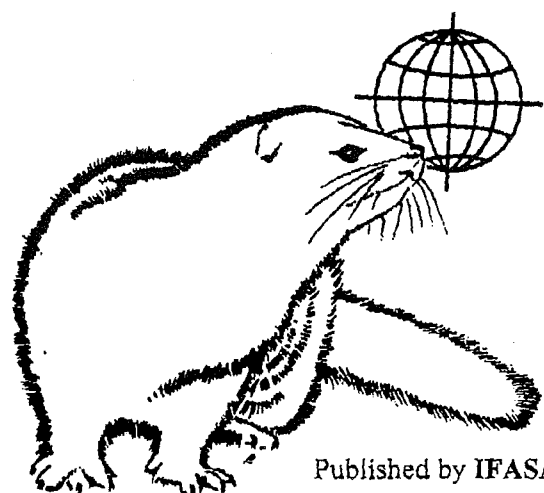


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## Notes

## SCIENTIFUR

Vol. 22, no. 3, 1998

It has been a hot summer until now, not outside but at Dorthe's computer, as she has got a scanner and has had her début as the "illustrator" of this issue of SCIENTIFUR, so from now on Dorthe can – and surely will – take full responsibility for the layout of SCIENTIFUR. We also thank Outi Lohi for proper installation of the necessary hard and soft ware and wish Dorthe good luck in becoming as professional as possible as "scanner and layouter" of SCIENTIFUR. I think that all authors and readers agree that the word processing performed by Dorthe has been extremely professional for many years.

I myself have been and am still very busy with the establishment of the referee system for scientific reports to be published in SCIENTIFUR. Especially all the formal rules for this and that. On pages 196 and 218 you will find my proposal for presenting SCIENTIFUR and the Instructions to authors that will be printed on the inside cover of SCIENTIFUR from vol. 23, No. 1. We would be very grateful if some of you would go carefully through the proposals and send me suggestions for improvements. Thank you in advance.

Until today we have not received any manuscripts for publication as scientific reports, so all of you who have been so kind to accept to be referees can still relax – at least as far as this extra work is concerned.

In this issue of SCIENTIFUR we bring 9 Original Reports and several are waiting for space in No. 4. We also hope to be able to bring abstracts from the

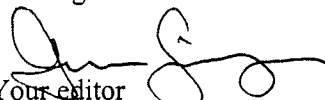
Scientific Meeting arranged by the Fur Animal Division of NJF (Association of Scandinavian Agricultural Scientists) taking place in Bergen, Norway, 7-9 September of this year.

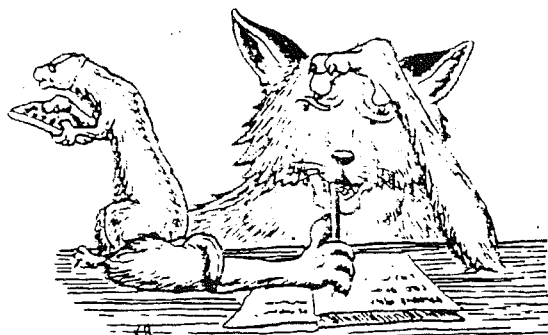
The suggestion to personal members of IFASA to pay 4 years' membership fee and thereby get a price reduction of 25% has been a success and we thank those of you who have already replied to our letter and paid the membership fee. At the same time we kindly ask the remaining – hopefully still IFASA members – to return the questionnaire to us.

We look forward to hearing from you. The day for the board meeting of IFASA has been postponed considerably but is now should now be scheduled for November in Montreal. Those of you who have questions and/or proposals to the board still have a lot of time to contact the undersigned or the individual board members, the names and addresses of whom are stated on the inside front page. Through your suggestions, you have an influence on your association and journal.

Have a good summer in the Northern Hemisphere and good luck with the fur animal reproduction in the Southern Hemisphere, where it is midwinter now.

Best regards

  
Your editor  
Gunnar Jørgensen



## Research into the quality of skin and hair from fur bearing animals

By **Palle V. Rasmussen and Bent Riis**  
*Department of Animal Product Quality, Danish Institute  
of Agricultural Sciences, P.O. Box 50, 8830 Tjele, Denmark*

The present times are reasonable for pelts producers. Pelts from mink, fox, chinchilla and fur rabbits have ensured an acceptable earning, but there is still room for improvement. We all hope the good times are continuing. However, from previous experiences we know that after good years, bad years will follow.

During good times we might have a tendency to pay little - or no - attention to the skin quality. This is only natural when practically all skins can be sold. The danger is that, when the hard times strike again, it will be too late to do anything to improve the quality of the skins and hairs and secure the highest possible auction price.

On September the 24<sup>th</sup>, 1998, Palle V. Rasmussen and Bent Riis invite to a thematic meeting covering "Quality of skin and hair". Anyone with an interest in fur bearing animals is encouraged to participate. The language will be Danish. The meeting fee is 400.- Dkk, including lunch, coffee and materials. The meeting will take place at the Danish Institute of Agricultural Sciences, Research Centre Foulum near Viborg, Denmark.

Various researchers from different areas will give 10-20 min presentations followed by the possibility to ask question and make remarks.

### Preliminary program for the thematic meeting "Quality of skin and hair"

9.00 – 9.45	Registration, welcome and presentation of research in fur bearing animals at DIAS
10.00 – 11.00	Demands of the quality of pelts Speakers: tanners, designers and sales people
11.20- 13.00	Research in fur development, skin and hair quality Speakers: biochemist, morphologist and microscopist
13.00- 14.00	Lunch
14.00- 15.10	Research in relation to pelt quality Speakers: scientists from animal behavior, genetics, management and nutrition
15.30- 16.00	Final discussion and concluding remarks

The language will be **Danish** – no simultaneous translation will take place.

Further info: Bent Riis, telephone + 45 89 99 11 04, telefax + 45 89 99 15 64 or e-mail: Bent.Riis@agrsci.dk



*Original Review***The cage environment of the farm mink - significance to welfare***Steffen W. Hansen**Department for Animal Health and Welfare, Research Centre Foulum**Danish Institute of Agricultural Sciences, P.O.Box 50, DK-8830 Tjele, Denmark***Introduction**

From several sides demands are made to the cage environment of the farm mink. The authorities pass laws and departmental orders regarding fur animal farming. The Danish Fur Breeders Association publishes guidelines on fur animal farming, and the fur animal farmer sets his own requirements to the cage environment. Besides, a generally intensified public attitude exists towards the way mink are kept on farms today.

The intensified attitude and the increased interest also involve other animals than domestic animals. For instance, it is no longer possible for a zoo to survive just by showing the animals in small, naked cages. The public demands to see the animals in an environment which is almost "natural", and a lot of efforts are made to prevent the development of stereotypes in animals in zoos.

For the fur animal farmer with fur animal farming as a career, and for whom the purpose is to produce as many healthy and thriving animals as possible, it can be done as on Danish mink farms with due consideration for an expected financial profit. This form of production is, however, also subject to criticism. The criticism is - just as for animals in zoos - based more on the feelings and attitudes of human beings than on knowledge of the animals' biology and welfare. It is fair for society to establish ethical rules for animal farming, but will that also secure the welfare of the animals? As far as the Danish Institute of Agricultural Sciences is concerned the problem will be to provide knowledge

about the needs and adaptation of the animals in order that the rules on welfare can be implemented in accordance with the biological knowledge and the financial reality.

**The concept of welfare**

The concept of welfare is in itself diffuse, and no final and acknowledged definition exists. Often the concept is defined by its contrasts: suffering, pain, disease and stress. The most important criteria for a scientific evaluation of the welfare of animals are their behaviour, their health status and a number of physiological measurements. These criteria are objective facts. It can, for instance, be proved whether a given behaviour occurs more or less frequently in a given environment, whether the frequency of disease increases or whether concentrations of various hormones in the organism change. These objective measurements are supposed to reflect the animals' experience of pleasure and discomfort and are the basis for an evaluation of the welfare of the animal.

In a given investigation, subjective choices are, however, also included. Thus it is a subjective choice what one wants to examine, which parameters to use and how to weight the results in the conclusion.

The results obtained must, however, be obtained in accordance with the rules existing for scientific research and must as such be independent of personal attitudes to the way in which we treat the animals. As mentioned, the interest of society in the production conditions to which our domestic animals are

subjected has increased distinctly over the latest 20-30 years. This interest originates from the increased intensification of the production, the increased distance between producers and consumers and the general prosperity of society.

In Denmark, the National Agricultural and Veterinary Research Council in 1971 took the initiative to illustrate animal welfare in intensive domestic animal production. In the fur animal area, the first behavioural studies were inaugurated in 1985 in a fruitful collaboration between the University of Copenhagen, the Danish Institute of Animal Science and the Danish Fur Breeders Association.

In the past twelve years of behavioural research in the fur animal area in Denmark, our knowledge of the biology and welfare of the animals has grown tremendously. This knowledge has been applied in the debate on the otherwise very sensitive subject - welfare.

In the following, results from our studies on the influence of cage environment to the welfare of farm mink will be presented.

### **The production environment of the farm mink**

The physical conditions of fur animal production in Denmark are very standardised and are presumed to have been established based on practical experience. The design has not changed very much during the years of fur animal farming, and the dimensions of the cages have been constant for the last 20 years.

#### *Cage size*

In regard to legislation as well as welfare, it has been an interesting issue to illustrate the significance of cage size to the welfare of mink. We therefore compared behaviour, physiology, feed intake, growth and pelt quality in mink in standard cages (0.27m<sup>2</sup>), with cages four times as large and with cages half the size of a standard cage. The behav-

our was recorded partly by direct observations and partly by 24-hour video recordings (*Hansen, 1988; Hansen & Brandt, 1989; Hansen & Damgaard, 1991; Hansen et al., 1994*).

From the table it appears that cage size does not affect the stress physiological parameters. For mink in large cages an increased weight of the suprarenal gland is seen and an increase in the occurrence of stereotypies. Cage size does not affect pelt quality. Based on the results obtained we have concluded that a cage size four times the recommended size does not enhance the welfare of the mink. In the small cages, certain forms of behaviour were limited due to the physical conditions.

### **Cage design**

#### *Nest boxes*

Apart from a water nipple, a nest box with straw is the only equipment in conventional mink cages. At the same time we therefore examined the significance of access to nest boxes to the welfare of mink by comparing behaviour, physiology, feed intake, growth and pelt quality in mink with nest boxes with mink without nest boxes. The cages were standard sized.

The stress physiological changes in a number of blood values indicating reduced welfare in mink without nest boxes corresponded to the changes obtained by fixing mink for 30 min. per day over a 10-day period. Besides, we have earlier proved that mink that have for a period been without access to a nest box will spend more time in the nest box when given the possibility than mink that have constantly been able to use a nest box.

Based on the results obtained, we have concluded that mink need nest boxes and that the absence of nest boxes reduces the welfare of the mink (*Hansen, 1988; Hansen & Brandt, 1989; Hansen & Damgaard, 1991; Hansen et al., 1994*).

**Table 1.** Significance of cage size to the welfare of mink

Cage size	Large (4x1)	Stand. (1x1)	Small (½x1)	Remarks
<b>Physiology</b>				
Plasma cortisol	-	-	-	
ACTH-challenge test (cortisol)	-	-	-	
No. of eosinophil leukocytes	-	-	-	
Heterophil/leukocyte – ratio	-	-	-	
Hematology	High	-	-	Hemogl., eryth.
Weight of organs	High	-	-	Suprarenal gland
Metabolic activity	High	-	-	Asat, alat
Body weight (growth)	-	-	-	
Feed consumption	-	-	Low	After week 37
<b>Behaviour</b>				
Activity	-	-	-	
Aggression	-	-	-	
Stereotypes	High	-	-	Video
Exploration	High	-	-	Scanning
Marking behaviour	-	-	Low	Scanning
Social behaviour	-	-	High	Video
Use of nest boxes	-	-	High	Video
<b>Pelt quality</b>				
Live animal	-	-	-	
Pelt	-	-	-	Cla., Qua., Colour
Fur chewing	-	-	-	
Fur bites	-	-	-	Leather side

Significant differences between cage sizes: high/low

No difference between cage sizes: - -

**Table 2.** The significance of nest boxes to the welfare of mink

	+ nest box	- nest box	Remarks
<b>Physiology</b>			
Plasma cortisol	-	High	
ACTH-challenge test (cortisol)	-	High	
No. of eosinophil leukocytes	-	Low	
Heterophil/leukocyte – ratio	-	High	
Hematology	-	-	
Weight of organs	-	-	
Metabolic activity	-	High	Asat, alat
Body weight (growth)	-	-	
Feed consumption	-	High	After week 37
<b>Behaviour</b>			
Activity	-	-	
Aggression	-	-	
Stereotypes	-	High	Video
Exploration	-	-	Scanning
Marking behaviour	-	-	Scanning
Social behaviour	-	High	Video
Passive alone	Highest	-	Video
<b>Pelt quality</b>			
Live animal	-	-	
Pelt	-	Poorest	Quality
Fur chewing	-	-	
Fur bites	-	-	The leather side

Significant difference between + and - nest box: High / Low / Poorest

No difference between + and - nest box: - -

### Enrichment of the physical environment

To enrich the physical environment we have experimented with shelves, wire netting cylinders and water trays in the cages, and various forms of toys for occupation of the mink have been tested. In the following, the results of these tests are explained.

#### *Shelves / wire netting cylinders*

Mink use shelves and wire netting cylinders for activity as well as for resting. If the mink have a choice between shelves and wire netting cylinders, they prefer shelves. The shelves are occupied for 15% of their active time and 15% of their passive time, whereas the cylinders are used considerably less. For comparison, the mink only used the cage bottom for resting for 5% of their passive time. The results show that when the mink do not use the nest boxes, they prefer a resting place elevated above the cage bottom (Hansen *et al.*, 1994). The use of wire netting cylinders as a possible refuge for nursing females was also examined (Hansen, 1990). The females use the cylinders but immediately before weaning the use of the cylinders becomes less frequent, perhaps because at this time the kits can reach the female in the cylinders. The wire netting cylinders reduced the frequency of stereotypes but did not affect the weight development of the female or of the kits.

Earlier studies have shown that nursing females use the shelves 8% of the time that they are out of the nest boxes, and if they have access to shelves in the latter part of the nursing period, they lose less weight than females without shelves and females with permanent access to shelves (Houbak, 1987).

#### *Water trays*

The effect of water trays (30 x 20 x 2 cm) suspended in standard mink cages was examined with regard to behaviour, physiology and production properties (Hansen, 1989). Apart from a higher activity level, no difference in behaviour was found between mink with and mink without water trays. Mink kits with water trays had a lower growth rate from July to October than mink without water trays. The difference in weight already appeared when the kits were 8 weeks old.

Quality and purity at live animal grading were poorer when mink had access to water trays. Likewise, purity was poorer at pelt sorting, but no difference in quality could be found.

As a measure of a possible stress reducing effect, we measured the number of eosinophil leukocytes in the blood, but no effect of access to water trays could be proved. Access to water trays did not affect the reproduction result, either. Experiments with swimming water could not prove any positive effect on the reproduction result (Skovgaard *et al.*, 1997).

An increased activity was seen in the mink just before the time when the water was changed, like that which is seen just before feeding time (Hansen, 1989). It was expected that the kits could supplement their liquid intake by licking water from the females' wet pelt. This behaviour was at no time observed.

#### *Toys (play balls, chewing rings)*

Access to toys seems only to provide a short-term occupational function for mink as they quickly lose interest. The toys have no reducing effect on frequency and extent of fur chewing (Falkenberg & Jeppesen, 1990).

### The social cage environment

#### *Group size*

Based on the solitary way of life of the wild mink (Dunstone, 1993) it has been interesting to study the social behaviour of the mink under production conditions. Earlier observations have shown that mink chose to lie together in groups independently of cage sizes and nest boxes (Hansen, 1989), and some studies imply that mink establish a social hierarchy when kept in groups (Houbak, 1988).

We have therefore studied various physiological parameters and production parameters when mink are kept singly as opposed to in pairs (male+female) and singly as opposed to in groups (3 males+3 females) (Hansen & Damgaard, 1991; Damgaard & Hansen, 1996).

**Table 3.** Significance of social housing to the welfare of mink

	Alone	In pairs	In groups	Remarks
<b>Physiology</b>				
Plasma cortisol (females)	Low		High	Females
No. of eosinophil leukocytes	-	-	-	
Heterophil/leukocyte ratio	-(low-high)	-	-(high-low)	Females
Leukocytes	-	High	-	
Hematology				
Erythrocytes	High	-	-	
Hemoglobin	High	-	-	
Hematocrit	High	-	-	
<b>Metabolic activity</b>				
ASAT	-	-	High	
ALAT	-	-	-	
Weight of organs				
Suprarenal gland	-	-	Low	
Kidney	High	-	-	
Heart	-	-	-	
<b>Body weight</b>	-	-	-	
<b>Pelt quality</b>				
Live animal Score 1-5 quality	-	-		
Pelt score 2-13 quality	Low	High		
Fur chew % (neck and back)	None (a few)	High		
(tail)	-	High		
Fur bites % (neck and back)	None	High	High	
(tail)	Low	High	High	

Significant differences between groups: High/low

No difference between groups: - -

Based on the stress physiological measurements (cortisol, eosinophil leukocytes and H/L ratio) no effect could be found of the mink being placed alone, in pairs or in groups. However, females kept in a group had a constantly higher cortisol level than females kept singly which might indicate increased stress. The hematological measurements were higher in mink placed singly than in mink in pairs but not different from mink in groups. In general it must be concluded that the hematological measurements are not suitable as indicators of welfare.

Housing had no effect on body weight, but the suprarenal glands weighed less in mink kept in groups and the kidneys weighed the most in singly kept mink. Apart from that no difference in organ weights could be found. Housing distinctly affected the pelt quality which was the best in mink kept in pairs. Fur chewing on neck and back almost never occurs in mink kept singly but is seen to a considerable extent in mink kept in pairs and groups. On the other hand, no difference in tail chewing was found. Fur chewing, recorded as marks on the leather side

of the skins, primarily occurred in mink kept in pairs and groups.

Conclusion: Females are stressed more when they are kept in mixed sexual groups than when they are kept alone or in pairs with a male. No indication of increased stress is seen in males kept in groups. Production wise the pelt quality is best in mink kept in pairs but fur chewing and fur biting increase considerably when mink are placed more together.

#### Alternative housing

In many of our previous studies we have experimentally changed a factor and studied the effect of this single change. We know, however, that many factors interact and we have therefore studied the behaviour of mink in an "alternative" housing system, called family housing, in connection with our studies of the problems related to fur chewing. The immediate advantages could be that the extent of tail chewing could be reduced by avoiding weaning (Mason, 1996; de Jonge, 1988). Besides, the increased space (not per animal, though) would fa-

cilitate an enrichment of the environment which is difficult to establish in a conventional cage system. Enrichment of the environment was not studied in this experiment. To increase the contrast to family housing we established a group weaned in pairs at

the age of 7 weeks and a group where the kits were weaned early and placed singly at the age of 6 weeks. The behaviour of the kits was recorded by direct observations and tests (Hansen *et al.*, 1997).

**Table 4.** Significance of growing up alone, in pairs and in a family group to the welfare of mink

	Alone	In pairs	Family	Remarks
<b>Behav. at weaning/moving</b>				
Calling sounds	High	-	-	
Active in the cage	High	-	-	
<b>Social behaviour</b>				
Aggression		-	High	
Grooming		-	High	
Play		-	High	NS
Pulling at neck		-	High	NS
<b>Non-social behaviour</b>				
Playing alone	High	Low	Medium	
Stereotypes	High	-	-	
<b>Marking</b>	High	-	-	
Aware of observer	-	Low	-	
Escape from observer	-	-	Low	
Auto grooming			High	
Activity (in-out of nest box)	High	Low	High	
<b>Intruder test</b>				
Head out of nest box	Few	Many		
Out in cage	Few	Many		
Contact with unknown object	Few	Many		
<b>Novel object</b>				
Head out of nest box	Few	Many		
Out in cage	Few	Many		
Contact with unknown object	Few	Many		
<b>Mating success</b>	Poor	-	-	
<b>Body weight</b>	High		Low	
<b>Pelt quality</b>				
Live animal	-		-	
Pelt	Low		High	
Fur chewing				

Significant difference between weaning/housing: High / Low / Few / Many

No difference between weaning/housing: - -

Conclusion: Mink weaned early and kept singly show reduced welfare in comparison with the two other forms of housing. There is no scientific evidence that mink kept in family groups have a better welfare than mink kept in pairs. The increased aggression in family groups compared to the increased stress level of females previously kept in groups might indicate social stress of females in family groups. The possibility of further developing the system so that the "family" can be separated when the solitary and territorial behaviour of the mink shows in September should therefore be studied. It is especially important to focus on the welfare of

the female in family housing. When kits are weaned early, the most important reason is often consideration for the welfare of the female.

### Summary and perspectives

In comparison with the housing problems discussed in relation to the welfare of other domestic animal species, the existing cage system considers many of the likely needs of the mink: freedom to move, access to nest boxes, to handleable material (straw) and social contact. It is, however, still relevant to examine which needs are not met in the existing

cage environment and how these could be met under practical production conditions. An increase in the cage area, with consideration for a financially profitable production, does not seem relevant. Likewise, it is uncertain whether more than two mink in the same cage really means enhanced welfare for the mink. Different forms of toys have been tested, but the mink quickly lose interest. A possibility of getting on with the development of the cage system could be to ask the mink! Tests of choice have been tried and are still used. Another possibility would be to study how much effort the mink is willing to put into getting access to different resources. The amount of effort could be taken as an expression of the strength of the need. If, at the same time, access to the resource changes the level of stress positively, we may be sure that we are really considering the need/welfare of the mink and not only the public/political opinion.

Internationally there is an increasing interest in research in the biological requirements of domestic animals, and the application of the above mentioned method has been initiated at several institutions. We find it essential that the Danish Institute of Agricultural Sciences is also involved in this area and have applied for financial resources for evaluation and further development of the method.

