	19	12	17	32	38	30	29	***
act. pendling	7	10	3	4	14	12	9	10	***
act. stereotype	15	8	4	8	7	7	22	5	***
act. wire nett.cyl.	14	24	22	20	12	14	11	27	**
act. water tr.	3	3	0	0	1	0	0	1	ns
inactive	58	81	88	83	68	62	70	71	***
kits out in cage	17	26	32	30	23	23	24	34	***
kits in nest entr.	2	12	10	12	11	5	6	8	***

*** indicates a p-value of less than 0.0001.
** indicates a p-value of less than 0.01.

The decrease observed in the use of wire netting cylinders by the females in week 25 is probably due to the fact that the wire netting cylinders were no longer considered "safe", as the kits could at this time reach the female in the cylinder.

Throughout the entire experimental period the use of water trays by the females was very limited. That the females used the water trays at the beginning and later on almost stopped using them, may be due to the fact that at the beginning the water trays may have stimulated the animals due to their novelty value.

In period 1 females with access to water trays differed from the other females by using the nest box more and by being less out in the cage. The interpretation of the result may be that females with water trays are cooled of when using the water trays and therefore do not have to get away from the nest box, or that the kits are cooled off by the wet pelt of the female and therefore need for the female to be with the kits for a longer time. Observations made where mink had access to swimming in pools showed that the animals often concluded their "bathing-session" by rubbing their pelt against a moisture-absorbing material, like for instance sawdust. The lack of this possibility may have a reducing effect on the use of water trays??? It is, however, more likely that the female has used the material in the nest for this sort of comfort-behaviour.

None of the results found as regards the use of water trays by the female, partly over the 4 weeks of observation and partly during an average day in periods 1 and 2 gave rise to the assumption that lactating females have a need to "bathe". As it was not observed that mink kits lick liquid from the female's wet pelt, this possibility for offering extra liquid to the kits is probably non-existant.

The identical weight development of females and kits, respectively, in all three experimental groups (despite the low number of experimental animals) supports the above mentioned conclusion.

The activity in the day-hours seems to be controlled by the feeding hours at 8-9 a.m. and approx. at 1 p.m. which has also been proved by previous investigations (*Jonge et al., 1985*). Between the two hours of feeding the animals were most passive and placed either in the nest box or in the nest box entrance.

In period 1 the noon feeding interrupted the resting period of the animals. After feeding the activity out in the cage remained high, and at the same time an increasing number of the females were lying out in the cage.

Period 2 was characterized by a considerably higher activity around the feeding-sessions. The resting period in the middle of the morning was also found in period 2 with almost the same frequency of inactive animals as in period 1.

The activity of the females just before feeding was considerably higher in period 2 than in period 1. The asynchronous presence of kits and females, respectively, out in the cage was significant in the morning hours. After feeding at 1 p.m. the females maintained a relatively high level of activity out in the cages corresponded by a decrease in number of females in nest boxes and nest box entrances.

In the lactating period where an effort is made to keep the female in a good body condition it seems inappropriate to interrupt the resting period of the female by feeding at the time when the temp is normally highest. Ad libitum feeding with dry fodder may prevent the increase in activity in the middle of the day and instead cause the mink to be active at a time more natural to them. Whether a change like that will balance out the advantages of feeding with fresh feed with a relatively high water content, has not been investigated.

The use of wire netting cylinders by mink females reduced stereotypic activity.

Probably installation of wire netting cylinders in production cages with only one animal may reduce stereotypic activity and thus reduce feed costs. Previous investigations (*Jonge et al., 1985*) have shown that on average females spend approximately 15% of their active time on stereotypic behaviour and that approximately half a mink population spends more than 25% of their active time on this energy-consuming activity.

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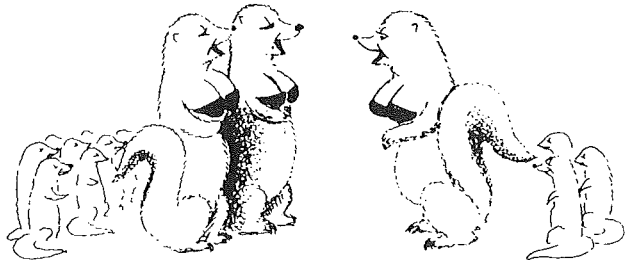

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Original Report

A computer program for fur skin identification based on comparison of microstructural features with file data.

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Abstract

A computer program SEEKFUR is described which enables identification of a skin sample based on its microscopic morphological features and comparison with structural patterns of 134 important fur species stored in program data files. The program can be run on almost any micro computer system operating either under 8-bit CP/M or 16 bit DOS. The efficacy of the program was checked against cross-comparison of important fur species and results show that this program is not only alternative to visual comparison using large amounts of micro photografic figures, but also offers flexibility which is not found in the atlas-book systems of fur skins.

Introduction

In past years valuable information about micro morphology of a number of important fur species has accumulated[1,2] and could be used in solving problems with fur skin identification when only a small sample of material is available. Such a situation is currently appearing in the fur trade, in zoology, archaeology and criminology. However, when one tries to use this technique, one is usually faced with a considerable amount of time needed to analyze the micro photographs and determine the most probable fur skin type.

In this report, we describe a computer program for rapid analysis and identification of fur skin species based on its micro morphology and a wide collection of fur skins and their microscopic patterns. The structural features can be described by special code numbers, previously suggested[1].

The identification of biological objects using a mathematical model was first suggested by Beers and Lockhart[3] for bacterial species. Later a number of practical uses of computer-aided probability testing for purposes of bacterial identification were described[4-10]. The mathematical basis by which such programs provide identification is derived from theorem of probabilities. SEEKFUR is the first program aimed for fur skin identification and for simplification of the procedure which has allowed a very quick and exact comparison of structural patterns and eliminates much of the tedious work associated with the use of the Atlas book.

The numerical code for the micro structures of the skin

To make computerized data processing possible, the description of the morphological structure has to be transformed into a numerical code. The coding system used in the program SEEKFUR was reported in Fur skin atlas[1,2] and this book is recommended as a useful aid in comparison of

results of program decision with true structure illustrated by micro photographs.

In the following scheme the coding system is described shortly. Here the first group of three letters belongs to the skin surface structure, and the other three groups with eleven characters determine the patterns of structural features observable in main types of hairs in fur skin.

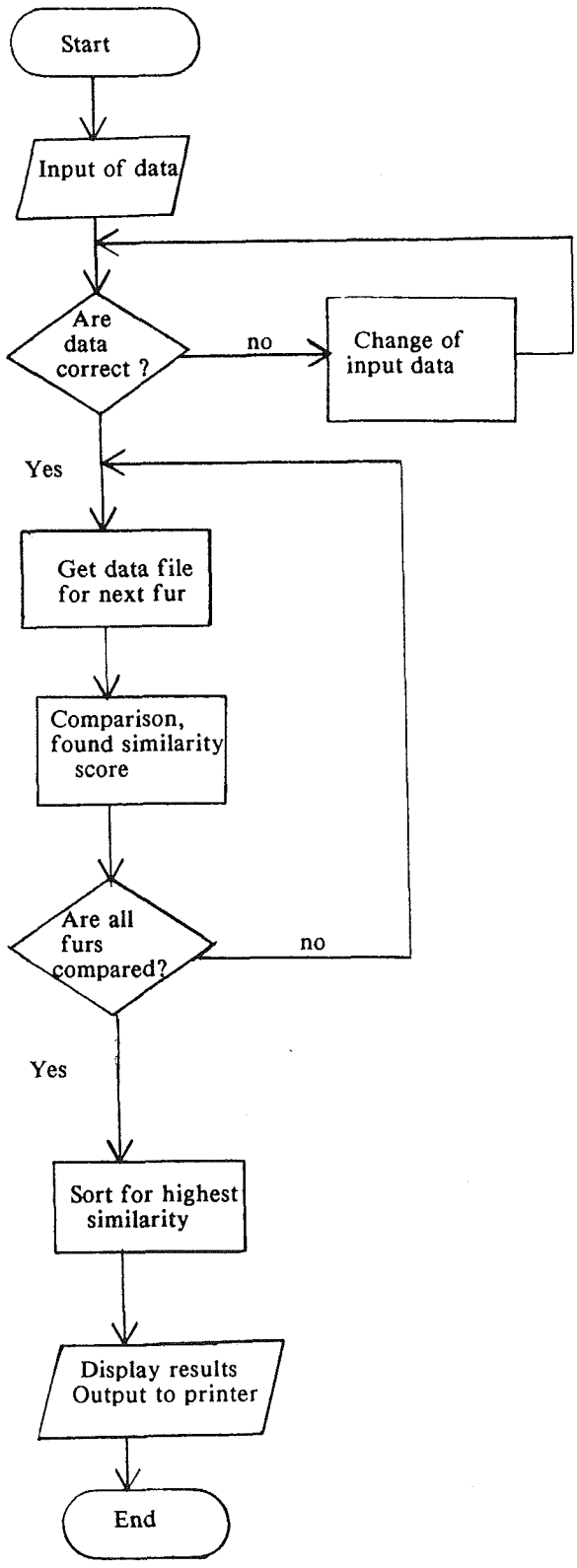
The skin surface: a - b - c
Fine fur fibres: d - e - f - g - h - i - j - k - l - m - n
Intermidiate fibres: d - e - f - g- h - i - j - k - l - m - n
Guard hairs: d - e - f - g- h - i - j - k - l - m - n

In this scheme, the individual characters represent the coding numbers for the following micro structural features:
a - the appearance of skin surface structure (3 types),
b - the shape of the upper part of the hair follicle (6 types),
c - the number of hair shafts in each follicle (3 types)
d - the cross sectional outline of the hair shaft (9 types),
e - the overall shape of cuticular scales (16 types),
f - the surface of the cucicular scales (3 types),
g - the scale margins (2 types),
h - the size of medulla (4 types),
i - the azial structure of the medulla (2 types),
j - the outline of the medullar cross section (4 types),
k - the overall structure of the medulla (16 types),
l - the structure of medulla infilling substance (8 types),
m - the minimal and maximal thickness of the hair (in μm),
n - the range of hair lengths (in mm)

The detailed scheme of the coding system together with the samples of the given structural pattern illustrated by micro photographs, are included in program SEEKFUR manual available at authors.

Program description
The program for fur identification, named SEEKFUR, is able to compare structural features of unknown fur samples with large volumes of structural data belonging to the most important fur species. Data for unknown fur specimens are, after microscopic observation, inputed from the keyboard and program procedures then compare and find most likely identification. All obtained similarity scores are then listed in order of decreasing probability and results can be output to any combination of display unit, printer or disc file.

Fig. 1 illustrates basic components and modules used in the program. The majority of the modules of the program is involved with file manipulation, user interface and data ordering.



The efficacy of the program was checked against manual comparison of all 134 fur skin types con-

tained in both volumes of the Fur skin atlas[1,2]. Computer-assisted comparison of every fur species against all others resulted in finding most similar pairs of fur skins. These are showed in table 1, together with the similarity expressed by the number of structural differences. These results suggest the significant diagnostical character of the micro morphological patterns of furs, as among tested species no one pair has better similarity score than about 11 important structural differences.

Table 1. The similarity of fur skin species.

Tested fur skin	most similar fur skin	number of differences
Alopex lagopus	Kolonocus sibiricus	27
Apodemus sylvaticus	Chinchilla laniger	25
Bos taurus	Antilope cervicapra	23
Canis fam. collie	Otocolobus manul	23
Canis lupus	Felis silvestris	19
Capra hircus	Panthera leo	22
Capreolus capreolus	Hyaena hyaena	20
Castor fiber	Ateles geofroyi	24
Cervus nippon	Tapirus terrestris	19
Chinchilla laniger	Apodemus sylvaticus	25
Citellus citellus	Citellus fulvus	23
Citellus fulvus	Citellus citellus	23
Cricetus cricetus	Galago senegalensis	23
Didelphis marsupialis	Talpa europaea	24
Equus caballus	Equus c. hucul	13
Equus przewalskii	Equus caballus	17
Equus zebra	Ovis cigaja	19
Eutamias sibiricus	Felis catus	20
Felis catus	Eutamias sibiricus	20
Felis silvestris	Canis lupus	19
Kolonocus sibiricus	Felis catus	20
Leopardus pardalis	Kolonocus sibiricus	20
Lepus europaeus	Kolonocus sibiricus	20
Lutra lutra	Enhydra lutris	22
Lutreola lutreola	Martes zibellina	11
Lynx lynx	Felis chaus	17
Marmota bobac	Canis aures	22
Martes martes	Lutreola lutreola	18
Martes zibellina	Lutreola lutreola	11
Meles meles	Ovis, persian lamb	25
Mephitis mephitis	Ondatra zibethicus	20
Mustela erminea	Martes zibellina	24
Myocastor coypus	Ondatra zibethicus	22
Oryctolagus cuniculus	Vulpes vulpes	27
Ovis, persian lamb	Ovis, semipersian lamb	22
Ovis, semipersian lamb	Hylobates lar	20
Ovis, syrian lamb	Equus przewalskii	22
Ovis, merino lamb	Ovis, persian lamb	22
Ovis, cigaja lamb	Cercopihecus mona	17
Ovis, valaska lamb	Equus caballus hucul	21
Ovis musimon	Dama dama	17
Panthera leo	Hyaena hyaena	17
Panthera pardus	Panthera tigris altaica	17
Panthera tigris alt.	Panthera pardus	17
Putorius putorius	Cryptoprocta ferox	23
Sciurus vulgaris	Tupaia glis	22
Sus scrofa scrofa	Giraffa camelopardalis	24
Talpa europaea	Talpa micrura	13
Trichosurus vulpecula	Kobus leche	26
Vulpes vulpes	Lynx lynx	22
Acinonyx jubatus	Felis silvestris	19
Aepyceros melaphus	Redunca fulvorufula	18

Table 1.