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### **New catalogue of Nordic research projects on fur animals**

The fourth edition of the catalogue came out in March 1998. All projects presently running or completed within the last two years are included. The status of running projects is updated and new ones started in 1997 or starting in 1998 are added. Altogether 127 projects are presented with title, participating institutes and researchers, time schedule and a short status description. The catalogue is mainly in the Scandinavian languages but the titles are given also in English.

The Nordic catalogue will be updated yearly and we hope to be able to present the next edition on Internet.

### **The number of projects per main research area in the fourth edition of the Nordic catalogue of fur animal projects:**

Breeding and genetics	18 projects
Biotechnology	7 projects
Nutrition, feeding and feed ingredients	15 projects
Physiology	15 projects
Hair and skin	13 projects
Reproduction	5 projects
Animal health, diseases, vaccination	16 projects
Animal welfare, behaviour, ethology	29 projects
Production systems	5 projects
Economics	2 projects
Environment etc.	2 projects

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**Nordiske Jordbrugsforskere Forening**  
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**Subsektion for Pelsdyr**

## **Katalog over nordiske pelsdyrprojekter**

Udgave 1998



*Short Communication***Preferences of blue foxes for lying site and posture on platform***Hannu Korhonen & Paavo Niemelä**Agricultural Research Centre of Finland**Fur Farming Research Station, FIN-69100 Kannus, Finland***Introduction**

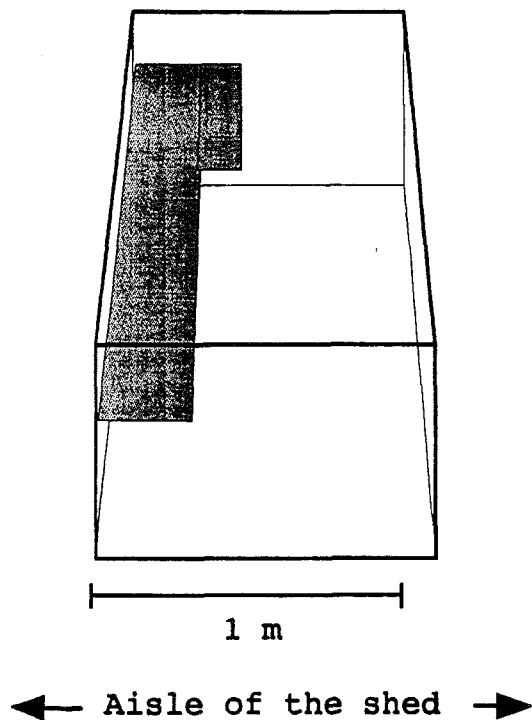
The need and quantification of platform use by farmed foxes has been intensively studied in fur animal husbandry (Bakken *et al.*, 1994; Mononen *et al.*, 1996). The main impetus for these studies has been the recommendations of the European Convention (1991) which cite that each weaned fox shall have a platform or nest box available in its cage. These enrichments are expected to enhance animal welfare (Pedersen & Jeppesen, 1993). Results of recent platform studies have shown that platform use depends on several factors such as platform construction, ceiling height, platform material and season (Harri *et al.*, 1991; Korhonen & Niemelä, 1996). In particular, the finding that platform use is highest in summer and lowest in winter has been crucial for engineering enhancements into platform design. The reason why foxes avoid significant use of platforms during winter, however, has been unresolved until now. One hypothesis is that the platforms are too narrow and prevent the foxes from lying in a curled posture on them. Although the insulation capacity of the blue fox's fur coat is considered to be excellent (7-8 clo values: Scholander *et al.*, 1950), the animal must be able to assume a tightly curled posture when lying in order to attain maximum insulation at cold temperatures (Korhonen *et al.*, 1988). Therefore, foxes might prefer the net floor of the cage during the coldest period of the year because it better facilitates the right posture. In addition, while males typically are larger in body size than females, there might also be some sex differences in their lying site and posture.

In the present study, a platform construction was designed which allowed the foxes to lie in both curled and outstretched postures. Preferences for these two lying postures at different-sized ends of the platform (wide vs. narrow) were evaluated. The aims were to test the following hypotheses: (1) during winter foxes prefer to lie in a curled position; and, (2) to attain a better lying posture during the winter they prefer the wider end of the platform.

**Material and methods**

The experiments were carried out at the Fur Farming Research Station of Kannus during January-December in 1994. The subjects were adult male and female blue foxes born in May 1993 (10 ♂, 10 ♀). All had previous platform experience since weaning. The test foxes were housed individually in wire-mesh cages measuring 110 cm long x 105 cm wide x 70 cm high. The foxes were weighed in June (minimum weight) and in November (maximum weight) with a Lario 30-kg balance.

The experimental platform type was a flat model with a total length of 107 cm. It had a wider end with a diameter of 45 cm (area 2025 cm<sup>2</sup>). The narrow end of the platform was 62 cm long x 30 cm wide (area 1860 cm<sup>2</sup>). The foxes' preferences between these two ends were tested. The platforms were made of board (22 x 125 mm) and placed 23 cm below the cage roof crosswise in the shed (Fig. 1). The wider part of the shelf was always turned away from the central gangway.



**Fig. 1.** Schematic diagram of the platform type studied. The platform was 107 cm long x 30 cm wide with an enlarged end section measuring 45 cm in diameter.

The amount of platform use was monitored by means of video camera equipment (CCD video camera 720, Bische UB-480 time-lapse tape recorder, Koyo monitor, Bische 12-300 infrared light: 500 W). Videorecordings of ten male and ten female blue foxes were made during one 24-h period each month. The video tapes were analysed by one investigator using a video tape recorder (JVC video cassette recorder HR-D560E) and TV monitor (Philips). The following behaviours were studied: (1) lying posture, i.e. (a) curled or (b) other posture (flat on side, legs more or less outstretched, or flat on belly, head and front legs stretched along the platform), and (2) the foxes' preference for lying site on the platform, i.e. (a) on the wide (45 cm) or (b) narrow (30 cm) end. In this study lying included both lying awake and asleep. After initial examination of the data, it was decided to divide the study year into four periods as follows: (1) January-March; (2) April-July; (3) August-October; and, (4) November-December. The reason for this

classification was the fact that platform use was very slight and deviated from the normal distribution between November and March. Furthermore, since the whelping period of foxes is from April to July, when most of females have nest boxes in their cages, it was considered necessary to study this period separately. Finally, period 3 was in late summer when platform use is typically high and normally distributed. Mean ambient air temperatures in the study periods 1-4 were -9°C, +19°C, +7°C and -2°C, respectively.

Because there were repeated measurements for each fox during each month, statistical analyses were performed with the MIXED procedure of the SAS statistical package. A detailed description of the methods is available in Korhonen et al. (1996). Briefly, video data analyses were based on the following model:

$$Y_{ijk} = \mu + S_j + P_k + SP_{jk} + e_{ijk}$$

where

$Y_{ijk}$  = time of platform use for fox  $i$  of sex  $j$  during month  $k$

$\mu$  = constant

$S_j$  = effect of sex

$P_k$  = effect of month

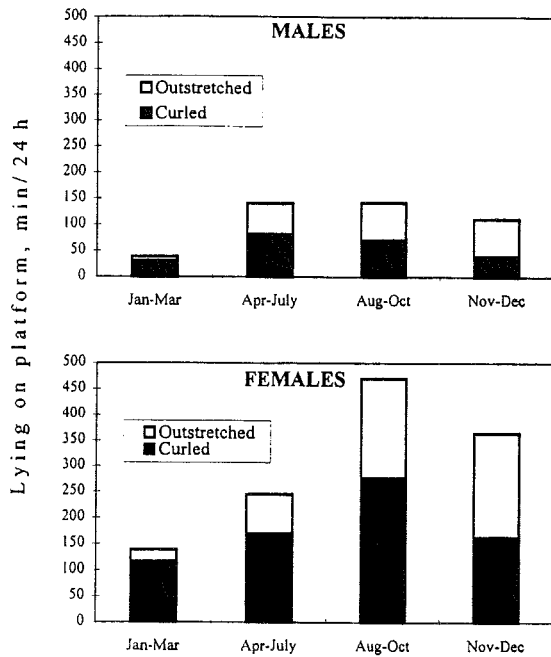
$SP_{jk}$  = interaction of sex and month

$e_{ijk}$  = residual, assumed to be independent and multivariate normal with the means 0 and arbitrary covariance matrices  $\Sigma$ .

Comparisons between lying postures and site were made using Mann-Whitney U-test (NPAR1WAY procedure).

### Results

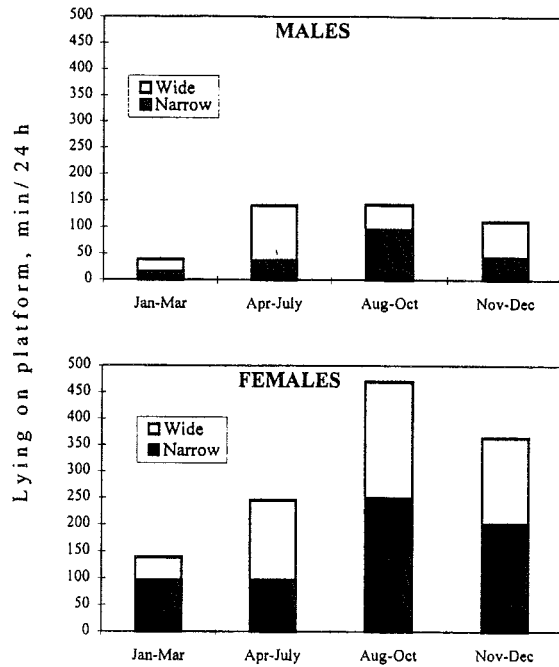
On average, expressed as whole-year mean  $\pm$  SE, females used the platforms significantly more ( $p < 0.05$ ) than males did ( $271 \pm 52$  min/24 h vs.  $103 \pm 17$  min/24 h). The corresponding median values for males and females were 204 min/24 h and 95 min/24 h, respectively. Significantly seasonal changes ( $p < 0.001$ ) were found in platform use for both sexes. Platform use was lowest in winter (period 1) and highest in summer (period 3), as shown in Figs. 2 and 3. On average, males were heavier than females ( $8.3 \pm 1.2$  kg vs.  $6.5 \pm 0.9$  kg;  $p < 0.05$ ).



**Fig. 2.** Lying postures of farmed blue foxes (10 ♂, 10 ♀) at different periods of the year. Lying included both lying awake and asleep.

Of the total lying time on the platforms foxes spent 60.2% on average in a curled posture. Females tended to prefer the curled posture slightly more than males did (64.1% of total time vs. 56.4%; not significant difference). During winter, the foxes laid on the platforms mainly in a curled posture, i.e. 83.1% of the total lying time on the platforms. During the summer, the foxes were in the curled posture on the platforms about half of the time and in the outstretched position the other half (Fig. 2).

Foxes spent 49.5% of the total curled time on the wider end of the platform. Of the total time lying on the platforms, the foxes were on average 51.4% on the wider end. Males tended to use the wider end of the platform somewhat more than the females did (57.2% vs. 45.5%; not significant). During winter, the foxes of both sexes did not significantly prefer the wider over the narrow end. The results were also rather similar for spring, summer and autumn periods (Fig. 3).



**Fig.3.** Lying site of farmed blue foxes (10 ♂, 10 ♀).

### Discussion

The amount of platform use for the present construction model was very close to the values obtained previously for other similar sized platforms without the wider end enhancement (Korhonen *et al.*, 1996). Thus, obviously the wider end as such did not promote greater platform use. Difference in platform use between sexes for females paralleled our previous results (Korhonen *et al.*, 1996). It is not quite clear why females preferred platforms more than males did. However, females were also more often found to be in a curled posture on the platforms compared to males. One obvious explanation could be that females were smaller than males in body size, which makes access and lying on platforms easier for females.

The wild arctic fox can attain maximum fur insulation whilst lying curled on its belly or side, with its snout stuck into its tail (Scholander *et al.*, 1950). Foxes have typically been seen in this position during the winter. The diameter of the curled

posture measured from impressions left in the snow by sleeping arctic foxes is about 40 cm (Korhonen *et al.*, 1991). However, the measurements are only rough estimates. In the present study, the farm blue foxes were also mainly in the curled lying posture during the coldest part of winter. However, the present foxes did not prefer the wider platform end (45 cm diameter) during that period. Three reasons for this lack of preference can be speculated: (1) 30-cm-wide platform is wide enough to allow farm foxes to lie curled upon it; or (2) foxes prefer the narrow platform because heat conduction from such a surface is smaller than that of the wider end, or (3) foxes avoid lying on wider cold area because the energy cost needed to heat such a surface by their body heat is excessive. According to the present results, platform size does not appear to explain the great seasonal variation in platform use. Among many possible reasons behind this year-round variation, the cold surface temperature of the whole platform itself can be one very great potential. For example, Korhonen (1987) found that the heat loss of farmed raccoon dogs from such a cold surface was markedly higher than that of animals lying on a wire-mesh floor. Obviously this applies to heat loss in blue foxes as well. Thus, it is more comfortable for the fox to lie on a wire-mesh floor than on a cold wooden surface during the winter. As concerns summer, possibly the extra heat in the summer stimulates the foxes to seek out higher places, such as platforms, because when they lie on them in the outstretched posture their ability to cool their body might be more efficient than that on the cage floor. More efficient body cooling would be suggested by the following points: (1) platforms are more in the shade than the cage floor is; and (2) higher places afford better air ventilation. The latter hypothesis requires further clarification. However, the present results support the notion that platforms should be long enough to allow the foxes to attain the ideal outstretched cooling posture on them in summer. In public forums, it has been demanded that farm foxes should have enough space for locomotion. From this point of view, the present results are important as there does not appear to be any logical reason why platforms ought to be over 30 cm wide. This provides additional space for movement within conventional cages compared to cages with platforms equipped with the wider end.

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*Original Report***Variability of the exterior traits in chinchilla females of different ages****Malgorzata Sulik<sup>1</sup> & Ryszard Cholewa<sup>2</sup>**

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**Abstract**

The aim of the study was to assess traits determining body conformation of chinchillas and their age variability.

The investigation was performed on 296 standard variety females aged 1 to 4 years in successive seasons: winter, spring, summer and autumn. The following body parameters were determined: chest circumference, body length, tail length, total length, ear height, and body weight, and their body conformation underwent point evaluation. The obtained results showed that growth of females depended on the season of their birth.

**Introduction**

The chinchilla (*Chinchilla velligera* L.) represents a species of fur animals which has a relatively short history with respect to its farming and breeding. This is of some consequence when it comes to differentiation of many traits in animals which are significant in fur production.

According to many authors (Jarosz & Rzewski, 1993; Jarosz, 1993; Parker, 1982; Brenon, 1952) chinchillas reared in farms originate from three types: La plata, Costina and Raton, which differ significantly with respect to their conformation.

Animals of the La Plata type have the most correct body conformation. They are squarely built, with a cylindrical trunk, short neck and rounded, wide apart ears. The Costina type is of a more delicate body conformation, with the overbuilt rump and narrowed shoulder girdle. Animals of this type have a clearly visible neck, "rat-like" head with clearly marked nasal bones and oblong ears set at a 45° angle to the head. Animals of the Raton type are square and cylindrically built, but are of a much smaller size than the La Plata type; they are distinguished by the most correct coat among all chinchilla types. The ears are small and high-set in this type.

Chinchillas are selected towards large animals with a strong body conformation approximating those of the La Plata type and with a coat resembling the Raton type.

**Objectives**

The aim of the study was to assess the traits determining body conformation of chinchillas and their age variability. Chinchillas represent a kind of fur animal in which many traits, including those connected with their conformation, become differentiated during rearing. Thus, learning about relationships between them could be very helpful in improving their exterior traits.

## Material and methods

The studies were carried out in 1994-96 on standard variety chinchillas from a breeding farm at Nowogard owned by Mr. and Mrs. Mielenczuk. The animals were of good breeding performance and uniform with respect to the evaluated exterior traits. The studies included 296 females of the foundation stock in which the following parameters were determined:

- chest circumference (measured just behind the shoulder blades) [cm]
- body length (measured from the tail base to the nose tip) [cm]
- tail length (measured from the tail base to its end) [cm]
- total length (body and tail length together) [cm]
- ear height (measured from the ear base to its highest point) [mm]
- body weight [g], and
- body conformation [points]

The chinchillas were divided into groups according to their age and birth season. These groups included animals from 1 to 4 years old in the successive season winter, spring, summer and autumn.

The body conformation of the studied animals was evaluated according to the evaluation standard for chinchillas approved by the Central Animal Breeding Station (*Zurowski & Rzewski, 1989*).

The obtained data were analysed statistically using single factor ANOVA with the Duncan's multiple-range test in order to test the significance of differences between the following groups:

1. Season, for animals of different ages (years)
2. Age, in successive seasons
3. Age, independently of seasons

The obtained results are presented in tables comprising arithmetic means ( $\bar{x}$ ). Capital letters found in the tables by the means denote differences significant at  $P < 0.01$ , while small ones mark differences significant at  $P < 0.05$ .

## Results and discussion

The body conformation and size parameters in chinchillas under the study changed in particular seasons and years with their growth. The one-year-

old chinchillas, which underwent evaluation, were not always fully grown. This was manifested by the increase of the chest circumference (Tab. 1), enlargement of the body length (Tab. 2), and the increase of the body weight (Tab. 6) with age of these animals, which confirms the results of Kidwell (1955). It was shown in the studies that the growth of these animals depended on their birth season. Chinchillas born in the winter were characterized by their larger chest circumference and greater body length. However, they had a slightly smaller body weight until they reached the third year of life when compared with chinchillas born in the summer. A smaller body weight with a longer trunk and greater chest circumference may testify to the smaller fatness of animals.

When it comes to the assessment of the chest circumference and body length measurements, an assumption arises that the body conformation criterion adopted so far in the exterior evaluation in chinchillas does not fully expose that trait. Thus it is possible to overlook a valuable animal or to leave in the foundation stock an individual of interior quality, although it has scored well in the exterior evaluation. However, with the use of chest circumference measurements and body length it would be possible to carry on selection in chinchillas and more easily efficiently with respect to their body conformation. This is also confirmed by the results of Schmidt (1980), who demonstrated that both body conformation and body weight are significant.

The standard of chinchilla exterior evaluation adopts a maximum score for body conformation for an animal aged 12 months (and above) after a weight gain of 620 grams. In the present study the one-year-old animals gained hardly 584.6 g on the average, thus not complying with the requirements of the standard, and obtained a score of 2.0-2.6 points for that trait (of 3 possible) depending on the season. In principal, all groups of older animals met these requirements, which could testify to the fact that younger animals may reach established levels for that trait at a later date.

There was no significant difference in the measurement of the tail length (Tab. 3). This trait assumed a similar level in all groups of animals ranging from 13 to 15 cm in each group. The length of the tail did not show any relation with other exterior traits studied. As Jarosz & Rzewski (1993)

report, the Costina type chinchillas are of a less massive body conformation than these of the La Plata type. Their front is narrow and hollow at the shoulder girdle, the head is elongated, and oblong ears are set at a 45° angle. It could result from this fact that chinchillas with oblong ears represent an undesirable type of body conformation. However, studies on the relation between measurements of the chest circumference, body length and ear length did not confirm this relationship. Correlations between

the chest circumference, body length and the ear length were very low and statistically insignificant (coefficients of correlation amounted to 0.054 and 0.063, respectively). On the other hand, a very low but highly significant correlation occurred between the body weight and ear length ( $r_{xy} = 0.18$ ). A positive value of that correlation demonstrates that with the increase of ear height the chinchilla body weight also increases.

**Table 1.** Chest circumference (cm)

Age (years)	Season														
	winter			spring			summer			autumn			total		
	x	v[%]	confidence interval	x	v[%]	confidence interval	x	v[%]	confidence interval	x	v[%]	confidence interval	x	v[%]	confidence interval
1	20.5 <sup>ABa</sup>	4.9	20.1-20.8	19.6 <sup>Ca</sup>	6.6	19.3-19.9	18.5 <sup>AC</sup>	5.4	18.2-18.8	18.9 <sup>B</sup>	5.8	18.5-19.3	19.4	6.7	19.1-19.7
2	20.1	10.9	19.7-20.6	19.3	9.8	18.9-19.7	19.0	9.5	18.6-19.4	19.3	8.3	18.6-20.0	19.4	9.8	19.2-19.7
3	20.4 <sup>ab</sup>	1.8	19.7-21.1	20.0 <sup>b</sup>	7.5	19.3-20.7	18.8	9.0	17.8-19.7	18.0	7.8	16.8-19.0	19.6	9.7	19.1-20.0
4	20.4	7.3	19.0-21.8	20.3	8.4	19.1-21.3	18.9	4.2	17.5-20.3	20.1	7.4	19.1-21.2	20.0	12.0	19.6-20.5

**Table 2.** Body length (cm)

Age (years)	Season														
	winter			spring			summer			autumn			total		
	x	v[%]	confidence interval	x	v[%]	confidence interval	x	v[%]	confidence interval	x	v[%]	confidence interval	x	v[%]	confidence interval
1	28.2 <sup>ABa</sup>	4.6	27.8-28.7	27.1 <sup>a</sup>	7.4	26.7-27.5	26.8 <sup>AX</sup>	5.2	26.3-27.2	26.7 <sup>B</sup>	3.7	26.1-27.2	27.2 <sup>x</sup>	5.9	27.0-27.5
2	27.9	6.1	27.5-28.3	28.2	7.1	27.8-28.5	27.6 <sup>y</sup>	4.0	27.2-27.9	27.4	3.6	26.9-28.0	27.8	5.8	27.6-28.0
3	28.2	5.3	27.5-28.9	28.3	5.7	27.6-29.0	27.2 <sup>c</sup>	5.5	26.3-28.1	27.4	8.0	26.4-28.4	27.9	5.7	27.5-28.3
4	28.4	4.2	26.8-30.0	28.7	7.0	27.4-29.9	29.3 <sup>XYZ</sup>	2.7	27.7-31.0	27.0	15.2	25.9-28.1	28.1 <sup>x</sup>	10.0	27.7-28.6

**Table 3.** Tail length (cm)

Age (years)	Season														
	winter			spring			summer			autumn			total		
	x	v[%]	confidence interval	x	v[%]	confidence interval	x	v[%]	confidence interval	x	v[%]	confidence interval	x	v[%]	confidence interval
1	13.7	7.3	13.4-14.0	13.6	7.4	13.4-13.9	14.0	7.9	13.7-14.3	14.1	7.1	13.7-14.5	13.8	7.2	13.5-14.2
2	13.3 <sup>A</sup>	7.5	13.0-13.7	14.1	6.4	13.8-14.4	15.0 <sup>AB</sup>	16.0	14.7-15.3	14.1	8.5	13.5-14.7	14.2	12.0	13.9-14.4
3	13.0 <sup>ab</sup>	7.7	12.6-13.3	14.0 <sup>A</sup>	4.3	13.7-14.3	13.6	3.7	13.2-14.0	14.0 <sup>B</sup>	5.7	13.5-14.5	13.6	6.6	13.1-14.1
4	13.4	7.5	10.1-16.7	14.0	6.4	11.4-16.6	13.4	8.2	10.1-16.7	16.2	5.7	13.9-18.5	14.6	3.8	14.0-15.1

**Table 4.** Total length (cm)

Age (years)	Season														
	winter			spring			summer			autumn			total		
	x	v[%]	confidence interval	x	v[%]	confidence interval	x	v[%]	confidence interval	x	v[%]	confidence interval	x	v[%]	confidence interval
1	41.9	4.1	40.4-43.4	40.8 <sup>xy</sup>	5.1	39.4-42.1	40.8 <sup>x</sup>	5.4	37.5-40.4	40.8	3.9	39.0-42.5	41.1 <sup>xs</sup>	4.6	40.1-41.0
2	41.2 <sup>A</sup>	4.6	40.8-41.6	42.5 <sup>axx</sup>	3.8	42.2-42.9	42.0	4.0	41.8-42.4	41.5 <sup>a</sup>	3.6	40.9-42.1	41.9 <sup>x</sup>	4.3	41.6-42.3
3	41.1	4.6	40.2-42.0	42.3 <sup>x</sup>	4.7	41.5-43.1	40.8 <sup>y</sup>	4.2	39.7-41.9	41.4	6.5	40.2-42.6	41.5	14.5	40.8-42.3
4	41.8	4.5	40.6-43.0	42.7 <sup>y</sup>	5.2	41.7-43.6	42.8 <sup>xy</sup>	2.8	41.6-43.9	41.8	5.3	40.9-42.6	42.2 <sup>x</sup>	4.7	41.5-42.9

**Table 5.** Ear height (mm)

Age (years)	Season														
	winter			spring			summer			autumn			total		
	x	v[%]	confidence interval	x	v[%]	confidence interval	x	v[%]	confidence interval	x	v[%]	confidence interval	x	v[%]	confidence interval
1	38.1	8.1	37.0-39.1	39.1	9.0	38.1-40.0	38.4	7.3	37.4-39.4	40.0	10.0	38.8-41.2	38.8 <sup>aa</sup>	8.5	38.3-39.3
2	40.0	9.0	39.2-40.7	39.9	8.0	39.2-40.5	39.3	5.6	38.6-40.0	41.1	11.4	40.0-42.3	39.9	8.3	39.5-40.2
3	43.4 <sup>a</sup>	10.1	41.9-44.8	40.1	9.0	48.7-41.4	39.6 <sup>a</sup>	3.8	37.8-41.4	40.0	11.3	38.0-42.0	41.0 <sup>A</sup>	8.8	40.2-41.7
4	42.3 <sup>a</sup>	5.7	40.7-43.9	40.7 <sup>b</sup>	6.0	39.5-41.9	37.5 <sup>ab</sup>	6.4	35.9-39.1	40.2	7.7	39.0-41.3	40.2 <sup>a</sup>	7.5	39.4-41.0

**Table 6.** Body weight (g)

Age (years)	Season														
	winter			spring			summer			autumn			total		
	x	v[%]	confidence interval	x	v[%]	confidence interval	x	v[%]	confidence interval	x	v[%]	confidence interval	x	v[%]	confidence interval
1	593.8 <sup>a</sup>	9.9	577.3-610.3	586.0	7.7	570.9-601.1	553.2 <sup>axxy</sup>	9.8	573.1-569.3	617.3 <sup>A</sup>	9.6	597.8-636.9	584.9 <sup>xy</sup>	9.8	574.2-595.7
2	623.0 <sup>a</sup>	12.7	606.1-639.9	604.6 <sup>b</sup>	13.6	589.7-619.4	625.2 <sup>xy</sup>	10.5	609.4-641.1	677.3 <sup>abs</sup>	6.6	650.8-703.9	623.2 <sup>y</sup>	12.1	614.9-631.4
3	615.5	16.2	583.0-647.9	640.7	7.7	610.9-670.6	610.0 <sup>ax</sup>	11.6	596.4-650.6	638.3	10.7	594.4-682.2	627.0 <sup>x</sup>	11.6	610.9-643.1
4	690.0	11.0	643.9-734.0	636.0	10.4	601.9-670.1	680.0 <sup>xy</sup>	5.1	635.9-724.1	677.5	13.6	646.3-708.7	667.9 <sup>xy</sup>	11.1	651.1-684.8

**Table 7.** Body conformation (point score)

Age (years)	Season														
	winter			spring			summer			autumn			total		
	x	v[%]	confidence interval	x	v[%]	confidence interval	x	v[%]	confidence interval	x	v[%]	confidence interval	x	v[%]	confidence interval
1	2.5	28.3	1.8-3.2	2.3	23.8	2.1-2.4	2.0	29.4	1.8-2.1	2.6	28.3	2.4-2.8	2.3	28.6	2.2-2.4
2	2.4 <sup>A</sup>	27.2	2.2-2.6	2.3 <sup>ba</sup>	26.9	2.2-2.4	2.7 <sup>a</sup>	21.4	2.5-2.8	2.9 <sup>Ab</sup>	8.8	2.7-3.1	2.5	24.5	2.4-2.6
3	2.4	32.4	2.1-2.8	2.7	17.8	2.5-2.9	2.6	30.6	2.3-2.9	2.7	19.4	2.4-3.0	2.6	23.4	2.5-2.8
4	3.0	0.0	2.5-4.0	2.7	17.9	2.5-3.0	3.0	0.0	2.7-3.3	2.8	16.4	2.5-3.0	2.8	24.5	2.7-3.0

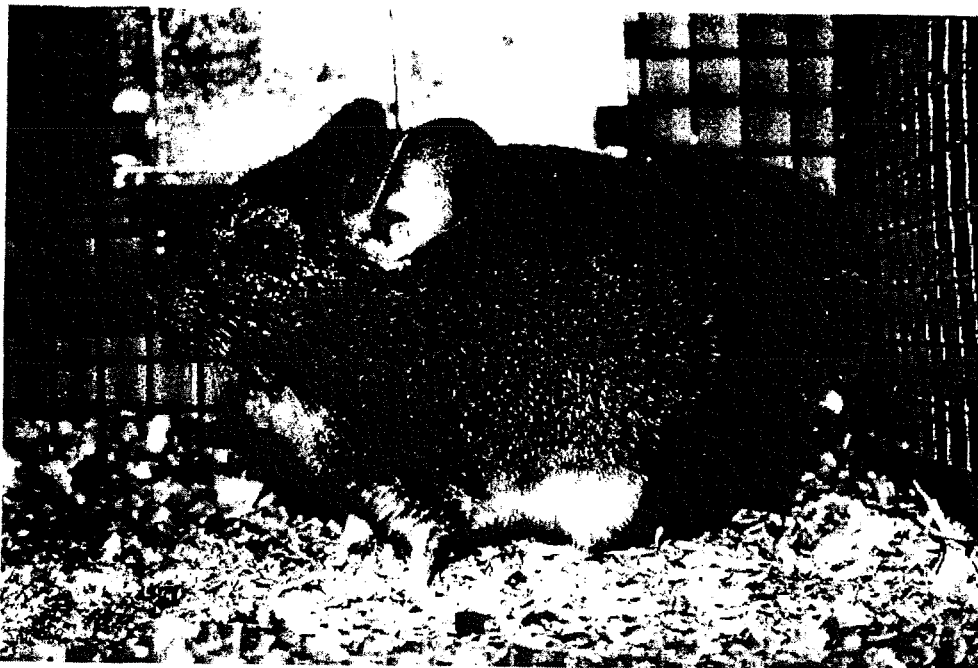


### Conclusions

1. The growth of chinchilla females depended on the season of their birth. Animals born in winter had larger chest circumference and were longer than those born in summer.
2. The measurements of the chest circumference and body length, apart from the body weight, may facilitate and improve the efficiency of selection in chinchillas with respect to their conformation.

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*Original Report***Repeatability of mineral element content in the fur of female silver nutrias**

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**Summary**

The aim of the experiment was to find out the concentration of Ca, K, Na, Mg, Fe, Zn, Cu, Mn and Co in the fur of female silver nutrias on the back and abdomen in dependence on their physiological state: at the age 8 months, at parturition and at weaning. There were 48 females in the experiment. They were kept in cages with pools in a shed. They were fed the pelleted feed mixture KK and were given alfalfa and fodder beet as supplementary feed. They drank water from the pools. The samples of fur were cut. The mineral element content was determined by atomic absorption spectral photometry. The obtained results were evaluated mathematically and statistically. The analysis of coefficients of repeatability enabled us to draw the conclusion that there is a high repeatability of mineral element content in the fur of silver nutrias dependent either on the studied regions of the body, season or both. From the mentioned facts we can deduce that the content of mineral elements is more or less stable also with regard to sporadic differences between the seasons.

**Introduction**

We were engaged in the study of repeatability of the mineral composition of fur in female silver nutrias in dependence on their physiological state.

Some of the main factors influencing the chemical composition of the animal's body are the species and breed differences, effect of seasons, physiological state, age, lactation and pregnancy (*Georgievskij et*

*al., 1982*). Mertin et al. (1997) studied the repeatability of mineral element content in the fur of female standard nutrias. They found a high repeatability of the mineral element content within the genotype, studied body parts, age and physiological stage.

**Material and methods**

The experiment was performed on the Experimental Fur Animal Farm of the Research Institute of Animal Production in Nitra. There were 48 female silver nutrias studied in the experiment. The animals were kept in one-storey cages with pools in a shed. They were fed pelleted feed mixture KK, and alfalfa (in spring and summer) and fodder beet (in autumn and winter) were given as supplementary feed. They drank the water from pools. The animals in the experiment were clinically healthy.

The aim of the experiment was to determine the concentration of Ca, K, Na, Mg, Fe, Zn, Cu, Mn, Co in the fur of female silver nutrias in chosen body regions, namely in the middle of the back and abdomen in dependence on the physiological state (period): 1. primiparous females – sexual maturity, age 8 months – fur maturity; 2. females on the day of parturition; 3. females on the day of weaning. Fur was sampled under halothane narcosis of the animals. One sample contained approximately 2 g fur. The concentration of the studied mineral elements was determined by atomic absorption spectral photometry. Three measurements were performed with each sample.

The obtained results were mathematically and statistically evaluated (*Winer, 1971; Grofik and Fl'ak, 1980*).

### Results and discussion

Basic variations and statistic characteristics of mineral elements content in the fur of silver nutrias according to periods and body regions are given in Table 1. The contents of Ca, K, Na, Fe and Mn were the lowest in females at the age of 8 months. Higher

contents of Ca and Mn were on the abdomen, and of K and Na on the back. The content of Fe was approximately on the same level in spite of differences between the individual seasons. We did not find marked differences with Zn concentration. Concentration of Mg decreased with the age and physiological state of the animals and this fact manifested itself more markedly in the region of the back. The highest contents of Cu and Co were in the weaning period.

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

			CALCIUM - Ca				POTASSIM - K				NATRIUM -Na			
			Back		Abdomen		Back		Abdomen		Back		Abdomen	
P	b <sub>1</sub>	n	x	s <sub>x</sub>	x	s <sub>x</sub>	x	s <sub>x</sub>	x	s <sub>x</sub>	x	s <sub>x</sub>	x	s <sub>x</sub>
8m	8	24	877.31	81.86	737.06	89.70	186.09	20.02	79.84	14.27	174.11	22.00	65.90	10.28
Pa	5	15	1373.52	140.48	1532.51	148.76	435.50	45.70	154.90	22.45	299.98	35.15	113.85	14.25
W	3	9	1007.74	34.05	1326.63	177.34	273.22	46.95	251.03	74.49	195.27	24.30	157.73	40.37
Total		48	1056.83	67.33	1096.19	88.78	280.37	24.85	135.39	19.04	217.41	17.87	130.31	17.59

			MAGNESIUM -Mg				IRON - Fe				ZINC - Zn			
			Back		Abdomen		Back		Abdomen		Back		Abdomen	
P	s <sub>x</sub>	x	s <sub>x</sub>	x	s <sub>x</sub>	x	s <sub>x</sub>	x	s <sub>x</sub>	x	s <sub>x</sub>	x	s <sub>x</sub>	x
8m	8	24	850.57	79.38	816.90	56.20	93.69	9.94	81.21	4.95	154.42	5.25	158.15	5.20
Pa	5	15	444.87	62.66	525.28	111.70	148.08	10.53	151.87	19.49	156.60	3.28	158.11	23.37
W	3	9	612.47	163.48	657.98	148.16	133.20	11.13	154.18	23.10	154.56	5.43	147.66	8.67
Total		48	679.14	58.79	695.97	54.68	118.09	7.19	116.97	9.25	155.13	2.95	156.17	7.76

			COPPER - Cu				MANGANESE -Mn				COBALT -Co			
			Back		Abdomen		Back		Abdomen		Back		Abdomen	
P	s <sub>x</sub>	x	s <sub>x</sub>	x	s <sub>x</sub>	x	s <sub>x</sub>	x	s <sub>x</sub>	x	s <sub>x</sub>	x	s <sub>x</sub>	x
8m	8	24	5.7837	0.1327	6.9238	0.1461	1.5200	0.1474	2.1600	0.1872	0.6650	0.0432	0.6838	0.0269
Pa	5	15	5.3200	0.2616	5.4080	0.4647	3.0700	0.4472	4.0400	0.3409	0.6600	0.0477	0.5880	0.0701
W	3	9	7.4467	0.1730	8.3833	0.4867	1.9333	0.2207	3.6867	0.1088	0.8233	0.0412	0.7900	0.0429
Total		48	5.9506	0.1533	6.7238	0.2362	2.0819	0.1882	3.0338	0.1906	0.6931	0.0284	0.6738	0.0282

P – periods; 8m – age 8 months; Pa – parturition; W – weaning

**Table 2.** 2-way analyses of variance of mineral element content in the fur of silver nutrias

		CALCIUM -Ca		POTASSIUM -K		NATRIUM - Na		MAGNESIUM -Mg		IRON - Fe	
		MS	F	MS	F	MS	F	MS	F	MS	F
<b>Back</b>											
P	2	1149739.42	1.887	287380.11	4.58*	75831.11	1.74	7829.52	1.64	149151.40	2.28
A	13	609271.06	3422.79**	62674.85	544.65**	43400.50	287.33**	47830.71	1613.09**	6541.90	125.28**
e	32	178.00		115.07		151.05		296.52		52.22	
P	$f_{bi}$	$f_e$									
8m	7	16	4217.52**		265.32**		393.80**		1067.89**		452.12**
Pa	4	10	3615.51**		673.59**		260.07**		1458.64**		41.19**
W	2	6	299.04**		2771.07**		152.16**		8906.03**		411.92**
<b>Abdomen</b>											
P	2	3214442.11	3.684	100065.68	2.12	5415.34	0.17	40049.28	0.88	307067.95	3.06
A	13	872589.30	2817.70**	47253.16	424.09**	31459.81	189.45**	45630.37	1207.26**	100449.16	283.13**
e	32	309.68		111.42		166.06		377.97		35.48	
P	$f_{bi}$	$f_e$									
8m	7	16	3901.91**		110.87**		63.12**		709.28**		39.18**
Pa	4	10	1695.88**		474.27**		57.80**		2306.74**		520.15**
W	2	6	14496.70**		1619.34**		392.84**		1293.06**		15003.15**

		ZINC -Zn		COPPER -Cu		MANGANESE -Mn		COBALT -Co	
		MS	F	MS	F	MS	F	MS	F
<b>Back</b>									
P	2	23.68	0.02	13.3884	6.973**	11.2107	2.633	0.0940	0.813
A	13	1495.70	389.31**	1.9201	48.139**	4.2577	63.442**	0.1156	29.542*
e	32	3.84		0.0398		0.0671		0.0039	
P	$f_{bi}$	$f_e$							
8m	7	16	979.30**		25.341**		16.903**		41.244**
Pa	4	10	70.10		299.408**		116.118**		25.374**
W	2	6	658.13		15.270**		105.427**		9.908**
<b>Abdomen</b>									
P	2	401.34	0.04	25.8580	4.723*	18.6737	5.725*	0.1172	1.097
A	13	103559.51	860.57**	5.4747	58.064**	3.2617	47.327**	0.1068	19.443**
e	32	12.03		0.0943		0.0689		0.0055	
P	$f_{bi}$	$f_e$							
8m	7	16	123.27**		54.347**		26.227**		9.588*
Pa	4	10	3345.03**		204.062**		169.174**		29.932**
W	2	6	572.94**		22.679**		5.556*		17.536**

P – periods; A – animals; e – error

P:  $F_{0,05}(2, 13) = 3.806$       A:  $F_{0,05}(13, 32) = 2.040$   
 $F_{0,01}(2, 13) = 6,701$        $f_{0,01}(13, 32) = 2.753$

8m:  $F_{0,05}(7, 16) = 2.657$       Pa:  $F_{0,05}(4, 10) = 3.478$       W:  $F_{0,05}(2, 6) = 5.143$   
 $F_{0,01}(7, 16) = 4.026$        $F_{0,01}(4, 10) = 5.994$        $F_{0,01}(2, 6) = 10.926$

The highest concentrations of the studied mineral elements totally were found absolutely expressed with Ca (back:  $1056.83 \pm 67.33 \text{ mg.kg}^{-1}$  dry matter and/or abdomen:  $1096.10 \pm 88.78 \text{ mg.kg}^{-1} \text{ d.m.}$ ), Mg ( $679.14 \pm 58.79$  and/or  $695.97 \pm 54.68$ ), and the lowest with Co ( $0.6931 \pm 0.0284$  and/or  $0.6738 \pm 0.0282 \text{ mg.kg}^{-1} \text{ d.m.}$ ). In Table 2 are given the results of 2-way variance analyses of the hierarchic classification with a firm effect of periods, random effect of animals with the periods and with error of experiment with content of mineral elements. Besides these items are in the table also F-tests of 1-way analyses of variance of comparison of animals within the studied periods. When we compare the F-tests of periods of mineral element content in the fur of silver nutrias we find statistically significant differences in the concentrations of the elements K, Cu and Mn. It is a matter of course that the 2-way analyses of variance pointed out the significant differences between the animals as these F-tests are in fact functions of 1-way analysis of variance. Statistically highly significant differences between animals were in all elements. However, the variability of content of mineral elements in the fur of silver nutrias was highly statistically influenced by the individuality of animals and was confirmed not only by F-tests of 2-way analysis of variance but also by F-tests of 1-way analyses of variance within the periods. We give these F-tests to characterise the statistical significance of repeatability coefficients of content of mineral elements within the periods. The gained estimations of repeatability coefficients are given in Table 3 with their standard errors. The

repeatability of individual elements in the fur of silver nutrias according to the individual regions of body was very high and almost in all elements higher than 0.95 and/or 0.99 with the exception of Fe (back-parturition, abdomen – 8th month), Zn (back and abdomen – 8th month, weaning) and Mn (back – 8th month, abdomen – 8th month, weaning). According to the repeatability coefficients we can state, in spite of the fact that there were only three repeated measurements in the animals, that there is high repeatability of the content of mineral elements in the fur of silver nutrias either from the viewpoint of the studied regions of the body, periods or both. Therefore it is possible to deduce from the above mentioned that the content of mineral elements is more or less stable also with regard to sporadic differences between the above mentioned periods. Our results document that the mineral composition of fur changes in dependence on age, genotype, and physiological state in adult females, and it is in line with studies of various animal species done by other authors (*Georgievskij et al., 1983*) and in nutrias (*Mertin et al., 1997*). Compared with standard nutrias (*Mertin et al., 1997*) there is a lower content of mineral elements, mainly Ca, Fe and Mn in the fur of silver nutrias. However, the changes in the content of mineral elements in dependence on age and physiological stages are similar with individual elements in standard and silver nutrias, and their repeatability is high in both colour mutations. The obtained results show that it is suitable to use fur in the study of mineral metabolism, physiological and pathological changes in nutrias.