Tested fur skin	most similar fur skin	number of differences
Ailurus fulgens	Felis silvestris	22
Allactaga major	Eutamias sibiricis	20
Alopex corsac	Lynx lynx	23
Antidorcas marsupialis	Equus przewalskii	26
Antilope cervicapra	Kolbus ellypsiprimnus	15
Arvicola terrestris	Allactaga major	21
Aeteles geofroyi	Hylobates lar	16
Atilax paludinosus	Ondatra zibethicus	21
Bison bison	Chrysocyon brachyurus	19
Boocercus euryceros	Tamandua tetradactyla	17
Camelus ferus	Ursus arctos	20
Canis aures	Lemur cata	18
Canis dingo	Bison Bison	23
Capra sibirica	Galago senegalensis	23
Cavia aperea	Martes zibellina	25
Cercopithecus cephus	Redunca fulvorufula	20
Cercopithecus mona	Ovis, cigaja lamb	17
Cerphus elaphus wapiti	Rangifer tarandus	18
Choleopus didactylus	Connochates gnou	29
Chrysocyon brachyurus	Hyaena hyaena	18
Connochates gnou	Antilope cervicapra	23
Cryptoprocta ferox	Putorius putorius	23
Cynocephalus temmincki	Lemur cata	15
Dama dama	Ovis musimon	17
Damaliscus dorcas	Equus caballus	21
Damaliscus lunatus topi	Hyaena hyaena	17
Dasyprocta aguti	Aepyceros melaphus	21
Daubentonia madagascarensis	Ondatra zibethicus	21
Desmana moschata	Ateles geofroyi	24
Dicotyles tajacu	Canis fam. collie	28
Dolichotis patagona	Ovis, syrian lamb	25
Eidolon helvum	Rhinolophus euryale	19
Enhydra lutris	Lutra lutra	22
Equus caballus hucul	Equus caballus	13
Felis chaus	Lynx lynx	17
Fennecus zerda	Felis chaus	24
Galago senegalensis	Lemur cata	18
Gennetta victoriae	Kolonocus sibiricus	21
Giraffa camelopardalis	Antilope cervicapra	20
Glis glis	Cricetus cricetus	25
Gulo gulo	Tapirus indicus	24
Hyaena hyaena	Damaliscus lunatus topi	17
Kobus ellypsiprimnus	Antilope cervicapra	15
Kobus leche	Damaliscus lunatus topi	19
Lama guanicoe	Cervus elaphus wapiti	24
Lemmus lemmus	Cynocephalus temmincki	24
Lemur cata	Cynocephalus temmincki	15
Macropus giganteus	Canis aures	19
Mus musculus	Galago senegalensis	23
Mustela nivalis	Myrmecobius fasciatus	19
Myrmecobius fasciatus	Mustela nivalis	19
Nasua nasua	Ondatra zibethicus	21
Ondatra zibethicus	Lemur cata	19
Oreamnos americanus	Redunca fulvorufula	18
Ornithorhynchus anatinus	Pusa caspica	24
Otaria byronia	Galago senegalensis	21
Otocolobus manul	Hyaena hyaena	17
Pagophilus groendlandicus	Hylobates lar	20
Pan troglodytes	Tapirus indicus	18
Panthera pardus japonesis	Tragelaphus angasi	21

Table 1.

Tested fur skin	most similar fur skin	number of differences
Paradoxurus hermaphroditus	Tupaia glis	16
Pongo pygmaeus	Pan troglodytes	22
Procavia capensis	Ursus arctos	23
Procyon lotor	Canis aures	23
Puma concolor	Panthera pardus	22
Pusa caspica	Eidolon helvum	20
Rangifer tarandus	Cervus elaphus wapiti	18
Redunca fulvorufula	Oreamnos americanus	18
Rhinolophus euryale	Eidolon helvum	19
Rupicapra rupicapra	Kobus ellypsiprimnus	21
Rusa unicolor	Redunca fulvorufula	21
Sorex alpinus	Mus musculus	23
Talpa micrura	Talpa europaea	13
Tamandua tetradactyla	Boocercus euryceros	17
Tapirus indicus	Pan troglodytes	18
Tapirus terrestris	Cervus nippon	19
Taurotragus oryx	Procyon lotor	25
Tragelaphus angasi	Panthera pardus japonensis	21
Tupaia glis	Paradoxurus hermaphroditus	16
Uncia uncia	Pongo pygmaeus	22
Ursus arctos	Camelus ferus	23

Discussion

The principle objective of this work was to develop a computer program for the rapid and simple analysis of microscopic data obtained from unknown fur sample. Secondly, a cross-comparison of 134 most important fur species was done with the help of this program and the most similar fur pairs were found.

The computer program has proven to be an important time saver which eliminates much of the tedious work associated with comparison of a large numbers of micro photographic material. A single identification procedure processed by the computer gives the result in few minutes, while the same procedure done manually take few hours and the result of such comparison is not so accurate.

The micro morphological pattern of the fur skins appears to be important unique feature with significant diagnostical value. In the most cases the fur skins differ by about 20 important features, and the least number of differences found in the cross-comparison, was eleven. This reflects high level of the individuality of micro morphological structure among various species of furs.

The computer program SEEKFUR can easily be adapted to operate with larger number of skin species, when new descriptions become available.

Mode of availability

The program SEEKFUR may be obtained by any organization or researcher by writing directly to the authors. The program is available on 3.5-inch, on 5.25-inch double density, single or double-sided discettes or on the magnetic tape. Please indicate which operating system and model computer will be used. The instruction manual and exact illustrations of individual patterns are included.

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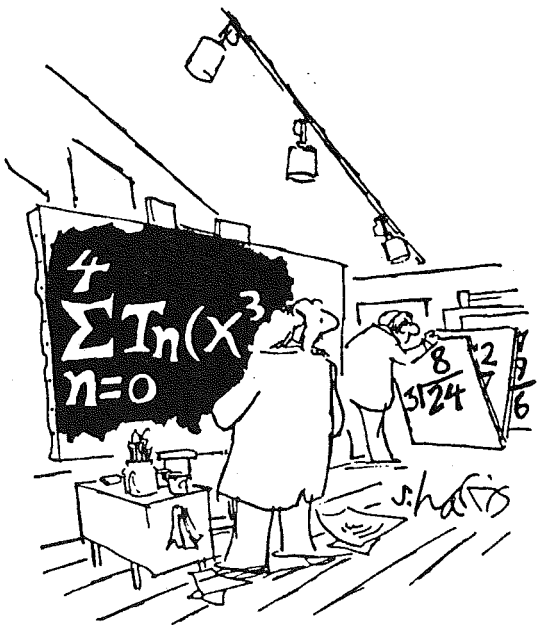
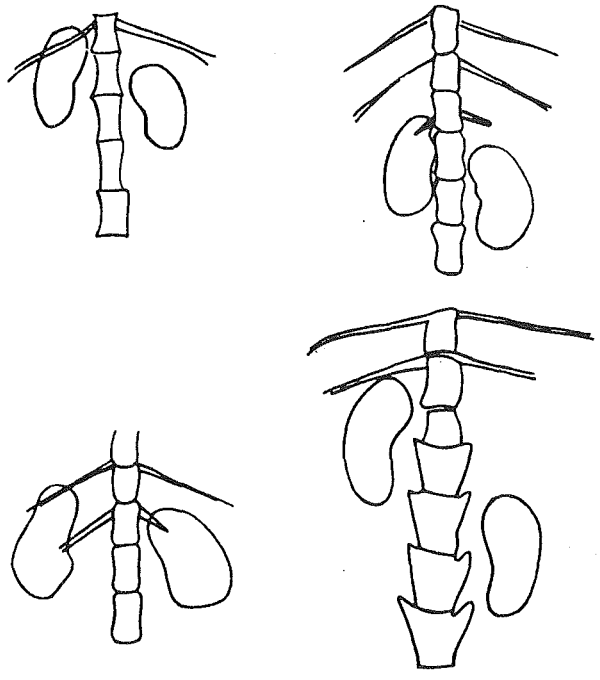


"That's some of my earlier work."

Position of the kidneys in relation to the skeleton in mink *Mustela vison*.

D. Goscicka, J. Grabowska.

A radiological and anatomical analysis of the position of 120 kidneys of 60 minks of both sexes in relation to the vertebral column was carried out. It was found that they are situated at the height of Th_{13} to L_5, the right kidney is situated more cranially than the left one and most often across the fourteenth rib (♀ 51.5%, ♂ 59.3%).



Polskie Archiwum Weterynaryjne; 28; 1-2; 87-98, 1988. 4 figs., 6 tables, 22 references. In POLH, Su. RUSS, ENGL. Authors' summary.

Position of the heart and its valves (in radiological estimation) in mink *Mustela vison*.

D. Goscicka, E. Krakowiak.

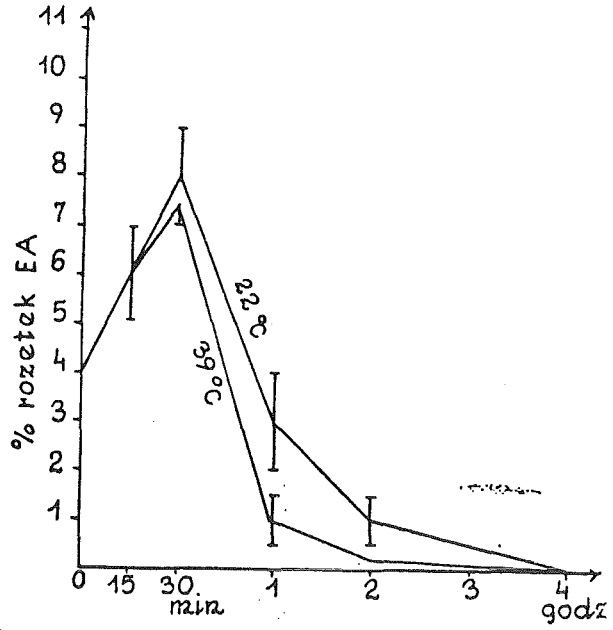
Resorting to anatomical and radiological methods we have examined the position of the heart and the projection of the heart valves. The costotopy and the ortodiagram of the heart was analyzed. Special attention was paid to the difference between the position of the heart in female and male minks. We have found that in the majority of minks the heart is enclosed between 5 and 8 rib; it is situated with its greater part on the left side of the chest, especially in females.

Polskie Archiwum Weterynaryjne; 28; 1-2; 75-85, 1988. 4 figs, 3 tables, 11 references. In POLH, Su. RUSS, ENGL. Authors' summary.

The method of lymphocytes isolation from the peripheral blood of foxes and the rosette test EA.

K. Kostro.

The purpose of the work was to elaborate a method of lymphocytes isolation from the peripheral blood of breeding foxes and to perform the rosette test EA. It was found that Ficoll-urupoline (density from 1.074 to 1.075 g per 1 ml) was most proper for lymphocytes isolation. The heighest percentage of lymphocytes forming EA rosettes was observed at 22°C preincubation for 30 min. and later incubation at 4°C for 30 min. No statistically significant differences were found concerning the number of cells forming EA rosettes in relation to the breed, sex and kind



Ryc. 1. Wpływ czasu i temperatury preinkubacji na tworzenie się rozetek EA w krwi obwodowej lisa
Objaśnienie: Wykres przedstawia średnie wartości uzyskane z trzech kolejnych badań

of serum used against sheep erythrocytes. A mean percentage of lymphocytes with Fc receptors in the peripheral blood of blue and silver foxes aged 1-3 years, was 9.08±1.96.

Medycyna Weterynaryjna; 45; 4; 231-234. 1989. 2 figs., 3 tables, 25 references. In POLH, Su. RUSS, ENGL. Authors' summary.

The lymphatic system of the ferret (*Mustela putorius*).

S. Shibata, T. Hayakawa.

Our detailed necropsies of the parietal lymphatic system of ferrets using 6 male subjects can be summarized as follows.

The sdc one of the terminal lymph nodes formind the trj, and the inferior labial lymphatics flow into this lymph node homolaterally and contralaterally. In the forelimb elbow lymph nodes (protean lymph nodes) were observed which implied that this lymph node should be considered as one important lymph node from the standpoint of coparative anatomy. In this animal the "lateral thoracic lymphatic trunk" which linked dax and ing was not observed.

Progress in lymphology - XI. Excerpta Medica International Congress Series, vol. 779, 65-68. 1988. 7 figs., 9 references. Authors' summary.

Description of the anatomy of the male reproductive apparatus of the chinchilla (*Chinchilla lanigera*).

A. Prego Garcia, G. Saredo.

This work has been conducted taking into account the great importance of this species in the fur industry and the scarce bibliography existing on its anatomy. The dissection of 19 chinchilla male corpses of different ages, was performed as well as to the observation of the behaviour of live animals at several breeding places.

The surface anatomy of the male reproductive system of this species is described, as well as a detailed description of the normal anatomy of each one of the organs included in this apparatus.

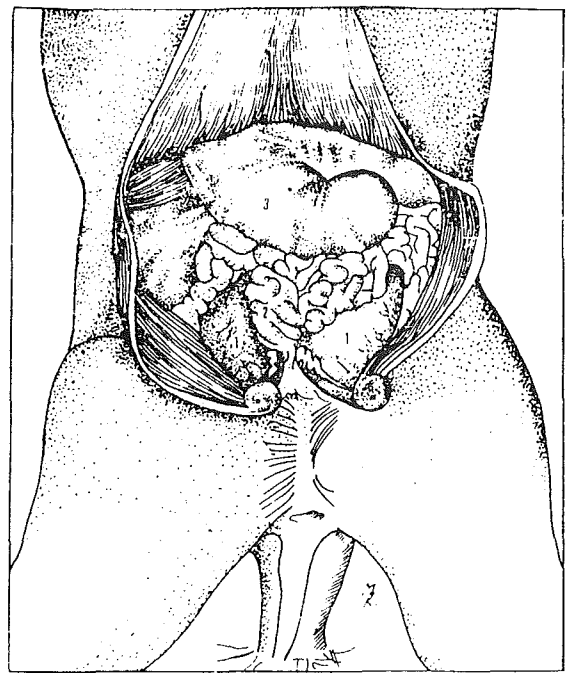
Veterinaria Argentina; Vol. 5; 46; 494, 496-499. 1988. 6 references. Authors' summary.

Anatomical description of the male sexual system in nutrias (*Myocastor coypus*), Part I.

V. Kulisek, M. Barta, I. Jakubicka, L. Zavodny, I. Zemanovic.

In the work, anatomic description is given of the organs of male sexual system of nutrias - testicle, epidymis, ureter, uretra, penis and accessory genital glands, namely at both the macroscopic and microscopic level, Macroscopically, but mainly microscopically, the presence of coagulation gland has not been identified on serial sections of the prostate.

Pol'nohospodarstvo 34; 8; 747-753. 1988. 1 fig., 5 references. In SLOV, Su. RUSS, ENGL. Authors' summary.



Obr. 1. Uloženie semenníkov a mechúrikovitej žľazy v brušnej dutine
1 — semenníky, 2 — mechúrikovité žľaza, 3 — hrubé črevo; šípka označuje vnútorný slabinový prstenec

Fig. 1. Location of testicles and follicular gland in the abdominal cavity
1 — testicles, 2 — follicular gland, 3 — large intestine; the arrowhead shows the terminal inguinal ring

The arterial vascularization of the intestines of the muskrat (*Ondatra zibethicus*).

A. Bisaillon, R. Bousquet, A. Grenier.

This study is based on dissection of 12 adult muskrats whose arteries were injeced with latex.

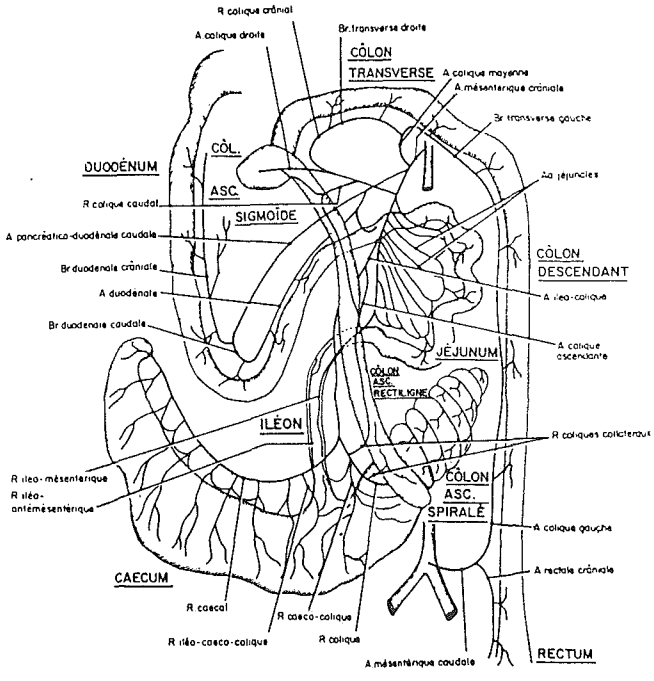


Fig. 1. Représentation shématique des artères intestinales du Rat musqué (intestin étalé)

The main branching patterns of the cranial and caudal mesenteric arteries for the different segments of the gut are described. The position and the branching of the arteries of the muskrat are comparable to those of the laboratory rat and the American beaver. In general, the distribution patterns are reminiscent of the laboratory rat and less so of the American beaver.

Anat. Histol. Embryol. 17, 149-155. 1988. In FREN, Su. ENGL., GERM, SPAN. 2 figs., 11 references. Authors' summary.

Carnivora: The amino acid seguence of the adult European mink (*Mustela lutreola*, Mustelidae) hemoglobins.

A. Ahmed, M. Jahan, G. Braunitzer.

The complete amino acid seguences of the hemoglobins from the adult European mink (*Mustela lutreola*) are presented. The erythrocytes contain two hemoglobin components and three globin chains. The isolation of globin chains achieved by ion-exchange chromatography on a column of CM-cellulose in 8 M urea buffer. The primary structure of globin chains and of the trypic peptides determined in liquid- and gas-phase se-

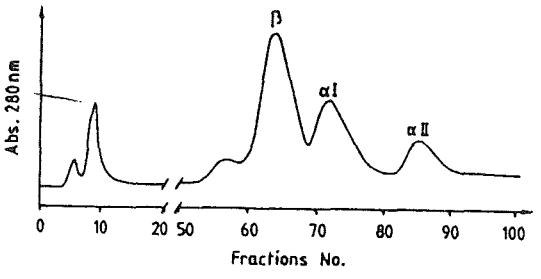


Fig. 2. Separation profile of the globin chains on a column of CM-cellulose (size, 1.6 × 15 cm). Buffer, 0.025 M sodium acetate, 0.2% mercaptoethanol and 8 M urea, pH 5.7.

quenators. The alignment of the α- and ß-chains with those of reported sequences from other carnivora species belonging to the family Mustelidae may give an insight into the evolution of this molecule.

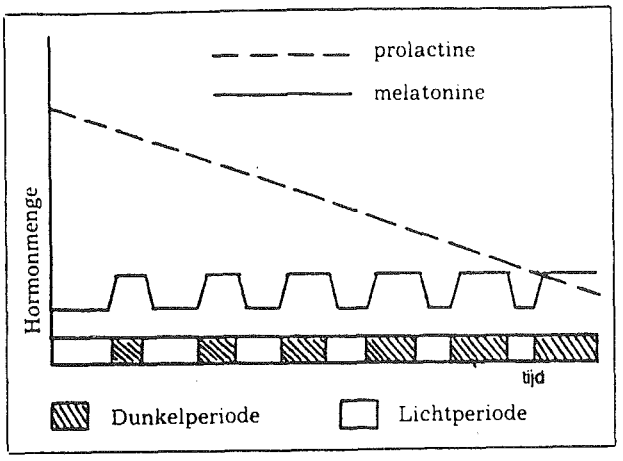
Z. Naturforsch. 45 c, 223-228. 1990. 3 figs., 3 tables, 21 references. Authors' summary.

Accelerated pelt maturity by means of shortened day length.

G. de Jonge, P. van Beek.

Work on the effects of shortened daylength on

Bild 2: Schematischer Ablauf der Hormoneinwirkung



mink pelt maturity and quality is reviewed. It was concluded that exposure to a daylength of 6-8 h from June/July results in mink being ready for pelting 4-6 wk earlier than for mink exposed to natural daylength, without any adverse effects on pelt quality.

Deutsche Pelztierzuchter, 63; 7-8, 99-101. 1989. 2 figs., 2 tables. CAB-abstract.

Coat colour and height of hair in Greenland coypu maintained with and without access to water basins.

R. Cholewa.

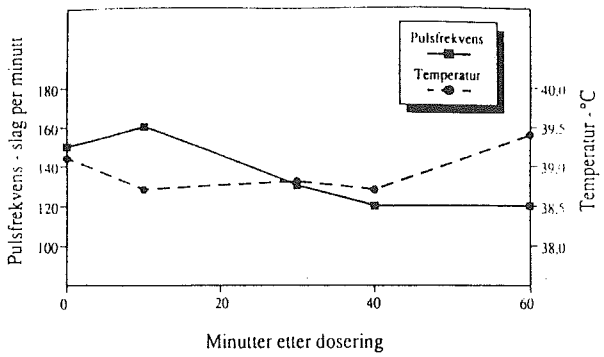
The investigations were carried out to determine the influence of maintenance conditions (with and without access to water in basin) on colour of coat in two areas in hind parts of belly and back and on hair (height) in three parts of coat: in 55 in the middle of belly, side and back coypus of Greenland variety. The objective laboratory methods were used. The results obtained concerning coat colour and hair height were little differentiated. The values of two features were similar in both methods of maintenance. It would suggest that the investigated environmental conditions had rather little influence on the colourimetrically evaluated coat colour and height of hair in Greenland coypu.

Roczniki Akademii Rolniczej w Poznaniu-CXCVI, 1988. 2 tables, 4 references. In POLH, Su. ENGL, RUSS. Author's summary.

Anaesthesia of the blue fox with ketamine hydrochloride (Ketalar®) and xylazine (Rompun®).

A. Indrebø.

Eight blue fox vixens (*Alopex lagopus*) were



Figur 1. Forandringer i pulsfrekvens og kroppstemperatur hos blårev etter injeksjon av Ketalar® 5 % (23–27 mg/kg) + Rompun® (1,0 mg 1,2 mg/kg).

anaesthized with 23-27 mg/kg of *Ketalar®* (ketamine hydrocloride 50 mg/ml) + 1.0-1.2 mg/kg of *Rompun®* (xylazine 20 mg/ml) i.m. for abdominal laparotomy. The drugs induced satisfactory anaesthesia for as long as the operation lasted (20-25 minutes). Side effects were minimal, pulse rate and body temperature were only slightly affected. The animals were awake 1-2 hours after the operation was completed.

Norsk Veterinaertidsskrift (Norway), Vol. 101 (10), 767-770. 1989. 1 fig., 5 references. In NORG, Su. ENGL, NORG. Author's summary.

Effect of selected factors on the quality of waste fat from foxes and the possibility of its modification.

J. Batura.

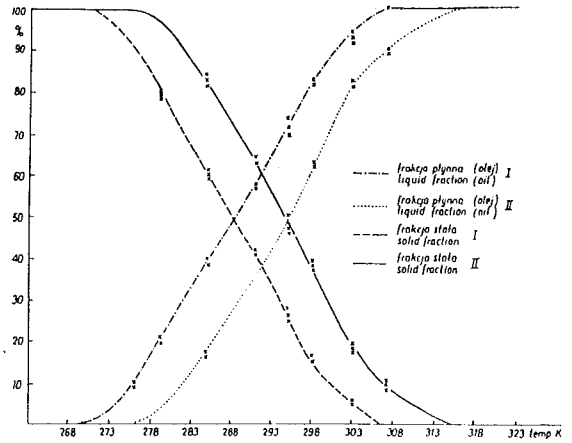
The estimation was carried out of direction and range of changes in quantitative composition of main fatty acids of deposit fat in foxes (waste raw material for management) caused by various factors.

For scientific purposes modification of the said fat has been made by fraction crystallization in mass, and the variability was determined of the composition of fatty acids in the obtained fractions, depending on the processing temperature (279-298 K) and the quality of acid.

It was found that the quantitative composition of fatty acids in deposit tissues in the examined animals depends mainly on the effect of such factors as: feeding and localization of the tissue in organism. Significant changes (at α=0.05) caused by feeding referred mainly to such fatty acids as $C_{18:2}$, $C_{18:1}$, $C_{16:1}$ and $C_{14:0}$, $C_{18:0}$, and also on the total composition of polyene acids and acids of 18 carbon atoms in the chain.

Depending on topographic situation of fat tissue in the organism (subcutaneous, mesenteric, kidney) significant differences were found in the quantity of composition of acids $C_{18:0}$ and $C_{16:1}$, and also in total saturated, unsaturated and monoene acids. Moreover, information was found on variation of quantitative composition of acids. of subcutaneous tissue fat, depending on layers (paracutaneous, paramuscular).

By carrying out modification of the examined fat by fraction crystallization in mass, it was found that the more significant factor differentiating the quantitative composition of acids in the obtained fractions is the quality of raw material, and not the effect of the processing temperature. The noted differences in the quality of raw material (mainly due to feeding), changed both the efficiency mentioned dependence referred mainly to liquid fraction.



Rys. 3. Uzysk frakcji w zależności od temperatury krystalizacji i jakości surowca
Fig. 3. Yield fraction depending on crystallization temperature and quality of raw material

Acta Academiae Agriculturae ac Technicae Olstenensis, Technologia, Alimentorum: No. 22 Suppl. C; 50 pp. 4 figs., 16 tables, 78 references. In POLH, Su. ENGL, RUSS. Author's summary.

Treatment of waste water from a mink feed industry - an example of a mobile anaerobic filter.

M. Hagelberg, L. Lindow, B. Svensson.

The production volume of fodder for minks varies within a year with peaks during the 4-5 months long period of birthgiving. The fodder is mainly prepared from fish, blood from slaughterhouses and fat.

The waste water from the production gives rise to COD of 7-30 g l^{-1}, heavy concentration of suspended solids and a pH between 4.5 and 6. The water flow is around 40 m^3 a day, from which a part is used to test a treatment equipment. The waste water treatment plant is com-

posed of three parts: separation of suspended solids, an 8 m^3 anaerobic filter and a 6 m^3 bio tower in series. After the separation step for solids the COD was reduced to ca. 7 g l^{-1}. The filter was seeded with sewage sludge and the plant was started in August.

Rapport - Sveriges Lantbruksuniversitet, Institutionen for mikrobiologi, Uppsala (Sweden), No. 40, 152-155. In SWED, Su. ENGL. Author's summary.

The present conditions of production in the German mink, polecat and fox breeding with special view to the problems of animal protection.

E. Haferbeck.

Objective (WEGNER, 1984) of this paper was:
- to provide a comprehensive status report;
- to register details relevant in view of animal protection about breeding, feeding, management, disease control and killing;
- draw conclusions with regard to animal protection relevance from the information obtained on the various production factors and on peltry production and
- highlight approaches for necessary improvement.

The production factors were registered on the basis of information obtained through questionnaires which were completed by the author together with the interviewed farmers, at 34.6% combined with an inspection of the farms (31.4% of the fox farms and 55.6% of the polecat farms had been visited). Data were collected on 73% of the mink-, 78% of the polecat- and 73.9% of the fox breeding farms. Between August 1984 and July 1985 there existed 136 mink-, 9 polecat- and 23 fox breeding farms.

Animal stock
In the Federal Republic of Germany 52.172-76.644 mink breeding females were kept between 1983 and 1984 on the farms registered, averaging 544-798 females per farm.
Six colour variants are bred to a larger extent, i.e. scan black, scan brown, pastel, pearl and silverblue and in North Germany, additionally, white. The mink fur-bearer production on the farms registered was between 114.638-164.408 animals.
Approximately 500-750 polecat females are kept on farms with an estimated polecat production of 2500-3750 animals.
In 1983/84, 1294 silver foxes and 638 blue foxes were kept on the registered farms. The calculated total production is assumed to be 8629 fur-bearers.
44.4% of the farmers sell part of their production by direct marketing, 33.3% sell their peltry to the Economic Cooperative of German Fur-bearer Breeders and 53.3% sell their peltry at auction sales, some breeders, in fact, using various forms of marketing.