**Table 3.** Coefficients of repeatability of content of mineral elements in the fur of silver nutrias

Period	CALCIUM -Ca		POTASSIUM - K		NATRIUM - Na		MAGNESIUM - Mg		IRON - Fe	
	q	s <sub>q</sub>	q	s <sub>q</sub>	q	s <sub>q</sub>	q	s <sub>q</sub>	q	s <sub>q</sub>
	<b>Back</b>									
8m	0.999289	0.000410	0.988777	0.006431	0.992420	0.004354	0.997196	0.001616	0.993394	0.003797
Pa	0.999171	0.000586	0.995559	0.003131	0.988553	0.008033	0.997946	0.001450	0.930545	0.046838
W	0.990034	0.008573	0.998918	0.000936	0.980539	0.016635	0.999663	0.000292	0.992752	0.006246
Total	0.999124	0.000384	0.994512	0.002397	0.989631	0.004514	0.998143	0.000813	0.976429	0.010170
	<b>Abdomen</b>									
8m	0.999232	0.000443	0.973420	0.015074	0.959457	0.022277	0.995782	0.002428	0.927142	0.040021
Pa	0.998233	0.001248	0.993701	0.004435	0.949832	0.034287	0.998701	0.000918	0.994255	0.004047
W	0.999793	0.000179	0.998150	0.001600	0.992402	0.006547	0.997684	0.002003	0.999800	0.000173
Total	0.998936	0.000466	0.992959	0.003072	0.981255	0.011648	0.997519	0.001086	0.989479	0.004580

Table 3 continued

Period	ZINC -Zn		COPPER - Cu		MANGANESE - Mn		COBALT - Co	
	q	s <sub>q</sub>	q	s <sub>q</sub>	q	s <sub>q</sub>	q	s <sub>q</sub>
	<b>Back</b>							
8m	0.996943	0.001761	0.890276	0.058715	0.841297	0.081933	0.930627	0.038200
Pa	0.958389	0.028607	0.990047	0.006991	0.982155	0.012468	0.890406	0.071833
W	0.995455	0.003924	0.826285	0.133019	0.972074	0.023734	0.748078	0.181529
Total	0.992333	0.003344	0.940167	0.025182	0.954158	0.019481	0.904890	0.039049
	<b>Abdomen</b>							
8m	0.976052	0.013605	0.946758	0.029648	0.893719	0.057014	0.741115	0.123671
Pa	0.999104	0.000633	0.985441	0.010195	0.982474	0.012248	0.906051	0.062271
W	0.994782	0.004503	0.878438	0.096744	0.602976	0.252826	0.846438	0.119374
Total	0.996522	0.001521	0.950054	0.021165	0.939181	0.025579	0.860095	0.055608

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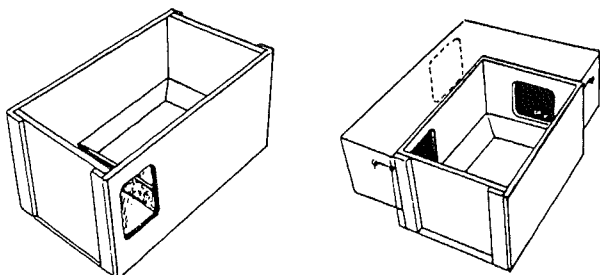
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### Behaviour of silver foxes in traditional breeding boxes and in boxes with an entrance tunnel

B.O. Braastad



**Fig. 2.** The main types of breeding boxes used in this study. **Left:** traditional box (non-tunnel box). **Right:** experimental box with exits through a tunnel measuring 18x20 cm in cross section (tunnel box).

The periparturient behaviour of silver-fox females inside traditional and modified breeding boxes was video-recorded. The behaviour was analysed from 24 hours before parturition to 72 hours after, and in three diurnal periods.

Twenty litters had the traditional simple breeding box, whereas 14 litters had a box with a narrow entrance tunnel. Compared to females in traditional boxes, females in tunnel boxes spent more time sleeping inside the box both before and after parturition, cleaning new-born cubs and grooming cubs while lying down, but less time looking out of the box. Excavation performed on the floor prior to parturition was performed equally often in both box types. The differences between box types were particularly pronounced for primiparous vixens. During the three postparturient days most differences in behaviour between box types were only found during working hours (0800-1500h). At this time females in non-tunnel boxes spent considerably less time sleeping and more time in locomotion within the box, looking out of the box, walking into or out of the box, standing partly out of the box, or staying out of the box, than females in tunnel boxes. Cub mortality was lower in tunnel boxes than in non-tunnel boxes. The results indicate that females in tunnel boxes had a more relaxed behaviour and were able to nurture their offspring more effectively. They did not watch their surroundings as frequently as females in traditional breeding boxes. Giving silver foxes a breeding box

with an entrance tunnel may improve the welfare of both female and offspring.

*Animal Welfare* 5, pp. 155-166, 1996. 5 tables, 2 figs., 21 refs. Author's summary.

### Open field activity early in the behavioural development of blue foxes (*Alopex lagopus*)

Teppo Rekilä, Morten Bakken

Generally, cubs were most active at the ages of 35 and 40 days. This indicates that the average sensitive period of primary socialization in farmed blue foxes is between 35 and 40 days of age. However, large amounts of between individual and between litter variation in the open field activity were found, but also a tendency for stability in activity level in the open field within individuals during the behaviour ontogeny from 30 to 60 days of age. This may indicate great variation in the length of the primary socialization period between different cubs and between cubs from different litters. However, before starting selection for more offensive and less frightened farmed blue foxes after the length of their primary socialization period more knowledge is needed about the relationship between the length of the socialization period and the animals behaviour later in life as well as more knowledge about the cause for the variability between cubs and litters in open field activity.

*Proceedings of the 29th International Congress of the International Society for Applied Ethology. Exeter, UK, 3-5 August 1995, pp. 213-214. 2 refs. Authors' discussion.*

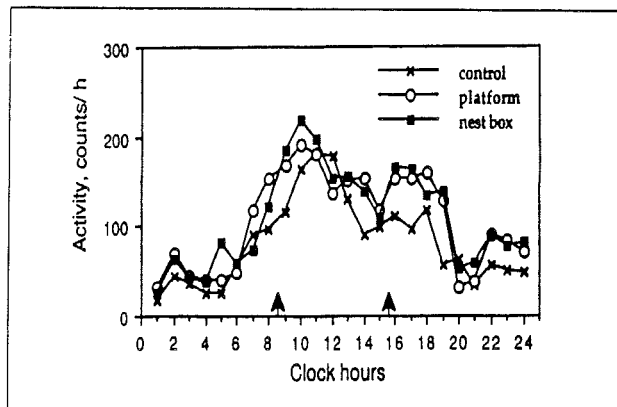
### Effect of inside-cage and outside-cage environment on behaviour test performance of blue foxes (*Alopex lagopus*)

Teppo Rekilä, Jaakko Mononen, Mikko Harri

In-cage reaction tests, the open field test and daily activity in the home cage were used to assess the effect of the internal design and location of cages on the behaviour of juvenile blue foxes (*Alopex lagopus*) during the growing season. The inclusion of nest boxes or resting platforms affected the behaviour of farmed blue foxes, but to a lesser extent than did the location of the animal in the cage



row, i.e. the environment outside the cage itself. The study demonstrated that the influence of the actual environment in which the farm foxes live may be far larger than the cage interior itself, and that attempts to improve housing design should take into consideration the environment outside the cage to a greater extent than has heretofore been the case.



**Fig. 1.** Intensity and circadian rhythm of activity in the home cage of blue foxes in different housing conditions. Sunrise and sunset are marked with arrows.

*Acta Agric. Scand, Sect. A Animal Sci.* 46, pp. 247-252, 1996. 2 tables, 3 figs., 17 refs. Authors' summary.

### Fur farming in large enclosures

Hannu Korhonen, Paavo Niemelä, Sakari Alasuu-tari, Auli Mäkinen

Over a period of 9-12 months, 41 female and 29 silver and blue foxes and their cubs were kept in groups of 4-11 animals in large (11-22 x 8 m) enclosures with earth floors. This type of management had an adverse effect on reproductive performance and kit mortality (56.6% of females produced a litter, and only 23.56% weaned their cubs), pelt quality and animal hygiene, and resulted in an increased incidence of aggressive behaviour. There was no evidence that group housing improved animal welfare.

*Finsk Pälstidsskrift* 30 (4), pp. 106-109, 1996. In *SWED*. 2 tables, 3 figs., 6 refs., 5 photos. CAB-abstract.

### Variation in the social system of the red fox

Paolo Cavallini

The existing literature on the ranging behaviour, territoriality, sociality and mating system of the red fox (*Vulpes vulpes*) is reviewed. Red fox home ranges are often unstable, varying in size suddenly or seasonally, shifting, and drifting; excursions are common. Floating individuals often occur in populations, but it is unclear whether they do not have a home range or range over stable areas much larger than those of resident foxes. Territoriality does not seem very strict. Sociality is limited to co-operation in the raising of cubs. Evidence for both monogamy and polygamy is present. The red fox social structure might have evolved as fairly tolerant assemblages under the pressure of larger predators..

*Ethology Ecology & Evolution* 8, pp. 323-342, 1996. Review, 2 tables. Author's abstract.

### Movements and habitat use of feral house cats *Felis catus*, stoats *Mustela erminea* and ferrets *Mustela furo*, in grassland surrounding yellow-eyed penguin *Megadyptes antipodes* breeding areas in spring

N. Alterio, H. Moller, H. Ratz

This paper reports a radio-tracking study of movements of feral house cats *Felis catus*, stoats *Mustela erminea* and ferrets *Mustela furo* during spring around Yellow-eyed penguin *Megadyptes antipodes* (hoiho) breeding areas in coastal Otaga, South Island, New Zealand. Grassland around these breeding areas has been retired from grazing by domestic stock to establish "vegetation buffers" intended to reduce predation of hoiho chicks by introduced mammalian predators. The "vegetation buffers" did not exclude or deter predators. In fact, the opposite effect was evident: "vegetation buffers" attracted cats, stoats and may have attracted ferrets to the area. Attraction of predators to "vegetation buffers" could increase encounter rates between predators and penguin chicks, especially by stoats, which are difficult to trap. "Vegetation buffers" may therefore increase predation rates, but this is unmeasured. This research highlights the need for rigorous testing of proposed biological controls such

as habitat modifications before widely implementing them as ways of protecting native wildlife.

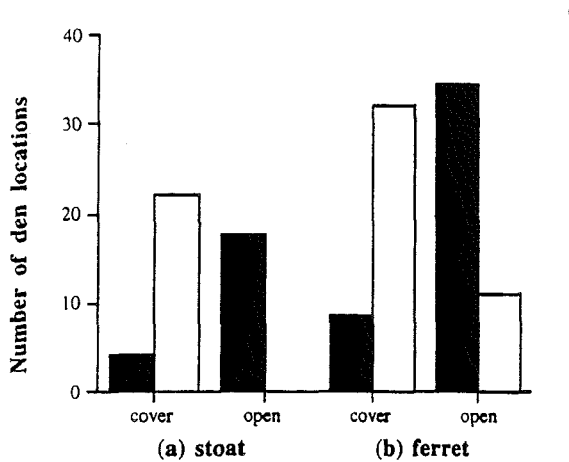


Fig. 8. Comparison of the pooled number of observed (□) and expected (■) locations of stoats ( $n=2$ ) and ferrets ( $n=5$ ) using cover and open areas in farmland at Boulder Beach ( $p=0.0001$  for stoats and  $p=0.0001$  for ferrets). Expected values are calculated from the proportion of cover and open areas encompassed within the home ranges of each predator species.

*Biological Conservation*, Vol. 83, No. 2, pp. 187-194, 1998. 8 figs., 26 refs. Authors' summary.

**Daily activity of stoats (*Mustela erminea*), feral ferrets (*Mustela furo*) and feral house cats (*Felis catus*) in coastal grassland, Otago Peninsula, New Zealand**

N. Alterio, H. Moller

This radio-tracking study reports the daily activity rhythms in autumn and spring of 11 stoats (*Mustela erminea*) (9 male, 2 female), 20 ferrets (*M. furo*) (8 m, 12 f) and 11 feral house cats (*Felis catus*) (7 m, 4 f) resident on coastal grassland, Otago Peninsula, New Zealand. Activity rhythms differed markedly amongst individual stoats in autumn, but little amongst individual cats and ferrets in either season. Stoats were equally active day and night in autumn, but were more active at day than at night in spring. Cats showed moderate day activity, but were mainly active at night in both seasons. Ferrets showed low activity during daylight in autumn and were entirely nocturnal in spring. Overall, stoats were more active during daylight than cats or ferrets; and cats were more active during daylight than ferrets. Therefore, cats and especially stoats may pose the main predation threat to diurnal native species in New Zealand. Effective biological control of rabbits

(*Oryctolagus cuniculus*) may effect the absolute abundance and daily activity of the predators, so it is impossible to predict the overall impact of predation on diurnal and nocturnal native species.

*New Zealand Journal of Ecology*, 21 (1), pp. 89-95, 1997. 3 tables, 2 figs., 28 refs. Authors' summary.

**The implications of territoriality for the social system of the European pine marten *Martes martes* (L., 1758)**

R. Schröpfer, P. Wiegand, H.-H. Hogrefe

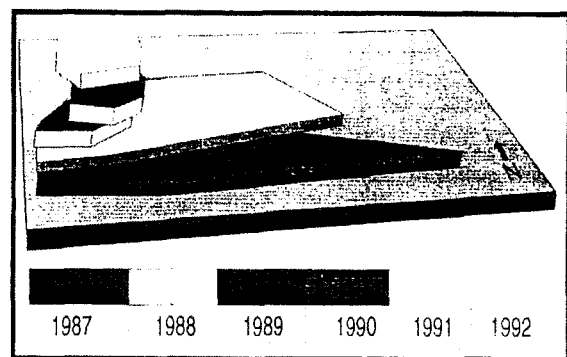


Fig. 1. Changes in size and location of the territories (territory-genesis) of the female F1 over 6 years (starting at the bottom with the plateau representing the forest area).

The social organisation and the structure of a population of pine martens in the northern part of a low mountain range in north-western Germany are investigated in a long-term study. Observations by radio-tracking and data from capture-recapture of 12 pine martens (6 females, 6 males) show at least four differences in territory size: the seasonal, the intersexual, that due to the mating system, and that due to genesis.

The territories are held over several years. Males already create summer territories in early spring, before the birth of the offspring and about 5 months before the mating season. They leave these only in late autumn and move into their winter territories. This extensive seasonal territorial behaviour cannot only be explained as mate guarding, but also as offspring guarding by creating a territory-tie.

Genetic paternity could be determined by the DNA-fingerprinting method. Parental care of the young by the territorial male was never observed. But males show a distinct guarding behaviour by creating a territorial tie. This social structure is called a male-mother-family.

*Z. Säugertierkunde* 62, pp. 209-218, 1997. 5 figs., 36 refs. Authors' abstract.

### Inter- and intraspecific competition between the fox species *Alopex lagopus* and *Vulpes vulpes*: an evaluation trial under penned conditions

Hannu Korhonen, Sakari Alasuutari, Auli Mäkinen, Paavo Niemelä

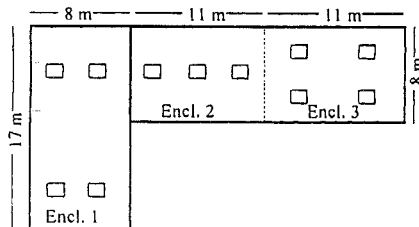


Fig. 1 Schematic picture of the experimental enclosures. Sites of wooden nestboxes are given. Enclosures (encl.) 2 and 3 were connected on 26 September 1994 by removing their common wall

This study compared competition capacity and dominance relations between arctic foxes (*Alopex lagopus*) and red foxes (*Vulpes vulpes*). Experiments were carried out in semi-natural earthen floor enclosures using farm-bred colour types of both species (blue fox and silver fox) as subjects. Results of the dominance scoring and open field behaviour after weaning in August-September showed that blue foxes dominated over silver foxes. Thereafter, the situation gradually became reversed and silver foxes were dominant during the breeding and whelping seasons. Housing both species together from weaning produced more curious animals as compared to when these species were placed in common quarters after the autumn equinox. In the case of blue foxes, the male dominated highly over all females. In silver foxes, the difference in dominance between the sexes was, however, less pronounced. The most dominant individuals in the study groups were typically among the heaviest. Breedings and whelpings succeeded better in silver than in blue foxes. However, none of litters born survived more than

one week. The present results support the conclusion that when both fox species are housed together, *Vulpes vulpes* tends to dominate over *Alopex lagopus*.

*Polar Biol* 17, pp. 330-336, 1997. 3 tables, 4 figs., 26 refs. Authors' abstract.

### Diet of feral house cats *Felis catus*, ferrets *Mustela furo* and stoats *M. erminea* in grassland surrounding yellow-eyed penguin *Megadyptes antipodes* breeding areas, South Island, New Zealand

N. Alterio, H. Moller

Spring and summer diets of feral house cats (*Felis catus*), ferrets (*Mustela furo*) and stoats (*M. erminea*) were studied in grassland surrounding breeding areas of yellow-eyed penguins (*Megadyptes antipodes*), a regionally threatened native species. All three predator species ate large numbers of young rabbits (*Oryctolagus cuniculus*) and birds. Stoats also relied heavily on mice (*Mus musculus*). Use of rabbits increased in rank order of increasing predator size, and male stoats ate more lagomorphs than female stoats. Diet differences may reflect character displacement as a result of exploitation competition, but interference competition or predation may force the smaller species to exploit micro-habitats with increased ground cover and consequent increased availability of smaller prey. Reduction of predation of native species like yellow-eyed penguins by decreasing or increasing staple mammal prey numbers of the introduced predators may provide lasting conservation benefits, but could also trigger diet changes that increase risk to endangered wildlife.

*J. Zool., Lond.* 243, pp. 869-877, 1997. 3 tables, 36 refs. Authors' summary.

### Secondary poisoning of stoats (*Mustela erminea*), feral ferrets (*Mustela furo*), and feral house cats (*Felis catus*) by the anticoagulant poison, brodifacoum

Nic Alterio

A poisoning operation using Talon 20P™, active ingredient brodifacoum, targeting rabbits

(*Oryctolagus cuniculus*) in coastal grasslands on the Otago Peninsula, New Zealand, also killed stoats (*Mustela erminea*), ferrets (*Mustela furo*), cats (*Felis catus*), and mice (*Mus musculus*) and probably possums (*Trichosurus vulpecula*), hedgehogs (*Erinaceus europaeus*), rats (*Rattus rattus*), hares (*Lepus europaeus occidentalis*), and chaffinches (*Fringilla coelebs*). A new immigrant ferret also died 41 days after poisoning. If repeated in other habitats such as tussock grasslands and forests this method could greatly assist in restoration of mainland eco-systems and mitigation of bovine tuberculosis (*Mycobacterium bovis*) by controlling a variety of pests/Tb carriers in one operation. The removal of small mammalian predators following poisoning operations could decrease immediate predation pressure on native wildlife. However, the efficacy of this multi-species pest control method and unwanted side-effects must be researched before its routine use. This research also demonstrates the potential threat of second-generation anticoagulant poisons such as brodifacoum to small mammalian carnivores with high conservation value in their native countries.

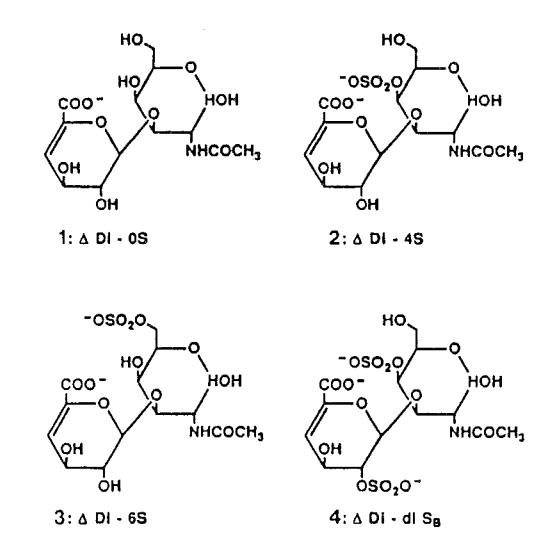
*New Zealand Journal of Zoology*, Vol. 23, pp. 331-338, 1996. 6 figs., 29 refs. Author's abstract.

### Separation and determination of glycosaminoglycan disaccharides by micellar electrokinetic capillary chromatography for studies of pelt glycosaminoglycans

Søren Michaelsen, Mai-Britt Schrøder, Hilmer Sørensen

Capillary electrophoresis based on cetyltrimethylammonium bromide micellar electrokinetic capillary chromatography (MECC) was developed for the separation and determination of glycosaminoglycan (GAG) disaccharide units without derivatization. The influence of changes in several separation conditions was studied, and the separation mechanisms are discussed. Tests of repeatability and linearity were performed for qualitative and quantitative evaluation of the method. The described procedure gives a rapid and efficient determination of GAG disaccharides. Samples of chondroitin sulphates and mink skin were treated with proteases, and the extent of protein cleavage was followed by free zone capillary

electrophoresis. The result of the chondroitinase ABC treatment following the protease treatment was evaluated by the MECC method.

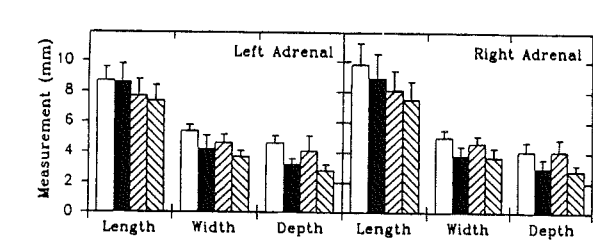


**Fig. 1.** Structures of the individual GAG disaccharides used in the HPCE analyses.

*Journal of Chromatography A*, 652, pp. 503-515, 1993. 1 table, 12 figs., 30 refs. Authors' abstract.

### Adrenal ultrasonography correlated with histopathology in ferrets

L. Neuwirth, B. Collins, M. Calderwood-Mays, T. Tran



**Fig. 3.** Comparison of gross and ultrasonographic measurements (mean  $\pm$  standard deviation) of length, width and depth in male and female ferrets. Open and solid bars represent gross and ultrasonographic measurements of male adrenal glands, respectively. Rising right and left diagonal lines represent gross and ultrasonographic measurements of female adrenal glands, respectively. Error bars depict the standard deviation.