Management
Except on few farms minks, polecats and foxes are kept in mink/fox barns which almost all are built as two-row units.
Cage sizes in the Federal Republic of Germany are almost all above those common in the Scandinavian countries and Great Britain, as well as above the measurements recommended by the ZDP e.V.
Including the demand of LÖLIGER future cage sizes for minks and polecats should be 90x45x45 cm (top cages: 60x45x45 cm) and for foxes 270x135x135 cm.
For reasons of inadequate housing capacities 57.3% of the breeders keep part of their animals for furring with up to four animals per cage and 26.4% of the breeders divide the litters after weaning to late.
On most farms the wire used meets both in diameter and mesh size the standards of the animals protection law. Wires with mesh sizes of 25 x 25 mm are used for the floor (88.5%), for the ceiling (95.8%) and for the sides (51.6%), furthermore wires with mesh sizes of 25 x 12.5 mm for the sides (46.3%) are in use. Zinked mesh with diameters $\geq$ 1.8 mm (83.2%) and plasticized mesh with diametes $\geq$ 1.8 mm (82.9%) is used.

On German mink farms the U-shaped wire model, mostly combined with additional wind break devices, the Danish A-model system and the starling box are used for nest boxes, the latter being more and more replaced. There is a fox box in use for the littering period and the first weeks of the rearing period.
53.6% of the German farms use flush systems. 4.12% water cups and 24.7% drink nipple systems, of which 8.2% are equipped with cooling/heating systems. Part of the breeders combine water cups with flush- or drink nipple systems.

Feeding
The nationwide questioning of the managers revealed that feeding is one of the problems of German mink/polecat and fox breeding. An exception are the farms in Schleswig-Holstein and Lower Saxony which, compared to farms in other regions, enjoy substantial competitive advantages in the purchase of entire fish and fish waste, the most important part of the diet in this region, due to their maritime location. The breeders in North-Rhine-Westphalia can optain this kind of food from the Dutch companies.

In South Germany there are farms which compose their diets of two main components only: poultry offal and cereals. A compensation of this

imbalance by supplementing with fish meal, milk powder or silage is hardly possible.
This situation is due to the restrictive interpretation of the refuse - and carcass disposal laws.
This investigation results in the central demand for the establishment of food kitchens in which the food compositions are supervised, checked and composed by experts.
Some farmers use zinc bacitracin as a feed additive, to increase resistance and to reduce rearing losses.

Disease situation
Infections with clostridium botulinum and pseudomonas aeruginosa as well as the plasmocytosis disease play an important part on German mink farms, additionally vesical and renal claculus affections.
The insatisfactory vaccine supply induced the farmers in the past again and again to do without the vaccination of the mink against botulism and virus enteritis, with the result than on 31.3% of the farms botulism has been occurring since 1980.
The occurring of plasmacytosis on 55.7% of the farms is explicable by the fact that not even one animal health service station is equipped with an agar test facility. Breeders are partly compelled to select aleutian-positive animals by, among other things, reducing the drinking water or by purchasing animals that are free of the disease.
Pseudomonas infections becoming more and more a problem on German farms is partly due to the fact that immediate diagnostic and therapeutic measures are not taken by the fur-bearer health services. This absence of veterinary assistence encourages the farmers to apply self-medication, resulting in the problem that they cannot react quickly enough to infectious phases, e.g. by vaccination or by separation of the affected enclosures.
For the agents of virus enteritis and the pseudomonas infection it is most important that drinking cups and defecation places are perfectly clean.
On many farms the time spent with hygiene measures that should be carried out as a matter of routine has to compete with the time spent with purchasing, mixing and distribution of food.

Breeding
Breeding for colur variants connected with gene defects and degeneration phenomena is practised on German farms only to an insignificant extent.
No biotechnical measures, such as the use of hormones or KB (JOHANSSON, 1982), are applied during oestrus season on mink-, polecat- and fox farms. Also the Scandinavian scientists' recommendation of the interruption of mating is only scarcely followed by German breeders.
The average breeding results of the farms are below those in Denmark in the percentage of barren females, reproductive performance, as well as young animal losses. In terms of breeding performance the farms in the southern parts of Germany (3.33 young raised/mated female) come off worse than those in northern Germany (3.78 young raised/mated female).
In the Federal Republic the average is 3.96 young born/mated female and 3.55 young raised/mated female. In the breeding season of 1983/84 there were 18.6% barren females (North-Germany: 15.5%; South-Germany: 23.2%). There was a kit mortality of 12.9% (South-Germany: 14%; North-Germany; 11.6%).

Killing
In the Federal Republic of Germany 57.6-58.3% of the minks are killed by gassing, 25.2% by poison injection, 12.3-12.8% by neck dislocation and 4.3% by electrocution, 82.7% of the foxes are killed by electrocution, 8.7% by poison injection and 8.4% by shooting.
Inquiries among the breeders on the various killing methods show that the handling of the various killing methods by the breeders leads to alarming situations from an animal protection point of view.
Furhtermore it still has not yet been definitely scientifically proved by experiments which killing method is acceptable and recommendable. According to this investigation veterinary control of the killing seems to be necessary.

Final summary
In various regions of the Federal Republic of Germany it will not be possible to conduct mink/polecat and fox breeding in conformity with animal protection concerns unless the recommendations made in chapter 13 for prohibitions, conditions, guidelines and suggestions for improvements are followed. The questioning of the breeders has also shown that the legislator, the subordinate authorities and institutions, rather than the breeders themselves are responsible, since the breeders are often not in a position to put requirements relevant to the protection of animals into practice.

Dr. Agric. thesis, Goettingen, 241 p. 1988. 16 tables, 120 references. In GERM, Su. ENGL, GERM. Author's summary.

Ecological and animal welfare aspects of furbearing animal husbandry.

E. Haferbeck.

Housing conditions for furbearing animals (mink, polecat, fox, marten, coypu) were investigated in the German Federal Republic. Space available per animal, cage sizes and hygiene, in particular dung removal and water provision, were general-

ly inadequate. Recommendations that a pair of mink should have 6 m^2 floor area and a water supply are largely ignored because fur production would no longer be economically viable. Battery housing is considered impossible from the point of view of animal welfare.

Tierhaltung, No. 19; 107-113. 1989. 2 tables, 16 references. CAB-abstract.

The conditions of nutria production in the Federal Republic of Germany with regard to aspects of animal welfare.

G. Aatz.

This paper is based on a questioning of nutria breeders, which took place nationwide i West-Germany from July 1984 to March 1985. This abstract contains the most important results.

General aspects
Most of the interviewed persons (74%) had established their farms between 1979 and 1981 or later. The breeders mostly kept nutrias on their farms for a secondary income. Therefore the stocks in most of the farms were kept small. 54% did not have more than 40 female breeding animals.

Every known fur colour was found. Greenland and silver nutrias were predominant; they were kept by 85% respectively 50% of the breeders. The number of the different fur colours on the farms was mostly not more than three.

More than half of the breeders did not produce more than 200 skins per year, only 7% produced more than 600. In 7% of the farms no skins were produced at all; these breeders sold all their young animals at the age of six to eight weeks to other breeders or animal traders.

Breeding
Only a few breeders carried out their breeding methodically. Often they did not see any necessity in it; besides only some of them had the qualification (livestock judging, experience) as to the selection of breeding animals.

Seldom the animals were marked. Because of this and group penning a clear identification of the animals was not possible. Therefore an individuell production assessment concerning certain productive characters like littersize, number of litters per year, rearing performance was not possible even if a regular documentation was carried out.

Fur colour, fur quality, body length, body shape, peaceable disposition and fertility were the productive characters for the selection of breeding animals. Body length and body shape were of greater importance in males than in females.

The servicelife of males at 74% of the farms and that of females at 84% was not more than three years. Only some smaller farms used the breeding animals longer than three years.

The stock replacement was performed in the following way: the female breeding animals were reared by the breeders themselves and some or all males were purchased. The amount of purchased animals depended on the size of the farms, that means, in relation smaller farms had to buy more male animals than larger ones.

On 70% of the farms females were not older than 7 months at the first mating. The males were mostly older than 8 months.

On nearly all holdings the breeding families always stayed together. On average they consisted of one male and 7.3 females. 35% had different large breeding groups.

Following average productivity was reached by the farms:

number of litters/female/year	2
littersize at birth/female:	5.1
littersize at birth/female/year:	10.2
reared young animals/female/litter:	4.6
reared young animals/female/year:	9.2

The age of weaning depended on the age of the youngest animals in one pen. 60% removed the young animals from the dams, when the youngest animals were 5 or 6 weeks old.

Feeding
There were no problems for the breeders to get enough feed, because they could cultivate it themselves, or used bought-in feedstuffs. Most of the time they obtained it from farmers, traders of agricultural products and agricultural cooperatives.

They got food wasted from bread factories and bakeries. How many brought-in feedstuffs were used, depended on the size and kind of agricultural area on the farms. Besides that, reasons of productivity of labour were decisive.

Very seldom the compounding of the feed rations was calculated. Different requirements of the animals resulting in age, production specialization and performances were also disregarded. 41% of the breeders had no or wrong ideas concerning the feed requirements of the nutria.

The feed for the animals consisted of a basic ration and additional concentrates. The basic ration and the concentrates were given together.

The animals were fed once or twice a day.

Housing
The coypus were mostly kept in pens without water basins.

The size of the cages varied extremely even within the farms. Pens with water basins had a size between 2 and 15 m^2, those without water basins had an area from 6 to 11 m^2. Cages were not larger than 7 m^2. In most of the farms no difference was made between pens of breeding animals, of young animals and of animals for furring.

In pens with water basins 87% of the breeders concerned provided 1 m^2 or more for their breeding animals. In systems without bathing facilities and in cages only 65% respectively 46% of the interviewed breeders made nearly 1 m^2 or more available to the animals. For the young animals and animals for furring the estimated area was in all housing systems 0.3 to 0.6 m^2.

The water for the basins came from natural waters or springs. Two thirds of the farms had permanent or temporary running water. One third of the breeders did not take care of a proper sewage disposal.

Pens without water basins were totally or partly in closed rooms. Most of them were completely littered.

Nearly all of the breeders had dung boxes in this kind of pens. The materials used for them were mainly gratings or wire mesh. The mesh sizes were mostly 25 x 25 or 30 x 30 mm. The wire often was 2 mm in diameter; because of its bad weight-bearing capacity and poor stability it was not a suitable building material.

The height of the cages over the ground was mainly 0.4 to 0.6 m. The floor of the cages was made out of wire mesh. Only on one third of the farms the cages were covered. Nearly on half of the nutria farms the subsoil under the cages was made of natural ground.

In pens with water basins and cages most of the animals had a refuge at its disposal nearly without exception. In pens without water basins, which had a shed or were in a closed room, were often none at all. Besides some exceptions, the boxes had one room and one or two gaps and an area of 0.36 to 6.25 m^2. You could not find substancial differences in the size of the different housing systems. The shelters were littered all year round.

The animals kept in pens with bathing facilities only got their drinking water in the water basin. All other systems mostly had automatic drinking bowls (cup drinker, nipple drinker). In the winter time most of the automatic drinking bowls did not work when frosty because of no existing heating possibilities and missing isolation of the water pipes.
Only some of the breeders, who had pens without bating facilities used bowls for the concentrates. 14% used automatic feeders and some gave the feed on separate areas in the pens.

Farm hygiene and animal health
The breeders' prophylactic treatments against diseases were completely insufficient. Only 56% desinfected the cages and boxes in certain intervals. Otherwise most of the breeders only controlled the amount of rats and mice and carried out worming treatments.

34% denied the incidence of diseases or gave no information to that point. Others named bacterial diseases (sepsis, salmonella infections) and damages caused by birth (prolapse or infection of uterus).

Injuries of the animals mostly occurred by aggressive interactions with animals of the same or the neighbouring cage.

54% of the interviewed breeders denied the occurrence cannibalism. If cannibalism occurred, mainly young animals were bitten dead and eaten up.

Death causes of old animals were mostly the diseases already mentioned. There were sepsis as a result of bites as well as uterus prolapses, -infections and complicated births.

Causes of loss concerning the young animals were being crushed to death, bitten dead, a too low or too high birth weight, abortion, losses as a result of feeding and parasitical diseases.

The supervision of the farms by the animal health service stations was insufficient. Regular visits were unusual; only a few farms had been visited by veterinaries before the time of interviews.

Pelting
At winter peltings, the age of the slaughtered animals varied from 7 to 12 months depending on the time of birth. Animals which were pelted at the earliest possible time (first ripeness of fur) were not older than 6 to 10 months. Outside of the season the body length was determinant for the age of pelting. If young animals were fed more extensively, the age of pelting was higher - caused by lower growthrate.

Before slaughtered the animals were narcotized with a club or by a slaughter's pistol. Sometimes they were killed by a shot in the head. The ne-

cessary bleeding after the narcotization or killing was not always carried out.

Working situation and economic aspects
Mostly the breeders managed their farms alone. 45% had one to three persons as helpers. Most of them were members of the family. 17% of the interviewed persons hired workers.

According to the breeders only 37% had a profitable farm at the moment of the interview. First of all, problems concerning the marketing of skins and meat were responsible for the unsatisfactory yields of the remaining farms; another reason was, that some of the farms had just begun with breeding. The time, necessary to make a farm profitable took three to five years.
Nearly all of the breeders sold the skins by themselves, because central marketing channels were of no importance to nutria skins. The skins were mainly sold as ready - made articles. This kind of marketing yielded in sales prices with on average of 120 DM per skin. The fur sale to furriers was another much used way for skin selling. There the breeders got 64 DM per skin on average.

The marketing of the meat was hindered by reservations of the customers as to these animals and often by the costs of the trichinosis examination, which was not in relation to the sales value per carcase. If breeders sold the meat for human comsumption it was mostly bought by private households. On the average 16 DM were obtained per carcase. Otherwise they used the meat in their own household or they used or sold it as feed.

Most breeders only sold breeding animals, if they had the opportunity for a good deal. Therefore this only made up a small part of the farm's sales. According to the age of the animals the breeders obtained prices between 40 and 350 DM.

The investigation showed, that the conditions for nutria breeding are not very favourable in West-Germany. An improvement in the present conditions can only be realized by a cooperation of the breeders, the competent authorities and legislator. An essential contribution to this would be the solving of the breeders' main problem: the marketing of furs.

Thesis; 1988; Bonn (Germany, F.R.); 180 p. 42 tables. Bibliography 98 ref. Summaries (De, En). Available at: Bonn Univ. (Germany, F.R.). Universitätsbibliothek.

"Of course it's safe. It has no preservatives, no additives, no artificial coloring..."

Genetic polymorphisms of blood proteins in foxes.

R.K. Juneja, T. Niini.

Plasma samples of 235 foxes from 38 complete families (I4 of silver foxes and 3 with arctic x silver fox hybrid offspring) were analysed by one-dimensional horizontal polyacrylamide gel electrophoresis (PAGE) pH 9.0, followed by general protein staining of gels. A major postalbumin of fox plasma was identified as $_{I}$B- glycoprotein by using immunoblotting with antiserum specific to human or pig plasma α_IB. Four codominant, autosomal alleles of α_IB were reported in arctic foxes. Two transferrin (FF) alleles (FF^F, TF^S) were observed in arctic foxes and two (TF^D, TF^F) in silver foxes; TF F type of both of the fox species showed identical electrophoretic mobilities. The arctic foxes showed a high degree of polymorphisms for both TF and α_IB. The silver foxes showed a limited polymorphism of TF and were monomorphic for $_{I}$B. The arctic fox, silver fox and their hybrids could be clearly differentiated from one another by their plasma protein patterns obtained by the PAGE method.

Proceedings, VI World Conference on Animal Production, 564; 1988. Authors' abstract. Only abstract received.

Analyses of pelt prices as an aid in breeding programmes.

O. Lohi, E. Børsting, U. Joutsenlahti, K.R. Johannessen, E.J. Einarsson, G. Lagerkvist.

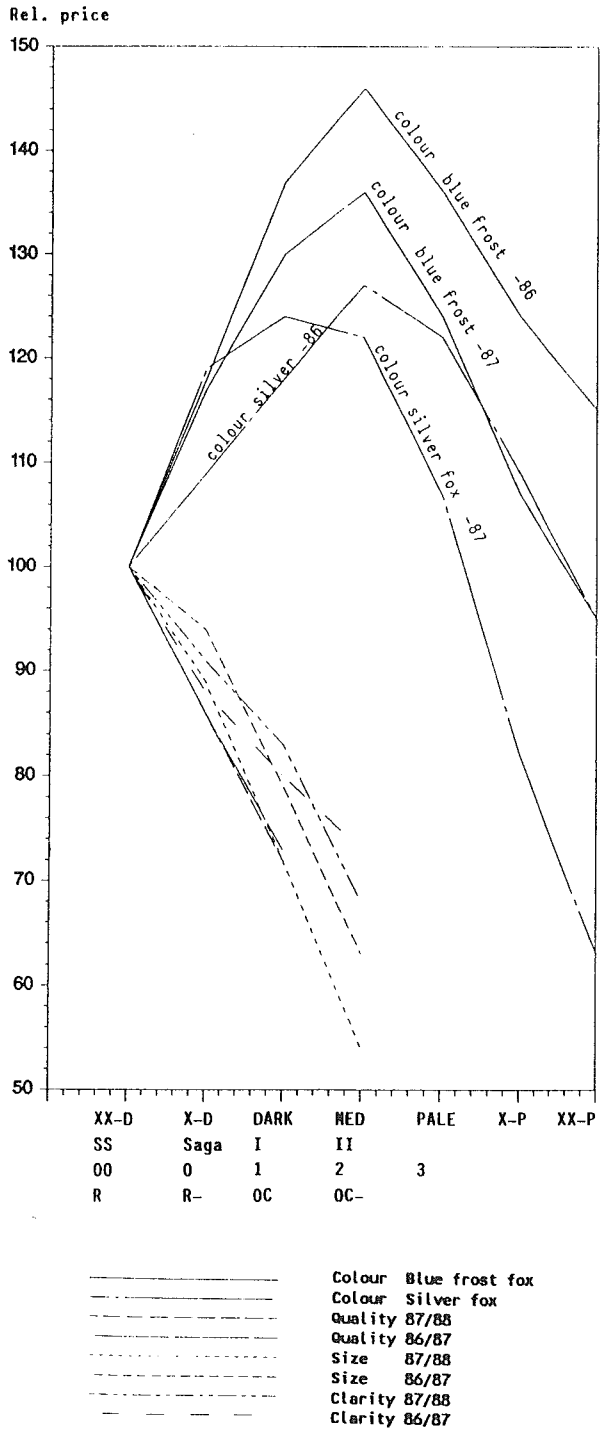
The total annual production of pelts in the Nordic countries has in the 1980's been between 12 and 20 million mink and 2 to 4 million fox pelts. These large numbers offer a reliable basis for studying how fur buyers evaluate the various pelt characteristics.

In the three reports included in this publication we give a review of the economic importance of different traits in the main colour types of mink and fox as well as some information about blue-silver fox hybrids.

The article have previously been published in Scandinavian languages in the nonthly magazines of the Scandinavian fur breeders organizations.

The statistical analyses will in future be carried out yearly, and reports on changes in price trends will be discussed in future articles.

Figure 10. SILVER FOX AND BLUE FROST FOX



Scandinavian Association of Agricultural Scientists, report no. 54, 1990. 19 figs., 6 tables. Authors' preface.

Heritability of fear motivated responses of silver fox cubs.

Patricia Risopatron.

This thesis is a part of an inter-nordic project with the purpose of examining behaviour and environment of farmed foxes. My experiment tried to examine the heritability of responses to two different kinds of fear tests (test of an unknown person and test of an unknown object) performed on silver fox cubs. Furthermore, the effect of litter, the effect of mother's age, sex of the cubs, litter size, owner, cage and shed type were examined in order to find out if these elements had any effect on the fear motivated responses.

The experiment comprised 563 silver fox cubs from Hallrøsta in Vingelen. The kits were distributed on 131 litters after 25 males from male stations, and they were tested when they were 52-59 days old. All cubs were tested twice the same day - once with each fear test.

In the test of an unknown person, body position and position of the cubs and movement in the cage were recorded. Before and after the observer went up to the cage, only the effect of litter and owner had any influence on the position of the cubs in the cage.

Also in the test of an unknown object, the position and movement of the cubs in the cage were recorded as well as time of latency for contact with the unknown object (max 4 minutes).

In this test also the effect of litter, where the cubs were born, and owner influenced the position of the cubs. Furthermore, litter size had an effect on the position.

38.9% of the cubs took less than 4 minutes to reach the unknown object. In this test only the effect of litter size and of father influenced the reaction of the cubs with regard to their approach to the unknown object. This applies when each of the effects was tested on an individual model. In a model including all the effects, only the effect of litter and cage type was important to the response of the cubs.

A positive correlation was found between cub tests. This means that to a large extent the cubs reacted alike to the two tests with regard to position in the cage.

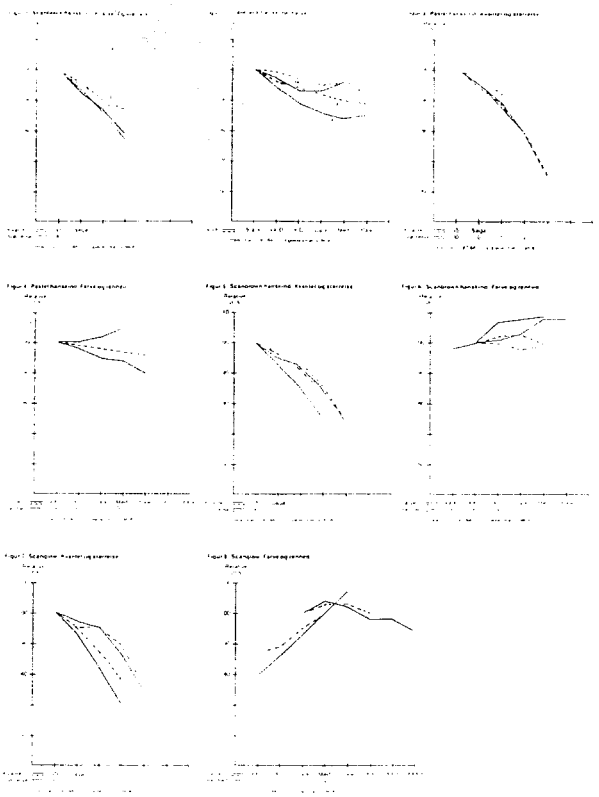
The heritability estimates for the different fear motivated responses in this fox population varied from 0.01-0.17. As these estimates are rather low, it will probably not be worth while to select for more animals that are less timid. The environment as well as the test methods will influence the estimates of heritability. A standardization of the environment or an improvement of the test methods might therefore increase the value of the heritability estimates.

Stenciled MS-thesis, May 1990, 59 pp. 9 figs., 11 tables, 44 references. In NORG. Author's abstract translated by Hanne Artved.

Price analysis of furs is important information for breeding.

Anonymous.

Since our latest report on price factors in the scanbrown and scanbrown/wild types (scanglow) we have experienced a steep fall in prices of all fur types, and many breeders feel that the situation is very uncertain. In spite of all uncertainty we must, however, try to plan the coming production year as well as possible, especially with regard to breeding work. An efficient breeding strategy is a possibility of fighting to maintain the Scandinavian reputation as fur producers. An important detail of this strategy is a weighting of various traits for determination of the total breeding value of the animal.

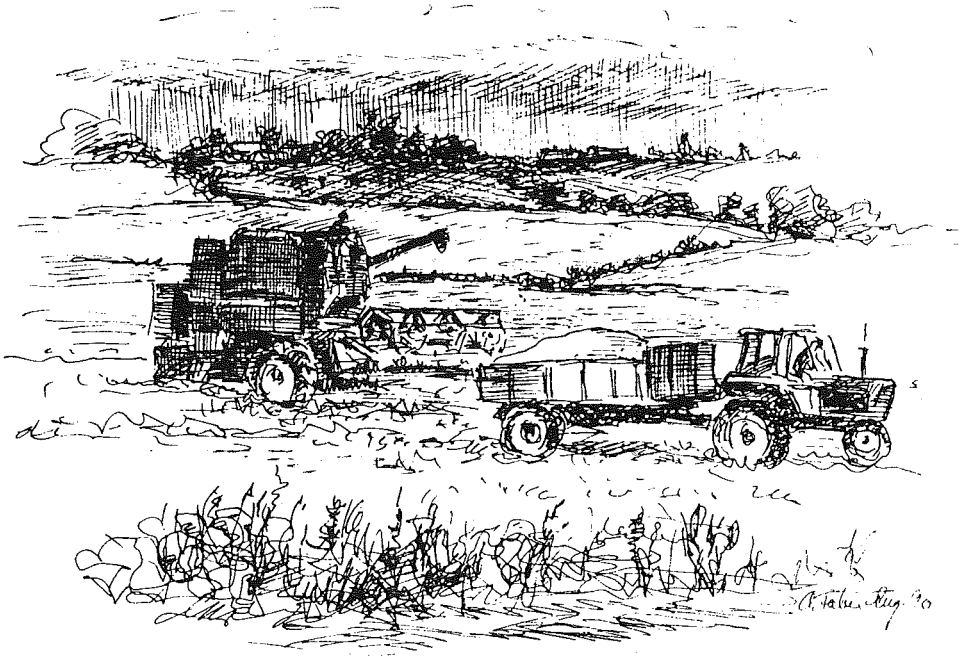


With our previous analyses we have given a picture of price conditions over a rather long period. In this article the 1987/88 season is compared

with the previous seasons as regards the basic traits: quality, size, colour and shade of colour. Furthermore, the analyses this time also include the price effect of silkiness, metallic, fleck and light underfur of mink skins as well as an analysis of price factors of the cross breeding types golden island and northern light. The analyses are based on Danish and Finnish productions of the mink types in question and on the Finnish production of fox skins.

In order to illustrate the most important changes which took place in the 1987/88 season, price relations from season 87/88 (full-drawn lines) have in the enclosed figures been compared to the latest season (dotted lines). Data processing has been done on both male and female skins, but as the trends are more or less identical in the two skin groups, only figures showing the prices of male skins are included. The previous articles are to be found in the March and August issues of the Danish Fur Breeders Journal.

Dansk Pelsdyravl (Denmark), Vol. 52 (1), 80-683. 1989. 10 figs., 3 tables. In DANH. Author's summary translated by Hanne Artved.



The reproductive physiology of the silver fox (*Vulpes fulva argentata*) and arctic fox (*Alopex lagopus*) with particular reference to ovarian histology before and during the breeding season.

M. Koivisto.

The present investigations refer to the reproductive physiology of the female fox.

Clinical symptoms of the external and internal genital tract, cytological and physical features of the vaginal secretion and the progesterone concentration in peripheral blood plasma were recorded and compared with histological criteria of the ovaries, concerning the quantitative occurence of primary, secondary, tertiary, and Graafian follicles as well as corpora lutea and atretic follicles before and during the breeding season.

The data were collected from six Bluefox vixens (*Alopex lagopus*) in October and November (before the breeding season) and from three Silverfox vixens (*Vulpes fulva argentata*) and three Bluefox vixens in March and April (during the breeding season).

The clinical and endocrinological symptoms of the animals examined before the breeding season proved to be typical for the anoestrus stage (missing odema of the vulva, less than 1.0 ng progesterone per ml blood plasma).

From the six animals examined during the breeding season, four (no. 7, 8 10, 11) were found to be in different stages of pro-oestrus. In vixen no. 9 the progesterone concentration of 4.3 ng/ml blood plasma as well as the clinical symptoms and the cytological and physical features of the vaginal secretion characterized the time close to ovulation, that means late pro-oestrus or early oestrus.
In animal no. 12, the high progesterone concentration 70.9 ng/ml represented postovulatory corpus luteum development. Corresponding the progesterone status, freshly luteinized tissue was identified histologically in the ovaries of these two vixens.