The adrenal glands of twenty-six 12- to 53-month-old ferrets without clinical signs of adrenal disease were examined and measured by ultrasonography and the findings compared with those from gross examination and histopathology. Of 51 adrenal glands examined, 27 were normal, 23 had either nodular or diffuse cortical hyperplasia and 1 had an adenocarcinoma. There was no statistically significant difference between the sonographic nor gross size of normal adrenal glands and those with hyperplasia. Moderate correlation was found between gross and sonographic measurements of length for both right ( $r=0.783$ ;  $p<0.0001$ ) and left ( $r=0.609$ ;  $p<0.001$ ) adrenal glands; however, the sonographic measurements were less than the gross measurements. Correlation was found between the sex and weight of the ferret and adrenal gland length ( $p<0.01$ ) and width ( $p<0.02$ ). In female ferrets, the length, width, and depth of the right adrenal gland sonographically measured (mean  $\pm$  sd)  $7.5 \pm 1.2$  mm,  $3.7 \pm 0.6$  mm,  $2.8 \pm 0.4$  mm, respectively, and the left measured  $7.4 \pm 1.0$  mm,  $3.7 \pm 0.4$  mm,  $2.8 \pm 0.4$  mm; in males, the right adrenal measured  $8.9 \pm 1.6$  mm,  $3.8 \pm 0.6$  mm,  $3.0 \pm 0.8$  mm and the left measured  $8.6 \pm 1.2$  mm,  $4.2 \pm 0.6$  mm,  $3.0 \pm 0.6$  mm. Accessory adrenal tissue was not identified during the sonographic examination but was grossly found in 10 of the ferrets. It was associated with either the right, left or both adrenal glands.

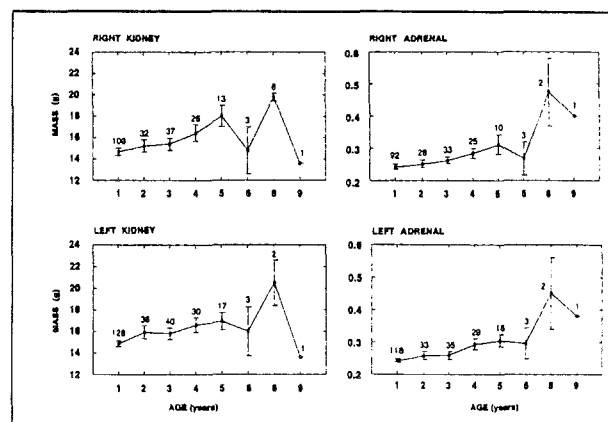
*Veterinary Radiology & Ultrasound, Vol. 38, No. 1, pp. 69-74, 1997. 2 tables, 3 figs., 19 refs. Authors' summary.*

### Internal organ masses of the red fox *Vulpes vulpes*: data from the wild

Paolo Cavallini

Totally, 330 (125 females, 205 males) red foxes *Vulpes vulpes* (Linnaeus, 1758), killed during predator control operations (January to April 1992) in central Italy, were dissected. Their kidneys, spleen, heart, liver, and adrenal glands were weighed and related to body mass, age, sex, and kidney fat index. The mass of all organs examined, except for the adrenal glands, was highly correlated with body mass. Sex, age, and fat did not affect liver or spleen mass. Kidney fat was negatively related to the mass of heart and kidneys. Only kidneys and adrenals increased in mass with age. The increases

were small, and could not explain an increase of total body mass with age. The hearts and spleens were relatively heavier in wild foxes than in farmed foxes, whereas livers were relatively lighter. Environmental factors (exposure to parasites and physical activity) may explain the differences. The masses of all of the organs were more variable in wild foxes than in farmed foxes, possibly because of a greater environmental and genetic variability.



**Fig. 1.** Increase of the mass of the left and right kidneys and left and right adrenal glands of wild red foxes from central Italy with age. Mean, standard error and sample sizes for each age are shown.

*Acta Theriologica 42 (1), pp. 91-98, 1997. 3 tables, 1 fig., 22 refs. Author's summary.*

### Overlooked names for European mammals

Boris Krystufek

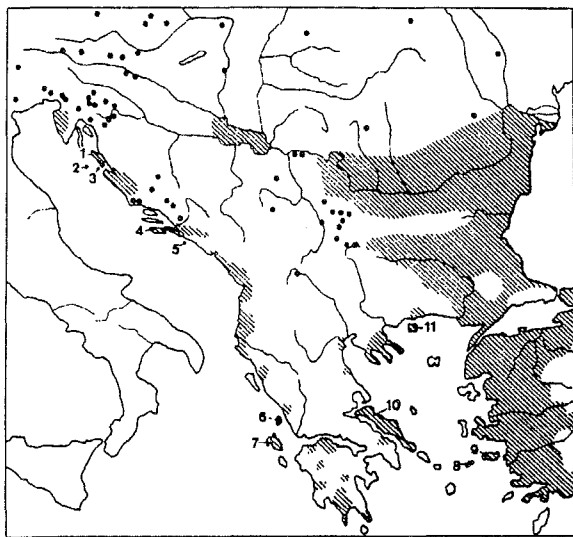
Eight specific or subspecific names are listed and discussed, that are proposed for European mammals between 1929 and 1986, but since overlooked in taxonomic inventories: *Sorex caucasicus sultanae* Simsek, 1986, *Vulpes vulpes hellenica* Douma-Petridou and Ondrias, 1980, *Microtus nivalis appenninicus* Dal Piaz, 1929, *Nannospalax bulgaricus* Savic and Soldatovic, 1984, *N. b. srebornensis* Savic and Soldatovic, 1984, *N. serbicus tranensis* Savic and Soldatovic, 1984, *N. serbicus softiensis* Savic and Soldatovic, 1984, and *N. rhodopiensis* Savic and Soldatovic, 1984.

*Folia Zoologica 46 (1), pp. 91-93, 1997. 15 refs. Author's abstract.*

### Present distribution of the Golden Jackal *Canis aureus* in the Balkans and adjacent regions

B. Krystufek, D. Murariu, C. Kurtonur

Small, scattered, but resident, populations of Golden Jackal *Canis aureus* occur along the coasts of the Balkan Peninsula. The bulk of these European Jackals is concentrated in the eastern parts of the Peninsula, mainly in Bulgaria. The northern border of the resident populations lies along the Danube in the Walachian Plain of Romania, and in Srem (Yugoslavia). Vagrants may appear far outside the Balkans in north-eastern Italy, Slovenia, Austria, Hungary and Slovakia. Whilst the species is in decline in Greece, it has expanded its area in Bulgaria from  $\approx 2400 \text{ km}^2$  in 1962 to  $80,000 \text{ km}^2$  in 1985, i.e. a 33-fold range increase within 23 years.



**Fig. 1.** Approximate distribution of the Jackal *Canis aureus* in the Balkans and adjacent regions. Areas of permanent occurrence are shaded and vagrants recorded after 1970 are shown as dots. Islands; 1, Pag; 2, Premuda; 3, Vir; 4, Korcula; 5, Sipan; 6, Leukas; 7, Kephallinia; 8, Ikaria; 9, Samos; 10, Evvia; 11, Thasos. The distribution in Asia Minor is redrawn from Turan (1984).

*Mammal Rev.*, Vol. 27, No. 2, pp. 109-114, 1997. 1 fig., 30 refs. Authors' abstract.

### Comparison of body condition indices in the red fox (*Fissipedia*, Canidae)

P. Cavallini

Six indices of body and physiological condition were determined for 330 red foxes (*Vulpes vulpes*) collected in Central Italy from January to May 1992: (1) subcutaneous fat; (2) perivisceral fat; (3) perirenal fat; (4) residual of the regression of body mass on body length; (5) spleen mass; (6) adrenal mass. During this season, females had more fat than males, whereas yearlings (9-13 months old) had the same fat as the adults. All the nutritional indices (1 through 4) were highly related, suggesting that they could be used at least for relative comparisons. Correcting for gut content mass marginally strengthened the relationship, and reproductive status of females had no effect on it. The two stress indices (5 and 6) were of little significance, at least during late winter and spring. The index based on body mass residuals may allow an approximate estimation of fat level of live foxes. It is also applicable retrospectively to museum collections and historical data, where body mass and body length were known, but no measure of fatness was taken.

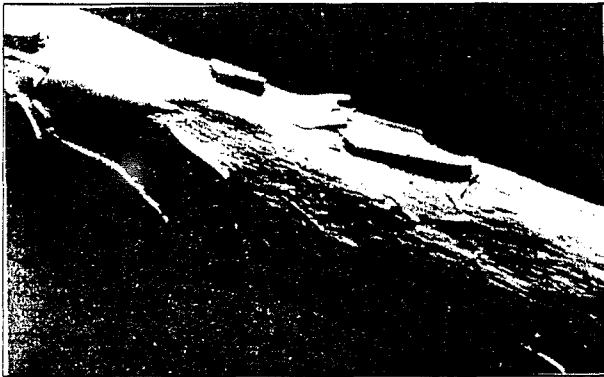
*Mammalia*, t. 60, no. 3, pp. 449-462, 1996. 6 tables, 4 figs., 39 refs. Author's summary.

### *In vitro* biodegradation of hair from different animal species by *Microsporum canis*

Krystyna Wawrzekiewicz, Grazyna Ziolkowska, Janusz Wawrzekiewicz

The studies aimed to compare the growth intensity of *Microsporum canis* on a mineral medium with hairs of various animal species as sources of nutrition and to evaluate the degree of hair destruction (under light and SEM microscopes). The fungus multiplied most quickly (3-10 days) at a temperature of  $25^{\circ}\text{C}$  on the medium containing the hair of guinea pig, fox, and sheep, and most slowly on the medium with hair of cat and dog. The destructive action of *M. canis* at 30 days was most

evident in the hair of sheep and silver fox, while human hair proved to be most resistant to it (at 65 days). The age of the animals affected the degree of hair decomposition; morphological changes brought about by fungal attack were found in the hair of kittens after only 10 days, whereas in mature animals, this took place only after 20-30 days. The decisive role in the decomposition of native hair keratin seems to be played by the proteolytic enzymes of the fungus.



**Fig. 1.** Fragment of a silver fox hair. Incubation of *Microsporum canis* in mineral medium at 25°C for 10 days. Visible partial separation of the hair sheath and exposure of the cortex. Original magnification about x2100.



**Fig. 2.** Fragment of a silver fox hair-control. Original magnification about x2100.

*International Biodeterioration & Biodegradation*, Vol. 39, No. 1, pp. 15-25, 1997. 4 tables, 10 figs., 50 refs. Authors' summary.

### Reversible immobilization of mustelids, hedgehogs, cattle and cervids based on alpha-2 adrenoceptor agents. A clinical and comparative study

Jon M. Arnemo

Drugs for reversible immobilization were evaluated in mustelids [mink (*Mustela vison*) and pine martens (*Martes martes*)], European hedgehogs (*Erinaceus europaeus*), cattle (*Bos taurus*) and cervids [axis deer (*Axis axis*), red deer (*Cervus elaphus*) and moose (*Alces alces*)].

In captive mink (Paper I), 0.1 mg medetomidine hydrochloride/kg combined with 5.0 or 7.5 ketamine/kg subcutaneously induced complete and reliable immobilization in February. The higher dose induced analgesia considered suitable for major surgery. Effective remobilization of the animals was achieved with 0.5 mg atipamezole hydrochloride/kg intramuscularly. To prevent hypothermia and prolonged recovery, especially at low ambient temperatures, the use of atipamezole for reversal is recommended.

In captive pine martens (Paper II), 0.13-0.24 mg medetomidine hydrochloride/kg (minimum-maximum) combined with 6.5-11.8 mg ketamine/kg intramuscularly induced complete and reliable immobilization in July, November and January. The degree of analgesia induced was considered suitable for minor surgery. Intramuscular administration of 5 mg atipamezole hydrochloride per mg medetomidine hydrochloride effectively remobilized the animals. To avoid hypothermia and prolonged recovery, especially at low ambient temperatures, the use of atipamezole for reversal is recommended.

In free-ranging hedgehogs (Paper III), 0.2 mg medetomidine hydrochloride/kg combined with 2.0 mg ketamine/kg and 0.1 mg fentanyl/kg subcutaneously induced complete and reliable immobilization in May-October. The degree of analgesia achieved was considered suitable for surgical interventions. Effective remobilization of the animals was achieved with 1.0 mg atipamezole hydrochloride/kg and 0.16 mg naloxone hydrochloride/kg intramuscularly.

In dairy calves (Paper IV), effective and persistent reversal of xylazine-induced immobilization was achieved with atipamezole. Recommended dose ratios (mg:mg) between xylazine and atipamezole hydrochloride are 10:3 or 4:1 for intramuscular and 5:1 or 8:1 for intravenous administration of atipamezole, respectively.

In free-ranging cattle (Paper V), xylazine at 0.55 (0.18 mg/kg [mean (SD)] or medetomidine hydrochloride at 0.039 (0.10) mg/kg, administered with a tranquillizing gun, were equally effective for immobilization. By doubling the dose of medetomidine hydrochloride [0.081 (0.007) mg/kg], the induction times could be shortened, without causing any major side effects (Paper VI). Intravenous or intramuscular administration of atipamezole hydrochloride at twice the dose of medetomidine hydrochloride effectively remobilized the animals, although moderate resedation occurred 2-4 hours after injection of the antagonist (Papers V and VI). To avoid heavy resedation with relapse into recumbency in xylazine-treated animals, the dose ratio between xylazine and atipamezole hydrochloride should probably not exceed 8:1 for intravenous administration of the antagonist (Paper V).

In free-ranging axis deer (Paper VII), captured with drive nets and sedated with xylazine at 3.4 (0.1) mg/kg intramuscularly in February-March, atipamezole hydrochloride at 0.34 (0.01) mg/kg intravenously was effective for remobilization.

In free-ranging red deer calves (Paper VIII), 0.147 (0.024) mg medetomidine hydrochloride/kg combined with 2.5 (0.4) mg ketamine/kg, administered with a tranquillizing gun, induced complete and reliable immobilization in January-March. Intramuscular administration of atipamezole hydrochloride at 1.4-3.3 times the dose of medetomidine hydrochloride was used to shorten the recoveries of captured animals.

In free-ranging adult moose (Paper IX), 30 mg medetomidine hydrochloride/animal combined with 400 mg ketamine/animal, administered with a tranquillizing gun, induced complete and reliable immobilization in August-September. Effective remobilization was achieved with 150 mg atipamezole hydrochloride/animal, half the dose

given subcutaneously and the other half intravenously or intramuscularly.

The present thesis is based on the following papers:

Arnemo, J.M., Søli, N.E. Immobilization of mink (*Mustela vison*) with medetomidine-ketamine and remobilization with atipamezole. *Vet Res Commun* 1992; 16: 281-92. **Abstracted in SCIENTIFUR, Vol. 18, No. 3, pp. 182, 1994.**

Arnemo, J.M., Moe, R.O., Søli, N.E. Immobilization of captive pine martens (*Martes martes*) with medetomidine-ketamine and reversal with atipamezole. *J Zoo Wildl Med* 1994; 25: 548-54. **Abstracted in SCIENTIFUR, Vol. 20, No. 2, pp. 224, 1996.**

Arnemo, J.M., Søli, N.E. Chemical immobilization of free-ranging European hedgehogs (*Erinaceus europaeus*). *J Zoo Wildl Med* 1995; 26(3). In press.

Arnemo, J.M., Søli, N.E. Reversal of xylazine-induced sedation in dairy calves with atipamezole: a field trial. *Vet. Res Commun* 1993; 17: 305-12.

Arnemo, J.M., Søli, N.E. Chemical capture of free-ranging cattle: immobilization with xylazine or medetomidine, and reversal with atipamezole. *Vet Res Commun* 1993; 17: 469-77.

Arnemo, J.M., Søli, N.E. Immobilization of free-ranging cattle with medetomidine and its reversal by atipamezole. *Vet Res Commun* 1995; 19: 59-62.

Arnemo, J.M., Moe, S.R., Søli, N.E. Xylazine-induced sedation in axis deer (*Axis axis*) and its reversal by atipamezole. *Vet Res Commun* 1993; 17: 123-8.

Arnemo, J.M., Negard, T., Søli, N.E. Chemical capture of free-ranging red deer (*Cervus elaphus*) with medetomidine-ketamine. *Rangifer* 1994; 14: 123-7.

Arnemo, J.M. Immobilization of free-ranging moose (*Alces alces*) with medetomidine-ketamine and remobilization with atipamezole. *Rangifer* 1995; 15: 19-25.

*Thesis, 56 pp, 159 refs. Author's summary.*



*Original Report*

**The pleiotropic effects of the one-locus *pp* and the two-loci *aapp* coat colour genes on the metabolism of brain neurotransmitters in mink (*Mustela vison*)**

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**Summary**

The metabolic features of the brain neurotransmitters serotonin and dopamine were studied in mutant Sapphire mink homozygous for the Aleutian and silver-blue coat colour (*aapp*) and in mink homozygous for the silver-blue coat colour (*pp*) mutation. The results were compared with those obtained for standard mink (+/+). It was demonstrated that the *aapp* mutation significantly affects the major metabolic enzymes of serotonin: the activity of the key enzymes of serotonin biosynthesis, tryptophan hydroxylase, and of the catabolic enzyme MAO A were considerably increased in the midbrain of *aapp* mink. The activity of one of the major catabolic enzymes of dopamine, MAO B, was also increased in the midbrain of *aapp* mink. A similar increase in the activity of tryptophan hydroxylase and MAO B was found in the midbrain of silver-blue (*pp*) mink compared to standard mink. However, the *pp* mutation had no effect on the activity of the catabolic enzyme of serotonin, MAO A. It was also shown that the *pp* mutation affects dopamine metabolism in one of the main dopaminergic structures of the brain, the corpus striatum. In *pp* mink, the activity of the catabolic enzyme of dopamine, MAO B, was increased, the level of dopamine was decreased, that of the metabolite 3, 4-dihydroxyphenyl acetic acid (DOPAC) tended to increase. There were no marked changes in the level of another dopamine metabo-

lite, homovanillic acid (HVA) catalysed by catechol-O-methyl transferase.

It is concluded that the *pp* alleles may be responsible for the changes in serotonin biosynthesis, while enhanced serotonin degradation in *aapp* mink is presumably determined by the *aa* locus. It is suggested that the consequences of the action of the *aa* and *pp* genes on the activity of the major enzymes of serotonin biosynthesis and dopamine may be regarded as a pleiotropic cascade manifested in changes in the metabolism of brain transmitters, possibly in serotonin- and dopamine-dependent physiological and behavioural parameters.

**Introduction**

The pleiotropic effects of the coat colour genes are manifest as changes in vital characters, such as fertility, stress reactivity and behaviour. Brain neurotransmitters are the physiological regulators of these characters. There is reason to suggest that the action of the mutant alleles be mediated through changes in the brain regulators. The "classical" brain neurotransmitters include serotonin and dopamine. There is a convincing body of literature concerning their significant and diverse roles.

Serotonin is a neurotransmitter with a remarkably wide spectrum of action. In vertebrates, serotonin is

involved in the regulation of the sleep-wakefulness cycle (Jouvet, 1988), endocrine glands (Naumenko & Popova, 1975), thermoregulation (Popova & Konusova, 1985), immunomodulation (Devoino & Iluytchenok, 1983), and the control of emotionality and anxiety (Dourish, 1987). Of great importance is the participation of serotonin in control of the stress response (Popova et al., 1985), the pituitary-gonadal system (Naumenko & Popova, 1975), and sexual behaviour (Popova et al., 1978).

Dopamine is involved in the regulation of emotionality, locomotion and muscle tone (Eilam et al., 1992). It controls some complex forms of behaviour in mammals (Snyder et al., 1970; Le Moal, and Simon, 1991). The dopaminergic system in coat colour mutants deserves particular attention because dopamine partly shares the metabolic pathway with melanin, a pigment determining coat colour. The immediate precursors of dopamine biosynthesis amino acid tyrosine and its hydroxylation product DOPA are also the initial substances in melanin synthesis. Furthermore, there is evidence indicating that dopamine may be involved in the regulation of the melanophore-stimulating hormone (MSH) as an agent inhibiting MSH secretion and producing dilution of coat colour (Levitin & Mezzadri-Levitin, 1982; Vivas & Celis, 1982).

In studies of the pleiotropic gene effects, one- and two-loci mutations appear promising, enabling us to reveal the relation of mutant alleles to changes in mechanisms regulating the stress response, reproduction and behaviour.

American mink has a series of one- and two-loci mutations with pleiotropic effects on fertility and behaviour (Evsikov, 1974). The two-loci *aapp* Sapphire is one of the most thoroughly studied mutations. In Sapphire mink, changes in behaviour (Trapezov, 1987), the level of the gonadal hormones and the stress response (Gulevich, Klochkov, 1988) have been observed. It is unknown whether the brain neurotransmitter system of Sapphire mink has features distinguishing it from that of standard mink. Nothing is known about the brain neurotransmitters in the silver-blue coat colour mutation *pp*. Analysis of the one-locus *pp* mutation in silver-blue mink and two-loci *aapp* mutation in Sapphire mink would not only reveal the features of the brain transmitters, but also the contribution of single alleles to these changes.

The aim of our experiments was to determine the features of serotonin and dopamine metabolism in the brain regions that distinguish Sapphire and silver-blue mink from wild-type. The following parameters were measured in the brain regions: (1) the levels of serotonin and of its metabolite 5-hydroxyindolacetic acid; the activities of the metabolic enzymes of serotonin; the key enzyme of serotonin biosynthesis tryptophan hydroxylase and of the major metabolic enzyme monoamine oxidase type A (MAO A); (2) the levels of dopamine and of its major metabolites homovanillic acid (HVA) and 3, 4-dihydrophenylacetic acid (DOPAC); the activity of the metabolic enzyme of dopamine monoamine oxidase type B (MAO B).