Concerning the total number of ovarian functional bodies, there were comparable amounts either within different localisations of the left and right ovary. In all cases the number of primary follicles significantly exceeded the number of the other ovarian functional bodies.
It was significantly higher before the breeding season than during the period of sexual activity. Old corpora lutea, resulting from the previous heat, were observed in all anoestrus ovaries, but were not histologically detectable in the pro-

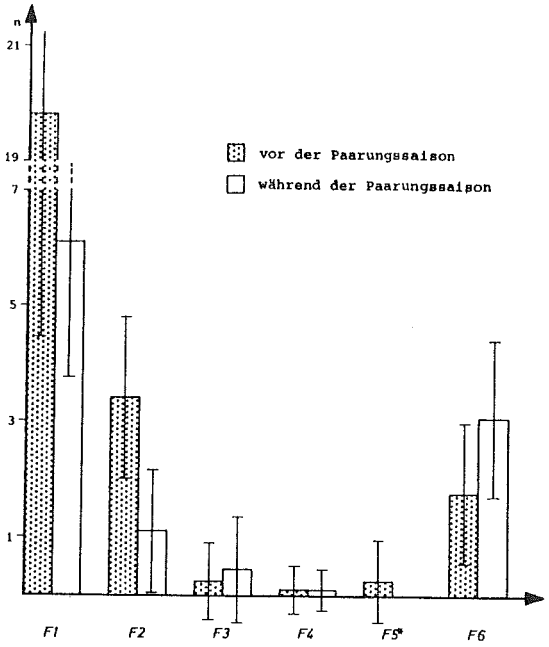


Abb. 6: Vergleich der Anzahl verschiedener Funktionskörper (F 1, F 2, F 3, F 4, F 5, F 6) in den fünf Lokalisationen beider Ovarien vor und während der Paarungssaison ($\bar{x} \pm sf$)

* Bei keinem Tier waren "alte" aus der vorangegangenen Paarungssaison stammenden Gelbkörper zu finden. Bei zwei Fähen (Nr. 9, Nr. 12) wurde frisches luteinisiertes Gewebe festgestellt, welches in der Abbildung keine Berücksichtigung findet.
$\bar{x}$ = Mittelwert
sf = Standardfehler

oestrus and oestrus organs.

The obtained results show, that the functional stage of the ovaries is reflected by the individual clinical, cytological, physical, and endocrinological findings. Thus, the suitabililty of these parameters for oestrus control in the fox is confirmed.

DMV Thesis, 71 pp, 6 figs., 7 tables, 55 references, 1986. Author's summary.

Reproduction in the male mink.

C. Sundqvist.

This is a bibliography of 187 references to literature in a variety of languages, but mainly in English. There is an introductory paragraph drawing attention to the main features of the reproductive physiology of the male mink.

Bibliography of Reproduction; 54; 1; unpaginated; 1989. CAB-abstract.

Sexual maturity and fertility in sables.

V.I. Usenko.

Sexual maturity of female sables occurred at 440-470 days of age. Insemination for the first time at 14-15 months did not adversely affect subsequent fertility.

Probl domestikatsii zhivotnykh 131-134. 1989. CAB-abstract.

Size of litter of coypu females in different maintenance conditions.

R. Cholewa.

To examine the influence of a maintenance system of coypu on the size of litter, experiments on 214 nutria females of Greenland variety were carried out. The females were mated in a harem-like way in 415 litters and gave birth to 1527 young. Animals of both sexes were divided into groups according to their origin (or bath or bathless maintenance). Then the number of born young in litters during the maintenance in three systems was analysed. The three systems were; bath, under a shower, in a building and bathless.

Results of procreation of females from bath and bathless maintenance bore insignificant differences in three various maintenance conditions. The achieved results speak for an insignificant influence a maintenance system has on the number of young born in a single litter. However, there was on average a smaller number of born coypus in litters of females that had been mated with males from bathless maintenance.

Roczniki Akademii Rolniczej w Poznaniu-CXCVI. 1 table, 5 references. 1988. In POLH, Su. ENGL, RUSS. Author's summary.

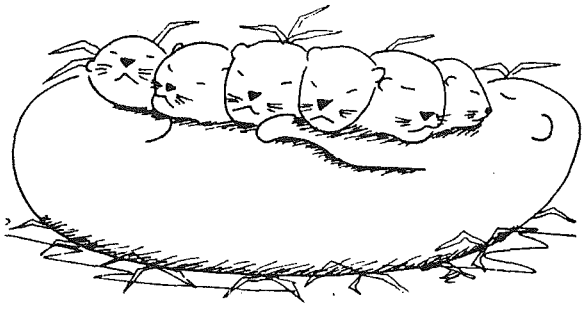
Whelping results in 1989.

K. Lindh.

For 808.856 mink, 19.900 polecat, 66.959 silver X blue fox, 85.587 blue fox, 161.771 silver fox and 4583 raccoon dog females recorded in Finland in 1989, the number of young born per mated female averaged 3.91, 5.65, 4.51, 5.81, 2.85 and 5.44 resp., and the percentage of infertile females was 21.22, 17.34, 32.04, 24.59, 30.88 and 30.07. Results are compared with those in 1988.

Finsk Pälstidskrift; 23; 9; 272. 1989. 1 table. In SWED. CAB-abstract.

Valpresultatet -89



Protein digestion in mink.

R. Szymeczko, A. Skrede.

The aim of the study was to investigate amino acid composition and digestion during passage through the digestive tract of adult mink, using chromic oxide as an indigestible indicator. Whole fish and fish meal were applied as dietary protein sources. The animals were sacrified 1 1/2 or 3 hours after a test meal. The average length of the digestive tract was 4.13 times the body length. The feed passage rate averaged about 3 1/2 hours. Analyses of digesta from stomach, three sections of small intestine and colon/rectum revealed certain changes compared with dietary values, mainly due to dilution with endogenous protein. Generally, the contents of methionine, lysine and arginine declined, while those of cystine and threonine increased. The digestibilities of amino acids were slightly positive in the stomach, but negative in the first section of the small intestine, reflecting the secretion of pancreatic juice. Towards the second and third section of small intestine and colon/rectum, the digestibilites increased rapidly. Compared with whole fish, fish meal proteins were less efficiently digested. It is indicated that the fecal digestibility method overestimates the amounts of absorbed amino acids.

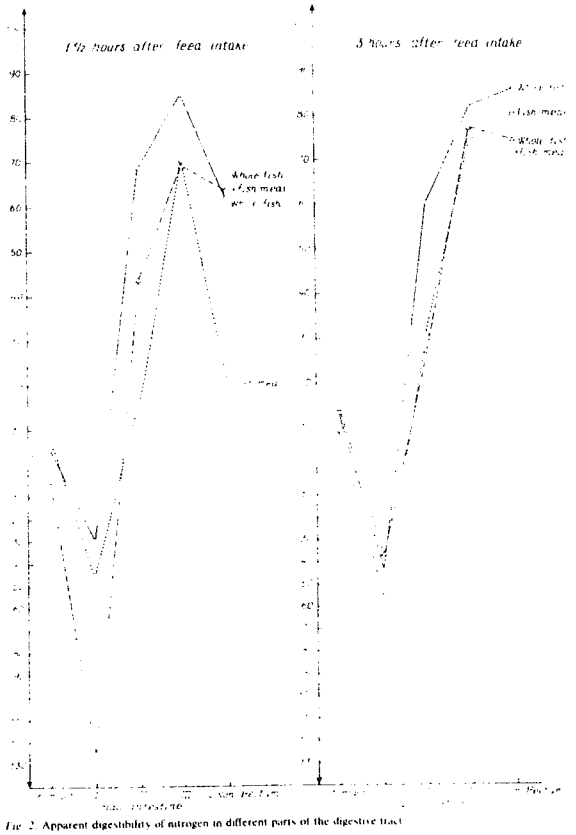


Fig. 2. Apparent digestibility of nitrogen in different parts of the digestive tract

Acta Agric. Scand, 40: 189-299. 1990. 6 figs., 6 tables, 16 references. Authors' summary.

Experiments with ensiled salmon entrails to silver foxes, blue foxes and minks.

Anders Skrede.

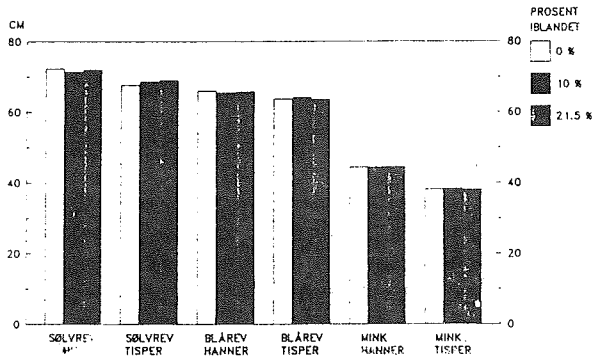
Ensiled salmon entrails conserved with 1.5% formic acid and ethoxyquin as antioxydant were delivered to the institute by Hordafor A/S, 5397 Bekkjarvik. In the experiment period, the feed was stored at room temperature. Parallel experiments were performed with silver fox, blue fox and mink. The experiment stages were in principle:

1) Control (without ensiled salmon entrails).
2) 10% ensiled salmon entrails.
3) 20% ensiled salmon entrails.

Each group included 30 silver fox kits, 32 blue fox kits and 80 mink kits.

The batches of ensiled salmon entrails examined were of a somewhat varying nutritive value, but they were of good quality and with a very good storage capacity. The experiments with ensiled salmon entrails for silver fox, blue fox and mink from weaning until pelting showed that the product was very suitable as fur animal feed in this period.

Figur 4. Kroppslengde ved pelsing. Forsøk med ensilert laksesio.



Norsk Pelsdyrblad (Norway), Vol. 63 (8), 14-15. 1989. 4 figs., 1 table. In NORG. Abstract by G. Jørgensen, translated by Hanne Artved.

Supply of vitamin B_1 to mink on different diets.

V.N. Tumanov, G.G. Petrova, S.P. Izotova, R.V. Trebukhina, V.A. Berestov, Y.M. Ostrovskii.

Keeping fur-bearing animals on a diet including fish rich in thiaminase, causes the development in the animals of an early stage of thiamine deficiency, in which in the tissues there is a significant decrease in the concentration of the coenzyme form of the vitamin, without disturbing the function of the enzyme which is dependent on it - transketolase.

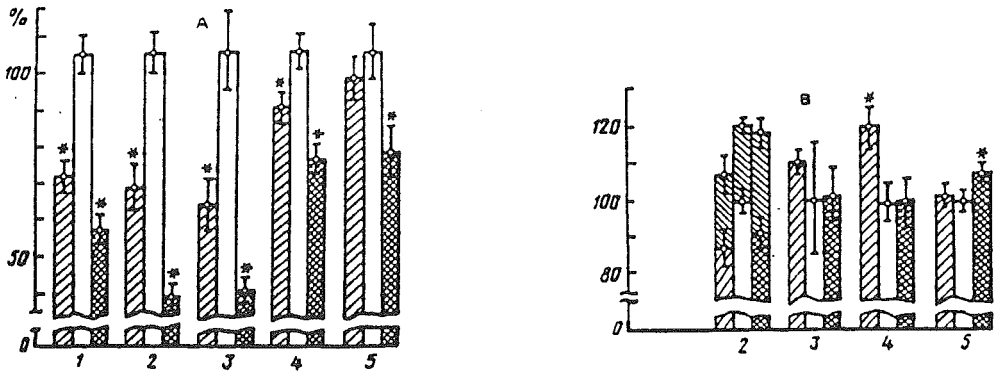


Fig. 1. TDP level (A) and transketolase activity (B) in tissues of caged mink: sparsely hatched columns) group I, blank columns) group II, densely hatched columns) group III. Axis of abscissas: 1,2) quantity of TDP and transketolase activity in blood after 3 and 4 weeks on comparable rations [100% corresponds to 0.2 mg TDP/l blood (A) and 5.77 mM sedoheptulose 7-phosphate per sec/l blood (B)]; 3-5) TDP content and transketolase activity after 3.5 weeks on rations tested (3) liver, 100% corresponds to 1.3 mg TDP/kg tissue and 33 mM S7P per sec/kg tissue; 4) kidneys, 100% is 1.85 mg and 58.8 mM, respectively; 5) brain, 100% is 1.5 mg and 27.6 mM]. The finely hatched upper portions of the columns (2) show blood enzyme activity by the application of TDP in vitro. An asterisk denotes significant deviations from the control.

Hence, the thiamine deficiency observed in the bodies of mink kept on economic rations is at the stage of development (under the conditions of this experiment - TK - is not yet disrupted, or the body under these conditions has sufficient reserves to combat the developing pathology.

Soviet Agricultural Sciences, No. 3, 56-58. 1987. 1 fig., 6 references. Translated from Doklady Vsesoyuznoi Akademii Sel'skokhozyaistvennykh Nauk Im. V. I. Lenina, No. 3, pp. 37-38, 1987; UDC 636.934.57:577.164.111. Authors' heading and conclusion.

Nutrition of young ferret during lactation.

B. Barabasz, A. Zon, J. Rafay, V. Parkany.

Experiments on the nutrition of young ferrets were carried out in 1986-88 in farms ZZD Chorzelów (Poland) and VUZV Nitra (Czechoslovakia). Investigation carried out at Chorzelów as part of complex study on ferret nutrition. The growth of ferret kits was studied, from birth to weaning at 42 days.

In 1986 best results in weight gains (215-219 g at 42 days) were in groups fed low-energy diet (105-115 kcal M.E. per 100 g of food) with mid-protein levels (6.7 - 7.9 g/100 kcal M.E.). Poorer results (200-208 g) were obtained in groups fed mid-energy diet (131-142 kcal per 100 g of food) with similar protein levels. Observations concerning additional feeding of kits have shown that best results are obtained when it takes place between 17-21 days.