### Materials and methods

American male mink (*Mustela vison*, Brisson) maintained at the Experimental Farm of the Institute of Cytology and Genetics, Novosibirsk were used in the experiments. Their genotypes were: (1) standard (wild type), (2) Sapphire, mutant homozygous for the Aleutian and silver-blue coat colour genes (*aapp*), and (3) silver-blue, homozygous for the silver-blue coat colour genes (*pp*). The experiments were performed in November when animals were sacrificed for commercial purposes. The mink were sacrificed by cervical dislocation, the brain was placed on ice, and the midbrain, hypothalamus and corpus striatum were dissected. The levels of serotonin and 5-hydroxyindolacetic acid (5-HIAA) were determined fluorometrically (Jacobowitz & Richardson, 1978); the measured values were expressed as  $\mu\text{g/g}$  brain tissue. The activity of tryptophan hydroxylase was determined fluorometrically (Kulikov, 1982) in the presence of 6, 7-dimethyltetrahydropteridine co-factor; the measured values were expressed as nmoles of 5-hydroxytryptophan/mg protein/min. The activity of the monoamine oxidases A and B types was determined by spectrophotometry (Gorkin, 1981) in the presence of serotonin (substrate of MAO A) and benzylamine (substrate of MAO B). The enzyme activity was expressed as nmol  $\text{NH}_3/\text{mg}$  protein/min. In analysis of dopamine metabolism and level, two main dopaminergic structures, the striatum and nucleus accumbens, were isolated. The hypothalamus, midbrain, and frontal cortex were also isolated. After chromatographic separation through Sephadex G-10 columns, the levels of dopamine and its metabolites, HVA and DOPAC were determined fluorometri-

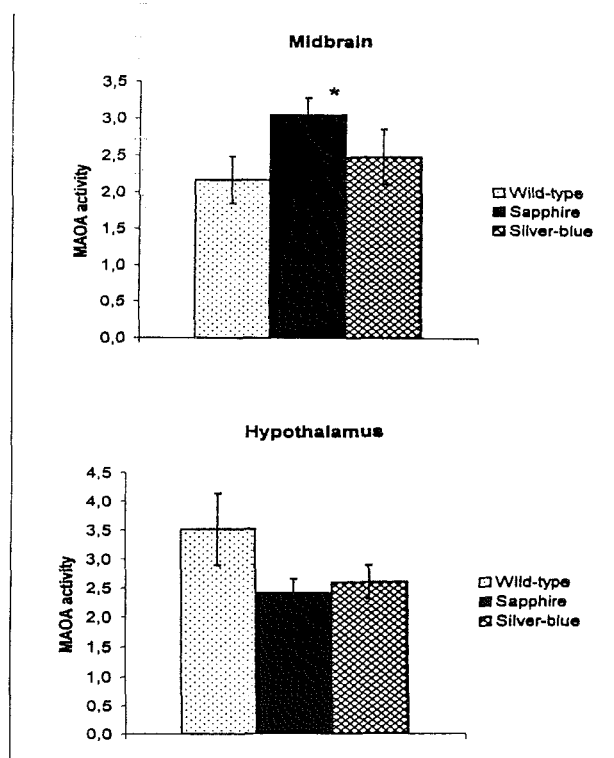
cally (Earley & Leonared, 1978) in the striatum and nucleus accumbens which represent the nigrostriatal and mesolimbic dopaminergic structures, respectively.

The kinetic parameters  $K_d$  and  $V_{max}$  were estimated using the least squares method (Cornish-Bowden, 1979). Student's t-test was applied to treat the other parameters.

## Results

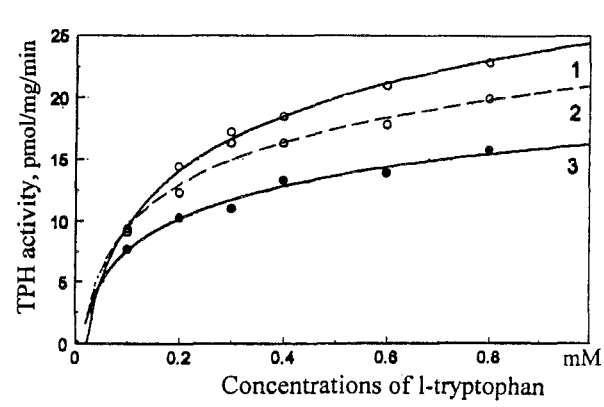
### Brain serotonin

This analysis demonstrated that the one- and two-loci mutations considerably affected serotonin metabolism in the brain. There were marked changes in the midbrain where the perikaryons of the serotonin neurons are concentrated (Dahlstrom & Fuxe, 1965). The mutations also significantly affected the activities of the major metabolic enzymes of serotonin.



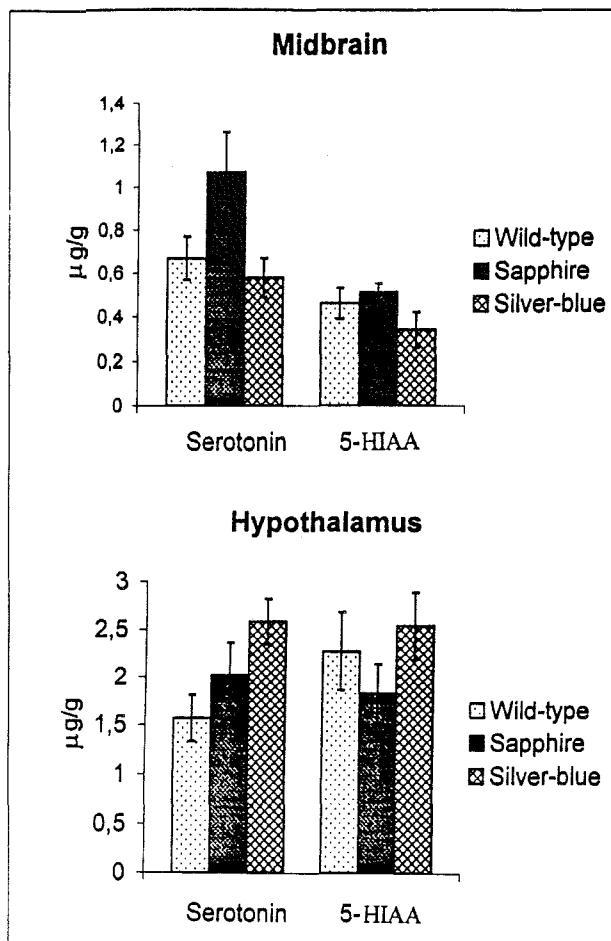
**Fig. 1.** MAOA activity in the midbrain and hypothalamus of wild-type, Sapphire (*aapp*) and silver-blue (*pp*) mink. \* $P < 0.05$ . The activity of type A MAOA was assayed using 1.0 mM serotonin as substrate and was expressed in nmol  $\text{NH}_3$ /mg protein per min.

The activity of the catabolic enzyme of serotonin (MAO A) was significantly elevated in the midbrain of *aapp* Sapphire mink (fig. 1). It will be recalled that oxidative deamination catalysed by MAO A is the major catabolic pathway of serotonin. In fact, up to 90% of serotonin is catabolised via oxidative deamination (Weissbach *et al.*, 1961). It is believed that MAO regulates the presynaptic concentration of serotonin (Kelder *et al.*, 1989). Concomitantly, the activity of MAO A was not increased in the midbrain of mink with the one-locus *pp* mutation compared to wild-type mink. It may be concluded that the increase in MAO A activity in the midbrain of *aapp* Sapphire mink is determined by the *pp* locus.



**Fig. 2.** The tryptophan hydroxylase (TPH) activity in the midbrain and hypothalamus of mink: 1 – wild-type, 2 – Sapphire (*aapp*) and 3 – silver-blue (*pp*).

An increase in the activity of the enzyme of serotonin biosynthesis was found in the midbrain of Sapphire mink (fig. 2). Tryptophan hydroxylase is the key enzyme of serotonin biosynthesis: of the two enzyme catalyzers of serotonin synthesis, tryptophan hydroxylase is the rate-limiting. The midbrain is a region of particular interest for the reason that tryptophan hydroxylase is mainly synthesized in the midbrain raphe nuclei. Analysis of the kinetics of tryptophan hydroxylase demonstrated a significant increase in the  $V_{max}$  values in Sapphire mink ( $22 \pm 1.75$  versus  $17.71 \pm 1.49$  in standard mink,  $P < 0.05$ ). The increase was not associated with appreciable changes in Michaelis constant. The increase in the  $V_{max}$  values ( $29.23 \pm 2.3$ ,  $P < 0.001$ ) was even greater in *pp* mink. Thus, it may be concluded that the changes in the activity of the key enzyme of serotonin biosynthesis tryptophan hydroxylase are caused by the *pp* locus mutation.



**Fig. 3.** Concentration of serotonin and its metabolite 5-hydroxyindoleacetic acid (5-HIAA) in the midbrain and hypothalamus of wild type, Sapphire (*aapp*) and silver-blue (*pp*) mink.

There were no significant differences in the levels of serotonin and its metabolite 5-HIAA among three genotypes. A tendency towards an increase in serotonin level in the midbrain was observed only in Sapphire mink (fig. 3). No specific changes were found in the level of serotonin in the hypothalamus of mutants.

#### Dopamine

This study revealed no significant changes in the levels of the neurotransmitter dopamine and its two major metabolites in the main dopaminergic structures of the brain of Sapphire mink. The levels of dopamine, as well as of HVA and DOPAC, in the corpus striatum and nucleus accumbens in Sapphire mutant were close to those in Standard mink (table

1). However, in Sapphire mink, the activity of the metabolic enzyme of dopamine MAO type B was increased in the midbrain ( $P < 0.05$ ); a tendency towards an increase was observed in the corpus striatum.

In contrast, the *pp* mutation significantly affected the metabolism of dopamine in the corpus striatum, which is one of the main dopaminergic structures of the brain (tables 1, 2). Being one of the components of the nigrostriatal dopaminergic system, the corpus striatum is involved in the regulation of the muscle tone. In silver-blue mink, the activity of the major catabolic enzyme of dopamine, MAO B, was increased, dopamine level was decreased and that of its metabolite DOPAC, the product of oxidative deamination catalysed by MAO B, tended to increase in the corpus striatum. Although there were no changes in the level of the second major metabolite of dopamine, HVA, the ratio of the two metabolites (HVA + DOPAC) to dopamine in silver-blue mink (0.73) exceeded more than twice the ratio in standard mink (0.34). This was evidence that dopamine metabolism was considerably increased in the corpus striatum in *pp* mink compared to wild *PP* mink.

There were no significant differences in dopamine metabolism in the nucleus accumbens, a component of the mesolimbic dopaminergic system. No changes were observed in the kinetic characteristics of the main two types of dopamine receptors (Popova *et al.*, 1996). Silver-blue mink did not differ significantly in the density of the D1 and D2 dopamine receptors and their affinities in the corpus striatum and nucleus accumbens from standard mink.

Thus, the one-locus *pp* mutation affects dopamine metabolism rather than the dopaminergic receptors. It seems likely that in dopamine synthesis the main target of the *pp* mutation is enzyme MAO B. Although the increase in MAO B activity was highest in the corpus striatum, it was not restricted to it in silver-blue mink. The activity of MAO B rose in the midbrain, where the perikaryons of the dopaminergic neurons are located and from which the nigrostriatal and mesolimbic structures arise. There was also an increase in the activity of MAO B in the hippocampus, the structure of the limbic system regulating emotions.

**Table 1.** Effect of *pp* and *aapp* mutation on dopamine and its metabolite levels in dopaminergic brain structures

Neurochemical indices, $\mu\text{g/g}$	Wild-type ( <i>PP</i> ) (n=8)	Silver-blue ( <i>pp</i> ) (n=8)	Sapphire ( <i>aapp</i> ) (n=8)
<b>Corpus striatum</b>			
Dopamine	11.81 $\pm$ 2.42	6.09 $\pm$ 1.80*	10.40 $\pm$ 1.64
DOPAC	1.65 $\pm$ 0.18	2.34 $\pm$ 0.48	1.47 $\pm$ 0.21
HVA	2.43 $\pm$ 0.46	2.10 $\pm$ 0.30	2.26 $\pm$ 0.35
<b>Nucleus accumbens</b>			
Dopamine	5.25 $\pm$ 1.90	5.25 $\pm$ 1.67	8.92 $\pm$ 2.13
DOPAC	0.95 $\pm$ 0.08	0.69 $\pm$ 0.11	0.97 $\pm$ 0.17
HVA	5.15 $\pm$ 1.15	4.03 $\pm$ 1.15	4.24 $\pm$ 1.02

\*P&lt;0.05 vs wild-type

**Table 2.** MAO B activity (nM NH<sub>3</sub>/mg protein/min) in the brain structures of wild-type, silver-blue and Sapphire

Brain structures	Wild-type ( <i>PP</i> )	Silver-blue ( <i>pp</i> )	Sapphire ( <i>aapp</i> )
Midbrain	3.55 $\pm$ 0.24 (10)	4.84 $\pm$ 0.30 (14)*	5.47 $\pm$ 0.27 (10)*
Corpus striatum	2.94 $\pm$ 0.16 (9)	4.84 $\pm$ 0.30 (13)*	3.73 $\pm$ 0.42 (6)
Hippocampus	2.70 $\pm$ 0.18 (9)	3.43 $\pm$ 0.16 (14)*	2.25 $\pm$ 0.22 (11)
Hypothalamus	6.23 $\pm$ 1.00 (10)	5.47 $\pm$ 0.49 (14)	5.02 $\pm$ 0.34 (10)
Frontal cortex	3.22 $\pm$ 0.38 (8)	2.78 $\pm$ 0.35 (14)	3.00 $\pm$ 0.29 (11)

\*p&lt;0.05 vs wild-type

## Discussion

Significant changes in serotonin metabolism were demonstrated in mink with the two-loci Sapphire mutation. The pleiotropic effect of the *aapp* mutation is manifest as changes in the major metabolic enzymes of serotonin, i.e. the key enzyme of serotonin biosynthesis, tryptophan hydroxylase, and the catabolic enzyme MAO A.

Serotonin is a phylogenetically ancient brain neurotransmitter with an extremely wide spectrum of action (Naumenko & Popova, 1975) and for this reason at least some of the physiological features of mutant mink may be explained by changes in serotonin metabolism. One of these features may be reduced aggressiveness of Sapphire mink towards humans (Trapesov, 1987). We have previously shown that selection of silver foxes and Norway rats

for lower aggressiveness towards man is associated with an elevation in serotonin level and an increase in the activity of tryptophan hydroxylase in the mid-brain (Popova *et al.*, 1991a, b).

A comparison of the two loci *aapp* mutation with the one-locus *pp* mutation revealed the alleles responsible for the changes in the serotonin and dopamine brain systems. Each of these alleles is responsible for the activity of a particular enzyme. The *aa* allele is presumably responsible for the major catabolic enzyme of serotonin MAO A. This appears plausible because the increase in MAO A activity was observed in the two loci (*aapp*), but not in the one-locus *pp* mutants. The *pp* allele is presumably responsible for the increase in the activity of the key enzyme of serotonin biosynthesis tryptophan hydroxylase. In fact, the changes in the activity of tryptophan hydroxylase in *aapp* and *pp* mutants

were similar. The one-locus *pp* mutation also affects the metabolism of brain dopamine. MAO type B appears to be the target of the mutation. In silver-blue mink, the increase in the activity of MAO B was not restricted to the corpus striatum, although most clear-cut in it. The activity of MAO B also rose in the hippocampus, the region regulating emotions. The activity of MAO B was elevated in the midbrain which comprises the perikaryons of the dopamine neurons and gives rise to the nigrostriatal and mesolimbic dopaminergic brain system. It should be noted that a distinct increase in the activity of MAO B in the midbrain and its tendency to rise in the corpus striatum were also observed in Sapphire mink.

We have previously suggested that neurotransmitters may be involved in the mechanism underlying the effects of pleiotropic genes (Popova *et al.*, 1980). Since neurotransmitters regulate various physiological functions, the endocrine glands and behaviour, alterations in any component of the neurotransmitter system may have various consequences. This is especially true for the key enzymes of transmitter metabolism that regulate the synthesis-degradation rate and, hence, the activity of the neurotransmitter system. If key metabolic enzymes were affected by a mutation, a pleiotropic cascade would be expected:

Changes in

a metabolic enzyme  
↓  
the activity of the  
transmitter system  
↓  
the function controlled  
by the neurotransmitter

Relevant here is the effect of the one-locus *pp* mutation on the activity of tryptophan hydroxylase. Tryptophan hydroxylase is not only the key enzyme of serotonin metabolism determining its synthesis rate, it is also thought to be a marker of the function of the serotonergic system (Boadle-Biber *et al.*, 1983). As noted before, brain serotonin is involved in the regulation of various physiological functions and behaviour. There is reason to expect that changes in the activity of tryptophan hydroxylase would produce physiological and behavioural changes making the affected genotype different from the wild type. The spectrum of effects widens

when the enzyme is not highly specific. A case in point is MAO B. Being one of two catabolic enzymes of dopamine, MAO B also deaminates adrenaline, noradrenaline, and other biogenic amines.

There is, as yet, no certainty that the changes we found in MAO B activity and dopamine metabolism are associated with coat colour of the mink. Their causal relation is a possibility that cannot be excluded. Indirect support for it comes from data indicating that MAO B activity is high in cells cultures of mouse melanoma (Powell & Craig, 1979). In any event, it appears to be a reasonable assumption that the involvement of tryptophan hydroxylase and MAO B in the action of the *pp* mutation and of MAO A in that of the *aa* mutation may largely determine the physiological and the behavioural features of *pp* and *aapp* mink that distinguish it from wild-type mink. Further studies of the physiological and behavioural features of *pp* and *aapp* mutants would perhaps provide insight into their association with the specific metabolism of the "classical" brain neurotransmitter.

#### Acknowledgements

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*Original Report***Examination of traits related to prolificacy and suckling ability in chinchillas  
(*Chinchilla laniger*)***József Lanszki, Edit Jauk and Zoltán Bognár**Department of Small Animal Breeding Science, Faculty of Animal Sciences, PANNON Agricultural  
University, P. O. Box 16, H-7401 Kaposvár, Hungary***Summary**

Examination of chinchilla females showed that 37 of them became pregnant after giving birth; the average length of time between two births was 190.5 days. The average litter size at birth was 2.04, and at weaning 1.87. The litter size expressed in terms of the number of young ranged from 1 to 5 according to the following ratios: 31, 39, 25.5, 3.5 and 1 %, respectively.

The litters in spring and summer were larger than in autumn and winter, the difference being 15 % ( $p < 0.01$ ). There was no significant difference in the litter size at birth depending on the number of births, but the litter size at weaning increased to the 7th birth. The litter size at weaning was the lowest at the first birth ( $p < 0.001$ ). The litter size does not depend on the length of time between two births and the females' weight.

Most frequently, the mothers had 2 activated teats (61 %). The activated teat number depended on the litter size at birth ( $r = 0.40$ ,  $p < 0.001$ ) and at weaning ( $r = 0.66$ ,  $p < 0.001$ ). Mortality depending on the activated teat number (from 1 to 3-4) was 100, 38, 32 and 15 %, respectively.

**Introduction**

The profitability of fur animal production can be improved through genetic improvement, better nutrition and better housing. As a further factor, however, breeding efficiency also has to be emphasized. Increasing litter size cannot be a preferable breeding goal in chinchillas due to the fact that the rate of mortality is higher in larger litters of 3 to 5 young because the individual birth weight is smaller. Improvement in the survival rate of the young can be a more preferable goal for the breeder. Fur prices have risen steadily in the past 2 years (Várady, 1997). The number of chinchilla farms in Hungary now exceeds 250.

Among the traits related to the prolificacy and suckling ability of chinchillas the distribution of births, the seasonal effect, the distribution of litter size, litter weight and mortality before weaning have been investigated (Garcia *et al.* 1989, Neira *et al.* 1989, Lanszki 1996, Szatkowska and Sulik 1996).

Our data set was processed with the aim of examining the factors that are important in relation to the maternal effect: these are the seasonal

distribution of births, the effect of the season of birth, serial number of births and maternal body weight on litter size and the relationship between litter size and the number of activated teats.

### Material and method

The examinations were carried out on the standard chinchilla stock maintained at the Experimental Station of the Faculty of Animal Husbandry of Pannon University at Kaposvár. The chinchillas were housed in a closed room, which was fitted with windows and heated in winter, in a 3-floor cage system, on bedding. The relative air humidity varied between 40 and 60 % in the room. The temperature was 16-18°C on average but 20-25°C in summer. The polygamic method of mating was applied, and the progeny were weaned at the age of 56-60 days. The breeding animals were fed a chinchilla mix available from commercial feed distributors. This mix was provided ad libitum. As a supplement, grass hay was provided every other day. Drinking water was available without limitation from valved self drinkers.

The experimental data were collected between 1989 and 1997. Birth weight of the young and live weight of the mothers (at birth) were measured only in the last 5 years; the number of activated teats was checked only in the last 3 years. This is the reason for the different number of animals included in the evaluations.

For technical reasons, we had to make three reductions. Data on litters of 4 and 5 young, births of 8 to 10 and mothers with 3 and 4 activated teats were considered as one group each because of the small numbers of units in these categories. For establishing the categories of birth interval two complete oestrus cycles, i.e.  $28 \pm 2$  days, were considered. For evaluating the mothers' body weight immediately after birth 4 categories were formed: under 630 g (low quartile), 630-685 g (part below average of the interquartile), 686-740 g (part above average of the interquartile), over 740 g (upper quartile).

For data processing the following statistical methods were applied: a/ frequency analysis (distribution of births throughout the year, distribution of litter size); b/ T-test (difference of

litter size between two time periods of the year); c/ ANOVA (litter size depending on birth); d/ analysis of correlations (relationship between birth interval and litter size; between the number of activated teats and litter size; between the mothers' body weight and litter weight or litter size);  $\chi^2$ -test (relationship between mortality rate in the progeny and the number of activated teats). The data were processed and evaluated statistically using the computer programmes Excel 7.0 and Statgraphics 5.0.

### Results and discussion

The births took place in 2 main seasons: the higher peak of 37 % occurred in spring and the lower peak of 31 % in late summer-early autumn. Hardly any births occurred in the rest of the year (Fig. 1). This distribution curve is very similar to those drawn in other investigations (*Hillemann and Tibbits 1957, Johansson 1980, Neira et al. 1989*). The reproductive pattern of chinchillas can be defined according to the two half-years: the periods from January to June and from July to December can be distinguished. The mothers producing litters in the first half-year have a long pregnancy period of 111 days before their next delivery in late summer.