In experiments carried out in 1987 high-energy levels were maintained in groups: 183, 179 and 173 kcal/100 g of food, respectively, with different protein levels: 5.3, 5.8 and 7.6 g of protein per 100 kcal M.E., respectively. Good lactation in females of group III, ave. 1081 g per female, gave the best growth in kits up to 28 days. In the period after lactation (28-42 days) the weight gains considerably decreased.

In 1988 again mid-energy levels were applied in groups: 150, 158 and 132 kcal/100 g of food with low-protein levels, respectively in groups: 5.3, 5.8 and 6.3 g of protein/100 kcal M.E. The best weight gains were obtained in kits at 28 days: 153 g and at 42 days: 233 g in group II.

The trials, simultaneously carried out in ferret farm at Nitra, have shown good growth effect at 28 days: 141 g at 42 days: 269 g, and lactation, ave. 893 g, in group fed diet containing 135 kcal per 100 g and 5.4 g of protein/100 kcal M.E.

The above experiments suggest that good breeding results can be obtained in ferret kits growth and good lactation in females by feeding lactation females low-protein diet in the range of 5.5 - 7 g per 100 kcal M.E. with low-energy levels in the range of 110-130 kcal M.E. per 100 g of food.

Zbornik prednasok z konferencie. VUXV, Nitra (Czechoslovakia), 173-179. 13th-14th of September 1988. In CZEC, Su. ENGL. Authors' summary. Only abstract received.

Protein requirement of ferrets in various breeding seasons.

B. Barabasz.

An increase in popularity of ferret breeding and interest in their beautiful fur coat stimulated research on finding optimal protein requirement of ferrets in various breeding seasons of the year.

A total of 60 females, 40 males and 200 young stock per year were used for the experiment, conducted in 1986-88. Every year experiment comprised two groups fed diet with the same levels of M.E. but differing in protein levels.

In pre-reproductive and reproductive seasons good results with respect to sexual activity of males and whelping in females were obtained only in 1986 and 1987 in group fed low-protein diet (protein:energy ratio 4.8-7.9; 22-35% M.E. from protein) and low-energy diet (120-130 kcal/100 g of food).

In lactation season there was a tendency toward better results in groups fed higher protein and energy levels. These results were especially good in group fed diet with protein:energy ratio 5.8-6.2 and 130-150 kcal/100 g of food. This diet gave good lactation results in femals (1038-1104 g milk per female) and in pre-weaning kits growth to 42 days.

In post-weaning kit growth to mid September, good results in live weight (males 870-900 g, females 700-770 g) were obtained in group fed diet with protein:energy ratio 5.6-6.7 and 140 kcal/100 g of feed.

In the last season of the breeding year, the so-called stage of fur coat maturing, final body weight and grading for winter fur quality data were analysed. Best results were obtained in 1987 in group fed low-protein level diet (protein:energy ratio 5.5-6.0) and 145 kcal M.E. per 100 g of food. Live weight of males reached in this group a value of 1652 g, and of females 1024 g, average grading score for exterier being 23.8.

Proceeding from Symposium "Physiology and nutrition of carnivorous fur animals". Bydgoszcz (Poland), 21st-23rd of September. 1989. In POLH. Authors summary. Only abstract received.

Nutria feeding with balanced feeds of different content of fiber and protein, corn grain with and without green and with oat forage.

O.N. DiMarco.

Body weight gain (BWG) was evaluated in nutria fed balanced feeds, or corn grain with or without green, and oat forage; during winter and spring of 1989. Additionally, the digestibility of the balanced feeds, corn and oat grain was estimated. Two balanced feeds of 17% and 13% of crude protein (CP) were studied, being the 17% CP ration formulated with ingredients of higher fiber content. The forages were fresh cut from pastures of oat, red clover and chicory (*Cichorium intybus*). Animals were grouped by sex and body weight in cages of 1x1 m, at a density of 6 to 10 or 10 to 14 in large and small animals, respectively. The BWG was estimated by difference between the initial and the final weight, when fed balanced feeds, and by regression in the other treatments. The diet with 17% CP formulated with some content of fibrous feedstuffs, promoted a higher BWG (30 vs 23 g/d) than the 15% CP diet without fiber. However it digestibility was lower (75 vs 90 %) in the higher fiber and protein content feed. Corn grain presented 91% of digestibility and oat grain 75%. Animals lost weight when fed corn grain or oat forage as only source of feeds, however when corn grain was complemented with green forages the BWG was between 17 to 22 g/d without differences among forages. In all treatment females BWG was 50 to 70 % of the males. From these results it was concluded that the inclusion of some fibrous ingredients, such as 12% of alfalfa meal and 15% of oat grain in a balance ration of 17% CP, did not affect BWG, although it digestibility decreased; and that corn grain or pasture separately should not be recommended for nutria feeding.

Rev. Arg. Prod. Animal, Argentina. 5 tables. 1990. In SPAN. Author's summary. Only summary received.

Titles of other publications - not abstracted.

Preliminary experiment on the use of pig blood to cure coronaviral enteritis in mink. *M.M. Han. Maopi Dongwu Siyang; No. 1; 3-5, 1989. In CHIN. Code 6-9-M.*

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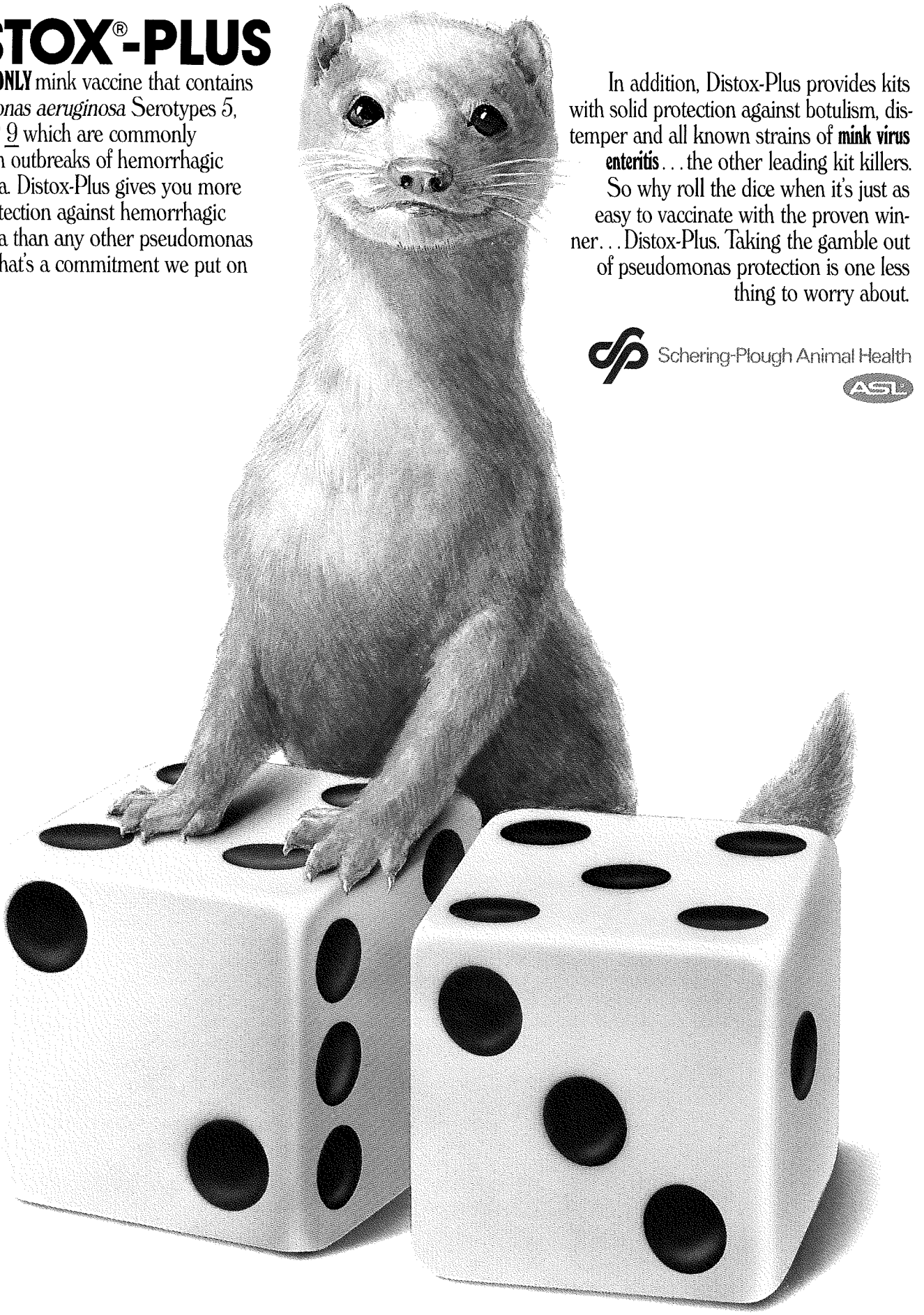

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Metabolic tyrosine disorder in mink and PLP therapy of hereditary tyrosinemia.

K. Christensen, P. Henriksen, K. Mortensen, H. Sørensen.

Tyrosinemia is a serious hereditary metabolic disorder in man. Various forms are known including tyrosinemia type I, which has been described to comprise defects related both to hepatic 4-hydroxyphenylpyruvate dioxygenase (EC 1.13.11.27) and other enzymes. In tyrosinemia type II defects at hepatic tyrosine aminotransferase (EC 2.6.1.5) are involved.

Three forms of hereditary tyrosinemia type II have been found in mink (*Mustela vison Schreb*). The disease may lead to death for animals with homozygotic recessive genes. Deficiency of hepatic tyrosine aminotransferase is found for all of the three different forms of this mink disease. This results in insufficient degradation and excretion of tyrosine and phenylalanine as well as their metabolites. The severity of the disease and the time of onset are characteristic differences among the three different forms of tyrosinemia type II.

The metabolism of tyrosine in normal and affected animals have been investigated by use of ^{14}C-L-tyrosine as precursor. The tracer technique combined with different analytical methods revealed that various tyrosine products are formed in other tissues and/or internal organs than the liver. Tyrosine products accumulated in diseased animals. In addition to tyrosine and phenylalanine the following products were found: 4-hydroxyphenyllactate, 4-hydroxyphenylacetate, 4-hydroxy-3-methoxyphenylactate, N-acetyltyrosine, dopa and some other products from the normal metabolism of tyrosin.

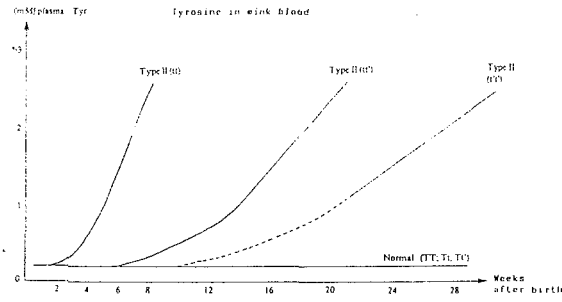

Fig. 1. Concentration of tyrosine in plasma of mink affected by the three different types of tyrosinemia II (Table 1).

Tyrosine aminotransferase isolated from mink liver has been investigated for clarification of the cause to tyrosinemia type II. Kinetics revealed that insufficient binding of the cofactor pyridoxalphosphate (PLP) to hepatic tyrosine aminotransferase is a likely cause of the disease. Dietary treatments of affected mink with PLP have been successful, as revealed from the data presented and discussed in this paper.

Amino Acids: Chemistry, Biology and Medicine, p. 762-772. 4 figs., 4 tables, 16 references. Authors' abstract.

Reproductive disorders in mink with Aleutian disease.

R.T. Shaikov.

Aleutian disease interfered with spermatogenesis and ovogenesis, resulting in reduced fertility.

Veterinariya (Moskva); No. 10; 43-45. 1989. 3 references. CAB-abstract.

Characterization of replicative form DNA of the autonomous parvovirus mink enteritis virus.

M. Shinagawa, Y. Nomura, T. Kariatumari, N. Ishiguro, M. Horiuchi, H. Goto.

Characterization of replicative form (RF) DNA of mink enteritis virus (MEV) was carried out. Most of the RF DNA were bound to terminal protein but some were free from the protein. The protein-free RF DNA increased about 7 times

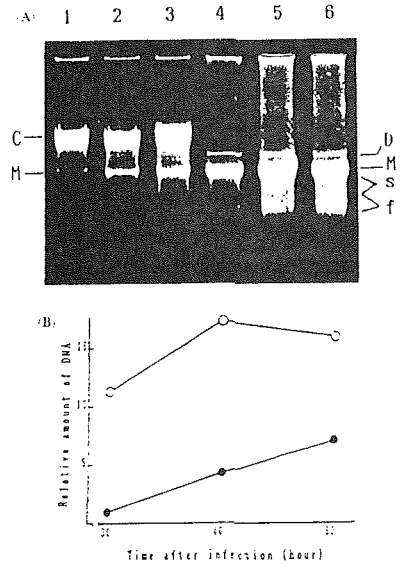

Fig. 1. Agarose gel electrophoresis of MEV RF DNA with and without terminal protein. (A) DNA fractions free from protein and bound to protein were prepared from three dishes of infected cultures at 30, 40, and 50 hr p.i. and were dissolved in 100 μl of TE without further purification. An aliquot of the DNA solution was analyzed by agarose gel electrophoresis. Lanes 1 to 3 contain protein-free DNA fractions which contain RF DNA free from protein (F-DNA). Lanes 4 to 6 contain protein-bound DNA fractions deproteinized with proteinase K which contain RF DNA bound to protein (P-DNA). DNA in lanes 1 and 4, 2 and 5, and 3 and 6 were prepared at 30, 40, and 50 hr p.i., respectively. C, chromosomal DNA; M, *monomer* RF DNA; D, dimer RF DNA; and s and f, slow and fast migrating fraction of incomplete RF DNA. (B) The relative amount of RF DNA was roughly estimated from the density of DNA bands as follows. Photographs were made by using films for an electron microscope from the negative film which was used for preparation of Fig. 1A. Density of DNA bands on the films examined by a densitometer (Densitron model-PAN, Joko Sangyo, Tokyo) was normalized by dividing the density of each band with that of F-DNA at 30 hr p.i. The relative amount of P-DNA (○) and F-DNA (●) was plotted against incubation time p.i.

from 30 to 50 hr post-infection, while the DNA with protein increased less. The molecules of the replicative intermediate which were partially single-stranded DNA and bound to terminal protein were present. Two terminal conformations, "extended" and "turnaround" were observed in both ends of both terminal protein-bound and protein-free RF DNA. The 5' end labeling revealed that 5' ends of protein-free RF DNA were not blocked to phosphorylation by an amino acid or an oligopeptide which attaches to 5' ends of proteolytically deproteinized RF DNA. Restriction analysis of incomplete RF DNA which was partially double-stranded DNA showed that extended conformation was dominant in such incomplete RF molecules.