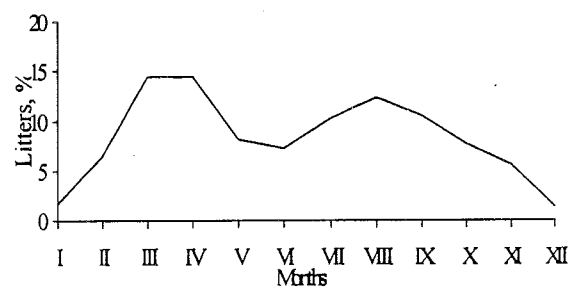


Fig.1. Distribution of births during the year.

The length of time between two births proved to be 190.5 days on average, so there were approx. two deliveries a year. Our finding is similar to those described by other authors (*Neira et al 1989, Cholewa and Sulik 1996*). One third of the females became pregnant immediately after delivery (Fig. 2). In the polygamic method of matings the male is kept separated from the female from the second day after delivery. Those females that fail to become

pregnant immediately after delivery do not have another chance to do so until the progeny are weaned 56 days later. During the suckling period (between the 116<sup>th</sup> and 180<sup>th</sup> days), the only females which could become pregnant were those which had lost their litter and were, therefore, exposed to the males. A quarter of the females became pregnant in the course of the two subsequent oestrus cycles following the weaning time (between the 181<sup>st</sup> and 245<sup>th</sup> days). In most cases, the females which did not produce a litter within one year were culled.

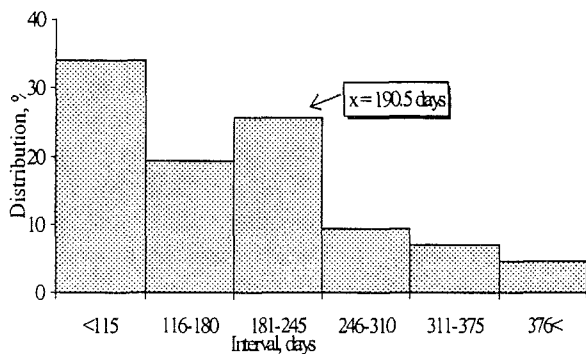


Fig. 2. Distribution of birth interval.

We examined the relationship of the birth interval with litter size at birth and at weaning. We found that the birth interval did not affect either of these ( $r=-0.08$ , NS; and  $0.03$ , NS, resp.). Litter size was found to be independent of how many days after the previous birth the female became pregnant again. We did not detect a significant effect of birth on the length of time between two births, either.

Chinchilla litter size usually falls into the range of 1 to 5 young. In our experimental stock the average litter size at birth was 2.04 and at weaning 1.87. Similar data on litter size at birth (2.0) were reported by U.S. scientists 40 years ago (Hillemann and Tibbits 1957), whereas other findings were also very close to these: 2.03 in Denmark (Anon. 1989), 1.75 in Chile (Neira et al. 1989), 1.94 in Poland (Szatkowska and Sulik 1996).

In the experimental stock, almost one third (31 %) of the females produced a single young. The ratio of litters with two young was the highest (39 %), whereas one out of four mothers (25.5 %) produced litters of 3. The ratio of litters of 4 and 5 was 3.5 % and 1 %, resp.

We also examined the effect of season on litter size (Fig. 3). The largest litters were produced in periods when the birth frequency was low (see Fig. 1 for comparison). The litters born in the first half-year were larger than those born in the second half-year by 15 % ( $p<0.01$ ). In this respect, our finding is different from the assertion of Szatkowska and Sulik (1996). That is to say, they did not reveal any significant difference in litter size between the two half-years.

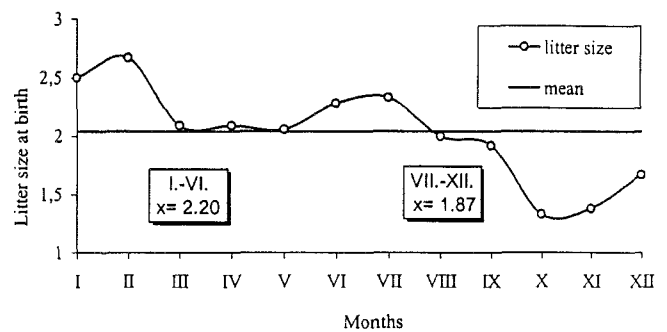


Fig. 3. Effect of "birth month" on litter size.

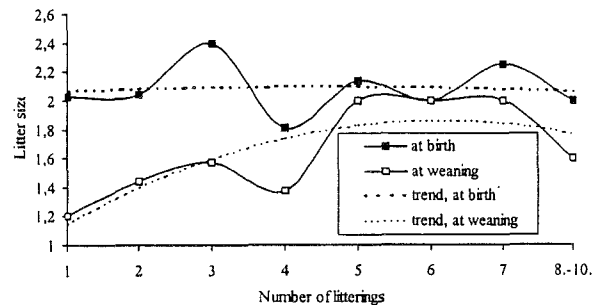


Fig. 4. Effect of parity order on the litter size.

Age also has an impact on the prolificacy-related traits. In our investigation we evaluated the relationship between birth and litter size. There was no significant difference in the litter size at birth depending on the number of births from 1 to 10. In the case of litter size at weaning, however, the poorest results were observed at the first parity (1.2,  $p<0.01$ ). The litter size at weaning increased steadily to the 7<sup>th</sup> delivery. After that point the suckling performance of the mothers began to deteriorate. For better demonstration we also plotted

trend curves (Fig. 4). Similar tendencies were reported by Garcia et al. (1989) and Szatkowska and Sulik (1996).

The mothers' body weight determined immediately after delivery varied between 527 and 932 g; it was 685 g on average. The body weight-related litter sizes at birth and at weaning were as follows: under 630 g: 2.1 and 1.3; 630-685 g: 1.9 and 1.3; 686-740 g: 2.1 and 1.4; over 740 g: 2.1 and 1.4. The differences were not significant. The correlation coefficient between the mothers' body weight at birth and the litter size proved to be low ( $r=0.04$ , NS at birth and  $r=0.1$ , NS at weaning), which indicates that the mothers' body weight had no impact on litter size.

Chinchilla females have 3 teat pairs. Most frequently, the front teats became activated first, while the third pair of teats located between the hind legs never gave milk. Actually, the number of activated teats ranged from 0 to 4. Activated teats

become flushed and the hair around them worn off. Inactive teats are pale and yellowish with intact hair around them. One fifth (20.7 %) of the mothers had only one activated teat (Table 1). Most commonly, the mothers had 2 activated teats (61 %), while the ratio of females having 3 or 4 activated teats was 13.7 %. The frequency of occurrence of mothers having no activated teats at all cannot be neglected, either (4.6 %). Such females are not capable of suckling and rearing their own progeny. They are usually culled when evidence is found that the reason for the lack of milk secretion is not environmental (e.g. nutrition, room climate). We could also detect a relationship between the litter size at delivery and the number of activated teats: the smaller the litter, the fewer the number of activated teats. A similar relationship was observed in mink (e.g. Korhonen 1992), in arctic fox (Frindt et al. 1989) and in rabbit (Mahmoud et al. 1990). The mothers with 2 to 4 activated teats produced markedly larger litters ( $p<0.0001$ ).

**Table 1** Relation between litter size, kit mortality and activated teat number

Marks: p = level of significance; a-b-c = in the rows the differences between groups marked with different letters are significant

Trait	Number of activated teats				p<
	0	1	2	3 and 4	
Distribution (%)	4.6	20.7	61.0	13.7	
Litter size					
- at birth	2.00±0.40 <sup>abc</sup>	1.39±0.20 <sup>c</sup>	2.19±0.12 <sup>b</sup>	2.83±0.17 <sup>a</sup>	0.0001
- at weaning	0.00 <sup>d</sup>	0.94±0.05 <sup>c</sup>	1.68±0.10 <sup>b</sup>	2.45±0.21 <sup>a</sup>	0.0001
Kit mortality (%)	100.0 <sup>c</sup>	38.1 <sup>b</sup>	32.2 <sup>b</sup>	14.8 <sup>a</sup>	0.001
Litter weight					
- at birth	81.5±17.2 <sup>bc</sup>	64.1±6.6 <sup>c</sup>	92.3±4.6 <sup>b</sup>	128.1±6.8 <sup>a</sup>	0.0001
- at weaning	0.00 <sup>d</sup>	273.4±9.8 <sup>c</sup>	437.7±23.4 <sup>b</sup>	626.5±62.1 <sup>a</sup>	0.0001

Our findings supported the observations described formerly, i.e. the larger the litter, the higher the number of activated teats. The data on mortality during the suckling period were calculated by comparing litter size at birth and at weaning. It is understandable that the mothers having no activated teats lost their whole litter. The ratio of lost progeny was still high (38 %) when there was only one activated teat, while the loss was 32.2 % in the case of 2 and 14.8 % in the case of 3 or 4 activated teats.

Similarly to our earlier observations (Lanszki 1996), 70 % of the mortality during the nursing period occurred in the first week: this is the most critical time for the young chinchillas.

The correlation coefficient between litter size at birth and the number of activated teats was medium and positive ( $r=0.40$ ,  $p<0.0001$ ). In the case of the litter size at weaning, the correlation was medium close and positive ( $r=0.66$ ,  $p<0.0001$ ).

## Conclusions

Chinchilla births occur in two main seasons, i.e. in spring and in late summer-early autumn. Average litter size proved to be 15 % higher during the first half of the year.

The chinchillas generally became pregnant immediately after birth or during the first two oestrus cycles after the weaning of the young. More than half of the pregnancies occurred in these two periods. The average length of time between two births was 190.5 days, which actually meant almost 2 litters per year.

The serial number of littering showed no impact on the litter size at birth. Litter size at weaning, however, was influenced by birth: the litters weaned were smallest in the case of mothers with a first litter. The fact that selection was carried out among the mothers after their first birth based on their own performance could have had an impact on our results.

Litter size was not affected by the number of open days the mother had after the previous birth. The mothers' body weight did not influence the litter size, either.

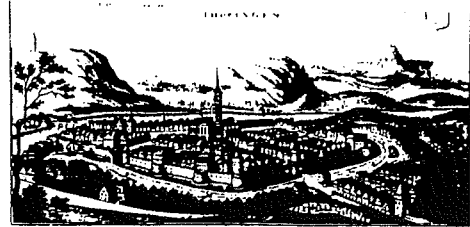
It is useful to check the number of activated teats after birth. The "surplus" of young, which cannot get access to an activated teat and would probably die, can be put out to nurse. A particular reason for this is the high rate of mortality in the first week of life. In our experiment there were more activated teats when the litter was larger. Also, with more activated teats, the rate of mortality was lower during the suckling period.

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## Announcement



The Institute of Nutrition and Environment of the Faculty for Biology and Pharmaceutics of the Friedrich Schiller University Jena, the Institute of Animal Nutrition of the Federal Agricultural Research Centre (FAL) Braunschweig Voelkenrode, the Society for Applied Vitamin Research and various other scientific institutions organize the **7th Symposium** to the topic

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- Vitamins and antioxidant status
- Indicators for the evaluation of the vitamin status
- Vitamins and additives in athlete nutrition
- Use, effects, and physical aspects of additives in food (stabilisators, preservative substances, enzymes/probiotics, trace elements, other substances)
- Use, effects, environmental aspects, and residue problems of additives in feedstuffs (growth promotors, probiotica, enzymes, trace elements, other substances)
- Specific substances of plants
- Analysis of vitamins and micro nutrients

Participants of the last symposium will receive further information by circular at the end of the year 1998. Every one who is interested but not registered may order further information via FAX: 03641 949612, via e-mail: [b5rasc@uni-jena.de](mailto:b5rasc@uni-jena.de) or by letter: FSU Jena, Lehrstuhl Ernaehrungsphysiologie, Dornburger Str. 24, D-07743 Jena (Germany).

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### Melatonin-induced downregulation of uterine prolactin receptors in mink (*Mustela vison*)

Jack Rose, Ov Slayden, Fredrick Stormshak

A study was conducted to investigate the effects of exogenous melatonin on serum concentrations of estradiol-17 $\beta$  (E<sub>2</sub>) and progesterone (P<sub>4</sub>) and uterine prolactin (PRL) receptor concentrations in mated mink. In Experiment 1, two groups of adult, standard dark, female mink were mated to fertile males on March 8 or 9. On March 16, mink in group 1 (N=8) received an empty Silastic implant inserted sc in the interscapular region and served as controls. Mink in group 2 (N=8) received an implant containing 10 mg crystalline melatonin. On April 2, all animals were lightly anesthetized and blood samples collected via cardiac puncture were analysed for serum concentrations of E<sub>2</sub> and P<sub>4</sub>. Animals were subsequently sacrificed and uterine samples collected for analysis of PRL receptor concentrations. In Experiment 2, adult female mink were assigned randomly to three treatment groups and mated to fertile males between March 6 and 9. On March 16, mink in group 1 (N=6) received empty Silastic implants and served as controls. Mink in group 2 (N=6) received a Silastic implant containing 10 mg melatonin. Animals in group 3 (N=6) received an implant containing 10 mg melatonin and in addition each mink was given daily sc injections of P<sub>4</sub> (1 mg) from March 21 to April 5. At this time the mink were sacrificed, the number of implantation sites recorded, and uteri collected for quantification of PRL receptors. In Experiment 1, exogenous melatonin reduced serum P<sub>4</sub> concentrations to almost nondetectable levels (controls, 8.08  $\pm$  0.73 vs. treated 0.82  $\pm$  0.12 ng/ml; P<0.001) and resulted in increased concentrations of E<sub>2</sub> (controls; 13.3  $\pm$  1.9 vs. treated 22.0  $\pm$  1.9 pg/ml; P<0.01). Uterine PRL receptor concentrations decreased (P<0.05) from 37.74  $\pm$  9.37 fmol/mg protein (controls) to 23.74  $\pm$  9.03 fmol/mg protein in response to melatonin treatment. In those mink treated with melatonin plus P<sub>4</sub> (Experiment 2), uterine PRL receptor concentrations were increased to levels not significantly different than those of controls. None of the mink treated with melatonin alone or in combination with P<sub>4</sub> exhibited implantation. Uteri of mink treated with melatonin or melatonin plus P<sub>4</sub> did not differ in weight but tended to weigh less than uteri of control mink. These data suggest that a high systemic ratio of P<sub>4</sub> to

E<sub>2</sub> is essential for production of the uterine PRL receptor in mink and supports the findings of others that implantation in mink cannot be initiated with P<sub>4</sub> alone.

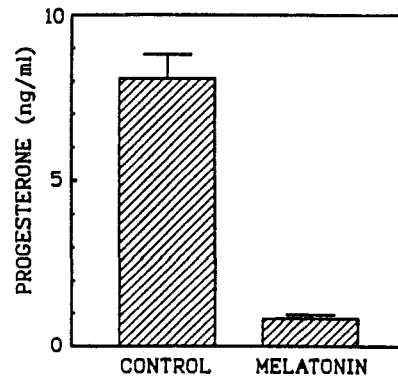


FIG. 1. Mean ( $\pm$ SE) serum progesterone concentrations in mated control and melatonin-treated mink (N = 8). Means are significantly different at the 0.001 level.

*General and Comparative Endocrinology* 103, pp. 101-106, 1996. 5 figs., 36 refs. Authors' summary.

### Cloning, sequencing, and characterisation of LDH-C<sub>4</sub> from a fox testis cDNA library

Mark P. Bradley, Amber Geelan, Virginia Leitch, Erwin Goldberg

A full-length cDNA encoding the sperm-specific enzyme lactate dehydrogenase-C<sub>4</sub> was isolated from a fox testis cDNA expression library and sequenced. The deduced translated protein sequence was shown to be 86% identical to that of human LDH-C<sub>4</sub>. In the fox testis, mRNA encoding LDH-C<sub>4</sub> was first detected in pachytene spermatocytes. The LDH-C<sub>4</sub> protein monomer was identified in Western blots of sperm membrane extracts as having a molecular weight of approximately 35,000, consistent with the monomeric size of this subunit previously identified in sperm from other species. The LDH-C<sub>4</sub> protein is localised on the sperm plasma membrane overlying the principal piece of the tail. Based on the available sequence data, we were able to identify an epitope within the N-terminal region of the LDH-C<sub>4</sub> amino-acid sequence which when administered to female foxes is antigenic and produces antibodies capable of recognising the native protein.

*Molecular Reproduction and Development* 44, pp. 452-459, 1996. 8 figs., 23 refs. Authors' abstract.

### **Regulation of reproductive tract immunoglobulins by estradiol-17 $\beta$ in the European red fox (*Vulpes vulpes*)**

*James de Jersey, Lyn A. Hinds, Mark P. Bradley*

The effect of the ovarian hormone, estradiol-17 $\beta$ , on reproductive tract immunity in the female fox was investigated. Reproductive tract antibody responses were induced by either Peyer's patch immunisation with a recombinant fox sperm protein, or by oral immunisation with live, attenuated *Salmonella typhimurium*. The effect of exogenous estradiol-17 $\beta$  or the stage of the estrous cycle on reproductive tract immunity was assessed. The secretion of specific vaginal IgA, but not vaginal IgG, antibodies was reduced by exogenous treatment with estradiol-17 $\beta$ , while both specific vaginal IgA and vaginal IgG levels declined during the period of natural estrus.

It is concluded that estradiol-17 $\beta$ , and probably other reproductive hormones, are involved in the regulation of antibody-secretion in the fox reproductive tract, and that reproductive status is an important factor to consider in the design and application of vaccines which aim to induce immunity within the female reproductive tract.

*Reprod. Fertil. Dev. 9, pp. 531-538, 1997. 6 figs., 20 refs. Authors' abstract.*

### **Fertility control and the management of feral animals**

*M. Bradley, P. Bird*

The concept of managing feral pest populations by fertility control is now gaining international support. In Australia and New Zealand there are several major projects underway which are exploring the use of immunocontraceptive vaccines for this purpose. This work brings together an amalgam of diverse scientific disciplines ranging from reproductive biologists, immunologists, to

ecologists. If these projects prove successful, fertility control for the management of feral animals is likely to become the practice of choice worldwide.

*Current Advances in Andrology, proceedings of the Vith International Congress of Andrology, Salzburg (Austria), May 25-29, 1997, pp. 348-352. Review, 16 refs. Authors' summary.*

### **A bait-delivered immunocontraceptive vaccine for the European red fox (*Vulpes vulpes*) by the year 2002?**

*Mark P. Bradley, Lyn A. Hinds, Peter H. Bird*

An orally-delivered immunocontraceptive vaccine is being developed for the control of fox populations. A number of genes (PH-20, LDH-C<sub>4</sub>, ZP3) encoding gamete proteins have been cloned, produced in recombinant expression systems and used in fertility trials to test the efficacy of these antigens. As the immunocontraceptive vaccine will be delivered in a bait, there is a requirement for a greater understanding of the immune responses of the reproductive mucosa in canids, and the assessment of the best vaccine delivery system that will evoke a mucosal antibody response. Several vaccine delivery systems including microencapsulated antigens, and body vaccinia virus and bacterial vectors are being investigated. Oral administration of *Salmonella typhimurium* recombinants expressing different fox sperm antigens stimulates both systemic IgG responses to the antigen and a mucosal immune response within the female reproductive tract in the fox, indicating that salmonella may have potential with respect to the oral delivery of antigen. The enhancement of mucosal immune responses to orally-delivered vaccines is also being examined, research focussing on the possible use of fox-specific cytokines or the  $\beta$ -subunit of cholera toxin in forming part of the vaccine construct.

*Reprod. Fertil. Dev. 9, pp. 111-116, 1997. 1 fig., 20 refs. Authors' abstract.*



*Original Report*

## Effect of Vegetable Fats on Some Performance Indices and Health State of Mink

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### Abstract

The aim of the research was to determine the usability of pumpkin cake and rapeseed oil for mink feeding. The experiment was performed on 120 standard mink. The effect of the above-mentioned feeds on body weight gains and pelt quality was determined. Histopathological examinations of the alimentary tract and some internal organs were conducted.

The research results indicate a positive influence of rapeseed oil on the growth of the animals, as well as on the size and quality of their pelts. Postmortem examinations showed more changes in the internal organs of the mink from the experimental groups. The changes did not, however, affect the animal productivity in any negative way.