Microbiol. Immunol. Vol. 33 (9), 721-732. 1989. 6 figs., 27 references. Authors' abstract.

Susceptibility of sable (*Martes zibellina*) to mink enteritis parvovirus and to botulism.

S.V. Aulova, N.S. Bukina, A.K. Kirillov, V.S. Slugin.

It is shown, that the sable are very resistant to natural infection by botulism and viral enteritis of mink. So their prophylactic immunization against these diseases aren't expedient.

Veterinariya (Moska); No. 9; 28-30. 1989. 2 tables, 5 references. Authors' summary.

Rear limb muscle degeneration in a ferret following an episode of hyperthermia.

B. Collins, A. Battles.

A group of 10 ferrets (*Mustela putorius furo*) was exposed to elevated environmental temperatures during transit in a truck. Two animals were comatose with temperatures exceeding 109°F. The remainder of the animals were panting and exhibited temperature elevations of 106°-108°F. After treatment with parenteral fluids, antibiotics, dexamethasone, and immersion in iced water, all animals recovered and appeared clinical normal. Within 1 to 2 weeks the two ferrets that arrived comatose were exhibiting signs of rear limb ataxia. Gross necropsy examination was unremarkable, but histopathologic examination of the thigh muscle of both rear limbs revealed myodegeneration and Zenker's necrosis. The longer time between the hyperthermia and the onset of ataxia is unusual, and the lesions were most likely secondary to the hyperthermia. Ferrets possess few sweat glands and have limited ability to withstand prolonged exposure to elevated environmental temperatures. Animal suppliers and transporters of ferrets must provide water, air conditioning, and adequate ventilation to prevent overheating.

Laboratory Animal Science, 38 (4), 501. 1988. Authors' abstract. Only abstract received.

Zoonoses in ferrets.

J.G.Fox, J.A. Adkins, K.O. Maxwell.

An appreciation of zoonoticmicroorganisms isolated from ferrets is important in establishing health surveillance protocols. Diagnostic procedures utilized in our program include monitoring for enteric pathogens, *Campylobacter jejuni/coli* and *Salmonella sp.* During the last 9 months, 4% (4 of 99) of the ferrets had *Salmonella sp.* (serotypes *hadar enteritidis, kentucky, typhimurium*) and 18% (18 of 99) had *C. jejuni/coli* recovered from their feces. It is not known whether *C. pylori* subsp. *mustelae* routinely isolated from gastric mucosa of adult ferrets is infectious to man. Ferrets are also monitored for upper respiratory infection and pyrezia indicative of influenza, a virus that can be transmitted to man via aerosol. Suspected cases have acute and convalescent sera assayed for rising antibody to confirm the diagnosis. Though ferrets are susceptible to rabies virus, approved vaccines are not available and rabies vaccination during quarantine is not recommended. Protozoal infections encountered include *Giardia sp.* and *Cryptosporidia sp.* Other zoonotic pathogens encountered in ferrets have included *Listeria monocytogenes* and *Myobacterium tuberculosis*. Because of the number of zoonotic microbial pathogens isolated from ferrets, appropriate quarantine, clinical evaluation, and diagnostic testing are recommended for ferrets used in biomedical research.

Laboratory Animal Science, 38 (4), 500-501. 1988. Authors' abstract. Only abstract received.

***Streptococcus sp.* Lancefield Group C infection in ferrets.**

J.K. Brieland, M.A. Suckow, B.J. Cohen, C.E. Chrisp.

Streptococcus sp. Lancefield Group C has been isolated from clinically normal ferrets, *Mustela putorius*, but fatal streptococcal infection in ferrets has only been reported in animals concurrently infected with human influenza virus. From June 1987 to January 1988, six ferrets presented with clinical signs of fever, lethargy, dyspnea,

and purulent nasal discharge. Two additional ferrets died prior to the onset of clinical signs. All ferrets were from the same supplier (3 different shipments, 10-16 animals/shipment) and had been at our facility for 1-4 weeks. All were vaccinated by the supplier with modified live canine distemper virus on the day of shipment. Severe rhinitis was found in all eight animals at necropsy. Other lesions found in one or more ferrets included pneumonia, abscesses, and encephalitis. *Streptococcus* Lancefield Group C was cultured from the nasopharynx (8/8), heart blood (2/8), and lung (3/8) of affected animals. Two weeks after the onset of symptoms, ferrets were seronegative for three influenza strains currently prevalent int hehuman population. Lack of influenza titers suggests this strain of *Streptococcus sp.* is more pathogenic than those previously isolated from ferrets. It is also possible that these ferrets were infected with an unidentified copathogen(s) resulting in symptomatic streptococcal infection.

Supported in part by NIH grants RR 07008 and RR00200.

Laboratory Animal Science, 38 (4); 500. 1988. Authors' abstract. Only abstract received.

Metastasis of proliferative colitis in ferrets.

J.G. Fox, J.C. Murphy, G. Otto, M.E. Pecquet-Goad, J.A. Scott.

Two ferrets (*Mustela purorius furo*) were referred to our laboratory with clinical signs suggestive of proliferative colitis (PC). A palpable abdominal mass present radiographically in one ferret was a circumscribed soft tissue mass associated with an area of bone density. Exploratory surgery exposed a nodular tissue mass in the mesentery of the intestine, and biopsy revealed what was interpreted to be an adenocarcinoma with bony metaplasia. The second ferret was found to have a palpably thickened colon, characteristic of PC. The two ferrets were killed and necropsied. Both animals had typical lesions of PC, and characteristic *Campylobacter*-like organisms (CLO) were present in Warthin-Stary stained hyperplastic epithelium. Both cases had localized areas of penetraction of colonic epithelium through the submucosa and muscular tunic onto the serosal surface of the intestine. The first ferret had metastatic foci of colonic epithelium in the mesenteric tissue and on the surface of the liver. The second ferret had metastatic foci of colonic epithelium within the subcapsular sinuses of a mesenteric lymph node. These cases demonstrate both invasive and metastatic properties that characterize neoplastic rather than hyperplastic processes. An interesting finding was the presence of CLO within the epithelial cells at the metastatic sites, which raises the possibility that these bacteria may have a carcinogenic role.

Laboratory Animal Science; 38 (4), 500. 1988. Authors' abstract. Only abstract received.

Gastric colonization and protein content of *Campylobacter pylori* subsp. *mustelae* in the ferret.

J.G. Fox, E.B. Cabot, N.S. Taylor, R. Laraway.

Campylobacter pylori subsp. *mustelae* has been isolated from the gastric mucosa of ferrets. Like *Campylobacter pylori*, which is associated with gastritis in humans, *C. pylori* subsp. *mustelae* is cultured from both normal and inflamed gastric mucosa. Examination of the gastric mucosa of neonatal, juvenile, and adult ferrets established that the majority of ferrets sampled were colonized with the organism after weaning (~ 6 weeks) and that 100% were colonized as adults. The organism was isolated on sequential gastric biopsies at intervals of 2-17 months in 9 or 11 ferrets in which reconstructive gastric surgery had been performed. Eleven strains of *C. pylori* subsp. *mustelae* isolated from five ferrets during a 12 month period had similar sodium dodecyl sulfate polyacrylamide gel electrophoresis protein patterns. Ten major whole cell protein bands were observed. One band, which migrated at 62,000 molecular weight, is also present in *C. pylori, C. jejuni,* and *C. coli*, which in the latter two *Campylobacter* strains is recognized as the major flagellar protein. Results suggest that ferrets colonize with *C. pylori* subsp. *mustelae* at an early age and that the organism establishes a persistent infection with strains that share similar protein profiles.

Laboratory Animal Science; 38 (4), 499-500. 1988. Authors' abstract. Only abstract received.

The isolation of a gastric *Campylobacter pylori*-like organism and a eugonic organism, EF4, from gastric lesions in the ferret.

J.L. Bryant, T.L. Hanner, D.G. Fultz.

Over the past 2 years, we have been engaged in studies involving gastric ulcers in ferrets. *Campylobacter*-like organisms (CLO-s) similar to *Campylobacter pylori,* isolated in human gastric lesions, *Campylobacter pylori*, has been reported in ferrets with gastric lesions. In this paper we report the isolation of a *Campylobacter pylori*-like organism and an organism identified as a eugonic organism, EF4 from ferrets with gastric lesions. Two groups of animals from two dif-

ferent suppliers were evaluated for gastric lesions. Animals from the first group had gastric lesion in the stomach and duodenum from which the CLO organism and EF-4 organisms were isolated. The CLO organism, isolated in a microaerophilic condition at 37°C for 3-5 days, was a gram negative curved to "U" shaped organism biochemically identical to the isolate reported in the ferret. The EF-4 organism was also isolated under microaerophilic conditions at 30°C, 37°C, and at 42°C and isolated aerobically at 37°C. Morphologically, EF4 was a gram negative, short, rod-shape to coccoid bacterium with some curved forms. Animals from the second group had similar gastric lesions, but only CLO organisms were isolated. Histopathologically, the lesions were described as lymphocytic gastritis and gastric and duodenal ulcers. We compared our CLO isolate with a human gastric CLO isolate. We were able to isolate not only the CLO from the vials containing the human gastric CLO's but were also able to isolate a eugonic organism, EF4, from several of the vials. Preliminary results using gerbils and hamsters showed that both organisms were capable of producing gastric lesions in hamsers and a focal necrotizing pneumonia in gerbils.

Laboratory Animal Science; 38 (4), 499. 1988. Authors' abstract. Only abstract received.

Electron microscopy of EF-4 and *Campylobacter pylori*-like organisms from gastric lesions of ferrets, hamsters, and humans.

D.G. Fultz, J.L. Bryant, T. Hanner, J. Henson, S.L. Hurley, M. Simkins.

The isolation of a *Campylobacter*-like organism (CLO) from the gastric mucosa of ferrets has been reported. This organism has morphologic similarities to *Campylobacter pylori*, which has been suggested as playing a role in the cause of gastric ulcers in humans. In our laboratory, we have isolated a CLO in ferrets with gastric ulcers and have also isolated what was thought to be another gastric *Campylobacter*, but was later proven to be a eugonic organism, EF-4. CLO's isolated from humans were compared with the ferret isolated and also found to contain EF-4 organisms. All bacterial isolates were subcultured after being frozen at -70°C and were prepared by standard EM techniques, negatively stained, and examined at different magnifications using a Zeiss transmission electron microscope. The gastric CLO's from ferret and human were similar morphologically, with both showing multiple flagella. The EF-4 isolates were also morphologically similar, but with no flagella.

Laboratory Animal Science; 38 (4), 515-516. 1988. Authors' abstract. Only abstract received.

A chronic granulomatous intestinal disease in ferrets caused by an acid-fast organism morphologically similar to of *Myobacterium paratuberculisis*.

J.L. Bryant, T.L. Hanner, D.G. Fultz, S.L. Hurley, C. Besch-Williford.

Two groups of ferrets received 3 months apart from a commercial supplier were diagnosed as having proliferative enterocolitis with lesions resembling Aleutian disease. Bacterial, serologic and histopathologic results showed that while there were similarities to proliferative colitis, all animals were negative for anibodies to the Aleutian virus. The receipt of the second group of animals allowed a more complete case work up. The disease condition clinically was characterized as a chronic, non-responsive diarrhea that persisted for months, depending on the condition of the animals. All affected animals (10) exhibited progressive weight loss, unthriftiness, wasting, debilitation, and eventually death. At necropsy, lesions were limited primarily to the gastrointestinal tract, mesenteric lymph nodes, and occasionally the kidneys and liver. Lesions were most prominant in the mid-colon area; however, in some cases the entire gastrointestinal tract was affected. Major histopathologic changes found in the colon were marked thickening of the mucosa, edema, and moderate round cell infiltration of the villus lamina propia. Adenomyosis occurred in multiple foci and was accompanied by a heavy granulomatous infiltrate that extended into and through the tunica muscularis to the serosal surface. *Campylobacter jejuni* was the only organism isolated from the lower gut. Impression smears from the liver, mesenteric lymp nodes, colon, and fecal samples were prepared and stained with the Auro-min-O stain and examined under a fluorescent microscope. The preparations were stained with and acid-fast stain. Acid-fast stain revealed numerous, small acid-fast bacili. Results of the Auro-min-O stain demonstrated small bacili (1.2-1.5μ) in pairs and clumps. Electron microscopy of tissue from the colon showed similar organisms in the colon. These animals had been fed offal from a cattle slaughter house.

Laboratory Animal Science; 38 (4), 498-499. 1988. Authors' abstract. Only abstract received.

A survey of parasitic helminths in wild Nyctereutes procyonoides.

Y.D. Cheng, L.Y Ye.

The helminths found in 6 wild male N. procyonoides in Dunting Lake area, Hunan, China, were Alaria alata, Echinostoma cinetorchis, Echi-

nochasmus liliputanus, Spirometra mansonoides, Ancylostoma duodenale, Arthrostoma miyazakiensis, Gnathostoma spinigerum and Toxocara canis. A. miyazakiensis is recorded for the first time in China. N procyonoides is a new host for Echinostoma cinetorchis, Ancylostoma duodenale and G. spinigerum. The morphology of Arthrostoma miyazakiensis is described.

Chinese Journal of Veterinary Science and Technology, No. 8, 25-27. 1988. 1 fig., 1 table, 8 references. In CHIN. CAB-abstract.

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