### Introduction

Good pelt quality of fur-bearing animals depends first of all on their feeding. It is connected with proper feed selection and ration balancing for individual nutrient and energy content. Energy balancing seems extremely important. Its aim is not only to determine the amount and origin of metabolizable energy in the diet, but also the energy-protein ratio in the period of animal growth

and development. The results of the research conducted by Ahlstrom (1995), Lyngs (1990), and Skrede and Ahlstrom (1992) show the necessity of increasing the energy content of rations for carnivorous fur-bearing animals. The sources of metabolizable energy are mainly carbohydrates and fats. Including a given component in a ration should depend on its energy value, availability on the feed market, and price. The energy from carbohydrate feeds, supplied most often in the form of steamed ground grain, has lower value, is more expensive - compared with fat, and requires an expensive and labour-consuming process of heat treatment. Fats constitute much cheaper sources of energy, and their availability on the market should draw more attention to this group of feeds. The advantages of fats are numerous: they are carriers of the most condensed metabolizable energy (1g=38.9KJ) and condition the assimilation of fat-soluble vitamins. Moreover, fat plays a protective role in relation to protein. Some authors claim that animals fed on diets with an increased fat content show higher body weight gains (*Barabasz 1984; Slawoń 1987*). Increasing the energy value of feeds for carnivorous fur-bearing animals by adding more fat to them seems fully advisable. However, the question of the kind and form of fat to be used, as well as its amount in rations, still requires further investigation. Foxes and mink efficiently utilize all

kinds of fats. Rouvinen et al. (1989) state that the assimilation of fat depends on the sources of its origin. According to them, the digestibility of fish oil is 96%, vegetable oil 95% and beef tallow 88%. The latest results of research on increasing the energy value of rations for fur-bearing animals in the growing period suggest that when 30% of ME comes from protein, as much as 60% of this energy may come from fat (*Ahlstrom 1995*). In traditional feeding of carnivorous fur-bearing animals, animal fats are used most often. They are added in an unprocessed form. The fats in question are usually kept in cold stores, where - despite low temperatures - they undergo the process of oxidation. It is a well-known fact that feeding animals on poor quality fats has a negative effect on their health state and reproduction indices. Vegetable oils have not been widely used in feeding of fur-bearing animals so far, although they are efficiently utilized and easy to apply. The sources of those fats are different oil plants, such as: soybean, sunflower, linseed, rape and pumpkin seeds. Fats are important components of diets as they contain exogenous fatty acids: linoleic and linolenic. Vegetable oils also contain phosphatides and tocopherols. Their presence contributes to better emulsification and splitting of fats in the alimentary tract, which conditions their higher digestibility. However, vegetable fats - compared with other kinds of fats - undergo the processes of oxidation which precede certain organoleptic changes that cause quality deterioration more quickly. These processes may be partly prevented by storing fats at low temperatures or by adding antioxidants. Some vegetable oils contain tocopherols (vitamin E) - natural antioxidants which partly inhibit the oxidation processes. Research conducted by Pierieldik et al. (1975) suggests that certain vegetable fats have an unfavourable influence on mink reproduction. However, it seems probable that the negative effect observed resulted from using poor quality fats. Those authors also noted lower fur quality (hair lost its gloss and became mat) in animals fed on diets containing vegetable fats. It was probably caused by a destructive effect of the fat decomposition products. Fur-bearing animals raised on farms receive diets containing soybean oil or linseed in order to make their furs more silky (*Jarosz 1993*). By-products of the fat industry, which are used in fur-bearing animal feeding are cakes and oil meals. When fat is

obtained by means of extraction, we receive oil meals; when it is extruded - cakes. The fat content of cakes is usually equal to 5 - 12%. It is much lower in the case of oil meals, i.e. 3 - 3.5%. Oil meals contain considerable amounts of protein (from 30% to 50%). The nutrient digestibility in the feeds discussed depends on the crude fibre content. Protein digestibility is usually 60%, fat digestibility 65% and carbohydrate digestibility 45%. Cakes are also a source of niacin, pantothenic acid, choline and other compounds important for the functioning of an organism. The cakes and oil meals of such plants as sunflower, soybean, linseed and peanuts are widely used in feeding of fur-bearing animals. Cottonseed, maize, hemp, rapeseed and pumpkin cakes and oil meals are less popular and their usability still requires further investigation. Research conducted by Pierieldik et al. (1975) indicates that replacing 20% of animal feeds with cakes in diets for foxes and mink had no negative influence on such performance indices as fertility, growth and development of young animals, and fur quality.

The aim of the paper was to determine the effect of rapeseed oil and pumpkin cake on the performance indices of growing mink, and to discuss the morphological changes in internal organs which may be caused by feeding animals on diets containing additions of those feed ingredients.

### Material and Methods

120 young standard mink, in the period from weaning to slaughtering, constituted the experimental material. The animals, selected at random, were divided into three groups. Each group included 40 animals, 20 males and 20 females, coming from different litters and born at a similar time. They were put into typical mink cages with 1 male and 1 female in each. The experimental factor was differentiated feeding. The animals of group I (control) received a standard ration with no additions, made of the following components: cod meal - 30 - 40%, mackerel and herring meal - 9 - 20%, poultry by-product meal - 13 - 20%, blood meal - 2%, meat-and-bone meal - 2 - 4%, animal fat - 4 - 5%, ground barley and ground wheat - 15 - 16%, wheat bran - 4%, steamed potatoes - 12%, plus Ewomix fur, Taiga fur and Polfasol B-compositum, as recommended by the producer. The

percentage of individual components was different depending on the breeding stage. The animals of group II received diets containing 10% pumpkin cake in the first period, and 5% in the next one. The chemical composition of the cake was as follows (%):

dry matter - 93.01  
 crude ash - 7.61  
 organic matter - 85.40  
 crude protein - 55.75  
 crude fat - 11.59  
 crude fibre - 2.95  
 N-free extract - 15.11

The gross energy of the product was 19.36 MJ/kg.

Group III received a 5% addition of rapeseed oil in the first period, and 2.5% in the next one. Oil made of improved rape varieties was used in the experiment.

The experiment was divided into two periods, during which the nutritive value of the rations was adjusted to the needs of growing animals. (Tab.1). The animals were fed and watered ad libitum. An analysis of their body weight and pelt quality was made. The body weight was determined by weighing individual animals (exact to 0.1 kg) every 14 days, at the same time, before feeding. The data concerning body weight gains were subjected to an analysis of variance for one-element orthogonal designs (*Ruszczyc 1981*). The animals were slaughtered when their fur was fully developed.

Their pelts were evaluated and classified according to the requirements of the Polish Standard (1984).

The results obtained were then compared in the form of mean values (Tab. 4). Directly after slaughter, the carcasses of 5 males and 5 females, selected at random from each of the groups, were subjected to postmortem examinations. Specimens of the following organs were taken for histopathological examinations: oesophagus, stomach, duodenum, jejunum, large intestine, liver, pancreas, heart, trachea, lungs, kidneys, urinary bladder, and - in the case of females - uterus, spleen and thyroid. The specimens were fixed in 10% formalin (pH 7.4) and paraffin embedded. The microtome sections obtained were hematoxylin and eosin (HE) and PAS McManus stained. The results are presented in Tables 5 and 6.

## Results and Discussion

The effect of pumpkin cake and rapeseed oil on the nutritive value of the rations is presented in Table 1. It was found that an addition of pumpkin cake increased the protein content of the diets for the animals in group II. As stated in the methodology, the cake in question contains considerable amounts of crude protein (55.75%). Therefore, the diets of group II contained the highest amount of digestible protein per MJ of metabolizable energy. An addition of rapeseed oil increased the fat content of diets in group III. The experimental rations were characterized by a higher energy value, compared to the control.

**Table 1** Nutritional value of diets

Periods (months)	Group	Digestible components per 1000 g of feed			ME in MJ/1000g of feed	Percent of energy from:			Digestible protein g/MJ ME
		protein	fat	carbohydrates		protein	fat	carbohydrates	
1 VII-VIII	I	130	74	75	6,613	37	43	20	19
	II	161	77	78	7,364	41	41	18	22
	III	130	115	75	8,207	30	54	16	16
2 IX-XI	I	116	70	94	6,520	33	42	25	18
	II	133	72	95	6,935	36	40	24	19
	III	116	91	94	7,337	29	48	23	16

**Table 2** Mink live weights (g)

Age (weeks)	Statistical measures	Group		
		I	II	III
8	n	40	40	40
	x	637	634	642
	v	12,13	15,39	13,84
10	x	777 $B,b$	842 $B,a$	916 $A$
	v	12,10	10,41	1052
12	x	1020 $aB$	993 $B,b$	1090 $A$
	v	8,78	9,40	10,37
14	x	1170 $B$	1150 $B$	1277 $A$
	v	9,06	9,65	9,37
16	x	1227 $B$	1215 $B$	1351 $A$
	v	8,18	8,37	10,62
18	x	1308 $B$	1288 $B$	1430 $A$
	v	12,78	9,25	10,05
20	x	1421 $B$	1440 $b$	1542 $A$
	v	9,98	9,34	10,73
22	x	1610	1550 $b$	1687 $a$
	v	11,86	8,58	10,08
24	x	1715 $b$	1687 $B$	1840 $A,a$
	v	8,73	10,02	9,97

a, b -  $\alpha = 0,05$ A, B -  $\alpha = 0,01$ 

Table 2 includes the body weights of growing mink. Their initial body weights did not show any statistical differences, which indicates proper selection of animals for the experiment. However, a statistically significant difference between group III and the other two groups was observed from the second weighing to the end of the experiment. The animals of group III were heavier by 125g compared with the control group (statistically significant difference) and by 153g compared with group II (highly statistically significant difference). An increase in the body weight observed in group III confirms a positive role of fat in feeding of carnivorous fur-bearing animals, discussed also by other authors (Barabasz 1984; Slawon 1987). An addition of pumpkin cake did not have any considerable influence on differences in the body weight between group II and the control group. It increased the protein content of rations in group II. However, the protein was not utilized efficiently. Therefore, due to lack of statistical differences, it may be concluded that pumpkin cake had no effect

on mink body weight gains, as the gains achieved are similar to those quoted by Jarosz (1993) and may be considered typical for this species. The results of pelt evaluation are presented in Table 3. They confirm the results achieved during body weight measurements. The longest pelts were obtained in the case of males and females of group III. It indicates a correlation between the body weight of an animal and its pelt length. Fur category also turned out to be the best in group III, compared with the two other ones, which shows that an addition of vegetable fat caused an improvement in fur quality parameters. Lorek and Gugolek (1993) in their studies on polar foxes and Gugolek et al. (1994) in those on minks obtained better fur thickness in animals fed on diets containing fat concentrates. Lorek (1987) in his paper claims that the results of pelt evaluation were much better in the case of ferrets fed on diets containing vegetable oil than in that of the ones which received diets containing less energy from fat.

**Table 3** Pelt evaluation (head)

Specification	Group		
	I	II	III
n	40	40	40
1. Size (cm)			
77 < (0)	2	3	7
71-77 (1)	13	13	11
65-71 (2)	5	8	7
59-65 (3)	11	10	10
53-59 (4)	9	6	5
x (cm)	63,20	64,55	65,75
2. Fur category			
1	23	27	28
2	8	9	9
3	9	4	3
x	1,65	1,42	1,37

**Table 4** Morphological changes in mink's alimentary tract

Organ	Group/number of changes					
	I		II		III	
	mucositis	no morphological changes	mucositis	no morphological changes	mucositis	no morphological changes
Stomach	3	7	8	2	9	1
Duodenum	6	4	5	5	6	4
Jejunum	3	7	1	9	5	5
Large intestine	5	5	7	3	6	4

Tables 4 and 5 present the data concerning morphological changes in the alimentary tract and some parenchymatous organs. The changes in the alimentary tract manifested themselves by inflammation of gastric mucosa (Fig. 1) and intestinal mucosa (small intestines - Fig. 2, 3; large intestines - Fig. 4). In the stomach, except for congestion, the following changes were noted: excessive exfoliation of epithelial cells of the gastric glands, infiltration of lymphoid cells and accumulation of large amounts of PAS positive

mucus. In the intestines the inflammatory process was observed in the duodenum and, to some extent, the jejunum and large intestine. The duodenal villi were infiltrated by numerous lymphoid cells and deformed. Their top parts underwent necrosis. Epithelial cells exfoliated excessively and cumulated on the mucosa surface. Mucositis was noted in the alimentary tract of all the animals examined, but the inflammatory process developed to the greatest extent in group III.

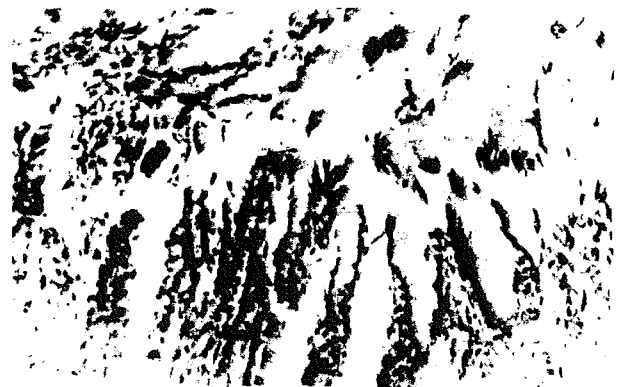
**Table 5** Morphological changes observed in internal organs studied

Organs	Type of morphological change	Group		
		I	II	III
Lungs	haemostatic congestion	3	3	2
	alveolar atelectasis	4	3	2
	pneumonia	0	1	2
Heart	congestion of capillary vessels	1	8	1
	parenchymatous degeneration with myolysis segments	0	4	1
Liver	parenchymatous and vacuolar degeneration of liver cells	4	8	6
	adipose degeneration of liver cells	0	1	2
	haemostasis in hepatic lobules	3	5	6
	proliferation of star cells	0	2	2
Kidneys	haemostasis in cortical and medullar layers	6	9	3
	parenchymatous and vacuolar degeneration of tubular epithelium	6	10	7
	necrosis of tubular epithelium cells	2	4	2
	interstitial inflammation	1	2	2

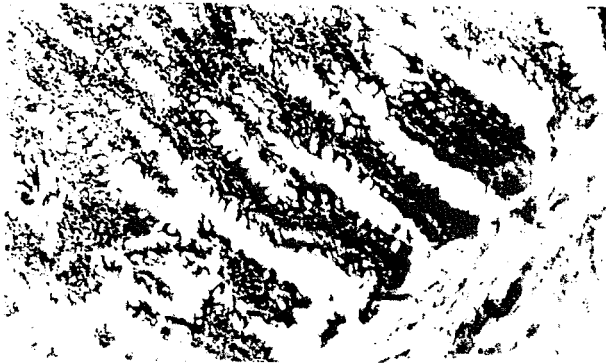
Parenchymatous and vacuolar degeneration was found in parenchymatous organs, including the heart muscle (Fig. 5), liver (Fig. 6, 7) and kidneys (Fig. 8), and adipose degeneration - in the liver cells. The changes were accompanied by congestion, which in the liver and kidneys had the features of haemostasis. The changes were visible in the case of groups II and III.

Atelectasis, haemostasis and oedema foci were observed in the lungs of all the animals, which suggests that they experienced a shock in the course of slaughtering. In the uterus of most females of group III and some of group II, necrosis of alveolar cells, infiltration of lymphoid cells and congestion were noted. In the spleen of all the animals studied, haemostasis was found in the splenic sinuses, as well as numerous haemosiderin granules and atrophy of lymphatic follicles in the white splenic

pulp. The structure of all the other organs subjected to histological examinations showed no changes.



**Fig. 1.** Surface of the gastric mucosa in a mink of group II (female). Considerable amounts of mucus and exfoliated gland cells. HE staining, magnification 240 x.



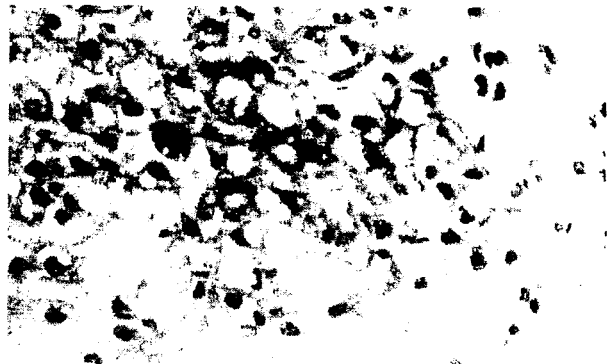
**Fig. 2.** Acute catarrhal inflammation of the duodenal mucosa in a mink of group III (female). Infiltration of lymphoid cells, deformed villi and oedema of the duodenal submucosa. HE staining, magnification 120 x.



**Fig. 5.** Microscopic image of the left ventricle muscle in a mink of group II (male); visible are: congestion, parenchymatous degeneration and increase in focal acidophilia (darker staining). HE staining, magnification 240 x.



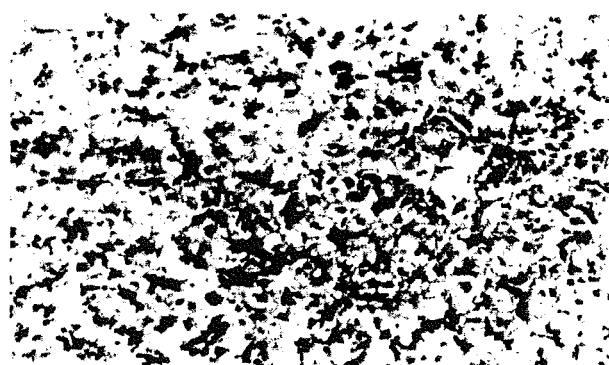
**Fig. 3.** Catarrhal inflammation of the jejunum mucosa in a mink of group I (male). HE staining, magnification 240 x.



**Fig. 6.** Adipose and vacuolar degeneration of the liver cells in a mink of group III (female). HE staining, magnification 720 x.



**Fig. 4.** Catarrhal inflammation of the large intestine mucosa in a mink of group II (male). HE staining, magnification 240 x.



**Fig. 7.** Haemostasis in the liver and vacuolar degeneration of the liver cells in a mink of group III (male). HE staining, magnification 240 x.

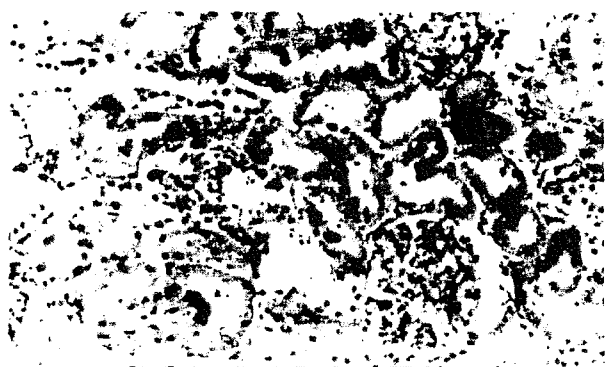


Fig. 8. Focal kidney damage in a mink of group I (female). Necrosis of tubular epithelium, its vacuolar and parenchymatous degeneration and slight congestion of renal glomerules. HE staining, magnification 240 x.

### Conclusion

A higher intensity of changes in the alimentary tract and internal organs was observed in the animals of the experimental groups, especially group III. However, it seems that the changes did not disturb the functioning of their organisms (at least in the relatively short period of growth), which finds confirmation in higher body weight gains and better pelt quality in groups II and III. The changes in question are probably connected with feeding animals on rations characterized by quite high nutrient concentration and energy value. The research results enable us to state that adding vegetable fats in the form of oil to rations for mink in the growing period gives the best effects.

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*Original Report***Digestibility of fats from feed rations for mink with different proportions of cod fillet by-products**

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**Summary**

We studied the digestibility of fats in feed for mink with various proportions of cod fillet by-products, and digestibility of fats in the tested ingredient (cod fillet by-products). The animals were fed the basic feed during the first stage, the content of the tested ingredient in the feed ration represented 41.7% during the second stage, and 62.5% of the feed in the third stage.

The direct method was used to calculate the digestibility of nitrogen in the studied feed rations with various proportions of cod fillet by-products, and the indirect (differential) method was used to calculate the digestibility of the cod fillet by-products (*Lichvár et al., 1969*).

The results were mathematically and statistically processed. The coefficient of digestibility for fats was  $81.91 \pm 0.67\%$  in the basic feed ration,  $83.14 \pm 0.29\%$  in the feed with 41.7% cod fillet by-products, and  $92.68 \pm 0.16\%$  ( $P \leq 0.01$ ) in the feed with 62.5% cod fillet by-products.

The coefficient of fat digestibility of the cod fillet by-products at 41.7% in the feed was  $84.86 \pm 1.02$ , and in the feed ration with 62.5% it was  $99.14 \pm 0.63\%$  ( $P \leq 0.01$ ).

The results of this experiment demonstrate that the coefficient of fat digestibility in feed for mink increases dependent on the proportion in the feed. The fat digestibility of the cod fillet rose significantly dependent on the proportion of fat in the feed rations as well.

**Introduction**

Some authors have studied the digestibility of feed for mink based first of all on fish and fish by-products, and in the nutrient requirements, mainly crude protein. Jørgensen and Glem-Hansen (1973) designed special cages for balance experiments with mink. Glem-Hansen (1979) studied suitability and digestibility of basic and supplementary feeds in feed for mink used in Scandinavia. Jørgensen and Glem-Hansen (1973), Jørgensen and Eggum (1971), Skrede (1978) studied protein requirements, their digestibility and biological value for growing mink, Glem-Hansen (1979, 1980), Mertin et al. (1996) studied lactating and growing mink.

**Material and methods**

The experiment was performed on the Experimental Farm of Furbearing Animals affiliated with the Research Institute of Animal Production in Nitra. The animals were housed in special balance cages. 5 unrelated males of standard mink at the age of 4

months were used in the experiment. The animals were clinically healthy and examined for plasmacytosis.

The experiment was divided into three stages. Fat digestibility in feed with various proportions of cod fillet by-products was studied. The fat digestibility

in the tested ingredient – cod fillet by-products – was determined as well. The animals were fed the basic feed during the first stage. The proportion of cod fillet by-products in the feed ration was 41.7% in the second stage and 62.5% in the third stage. The feed composition is given in Table 1.

**Table 1.** Feed for mink – cod fillet by-products (g/ 418 kJ ME)

Feed	Basic feed	Cod fillet 41.7% *	Cod fillet 62.5% *
Cod fillet	16.0	25.0	40.0
Feed mixture Mäsonmix	20.00	16.0	10.0
Beef	14.0	10.0	2.5
Animal fat	1.2	1.2	2.8
NOR II	6.0	6.0	6.0
Dried milk	0.8	0.8	0.8
Plastín MD (g/animal/day)	5.0	5.0	5.0
Roboran H (g/animal/day)	0.4	0.4	0.4
Vitamin C (mg/animal/day)	40.0	40.0	40.0
B- complex (g/animal/day)	0.25	0.25	0.25
TOTAL (g/animal/day)	180.0	183.0	205.0
ME kJ/animal/day	1254.0	1254.0	1337.6
Digestible nitrogen (g/418 kJ ME)	9.07	9.06	9.03
Digestible fats (g/418 kJ ME)	4.56	4.61	4.66
Digestible carbohydrate (g/418 kJ ME)	3.95	3.95	3.95
Dry matter (%)	32.74	34.79	36.98

\* Percentual proportion of cod was calculated based on basic feed

NOR II – Commercial coarse meals for carnivorous fur animals

Roboran H – Commercial vitamin and mineral premix

Plastín MD – Commercial mineral premix

Feed mixture Mäsonmix – Commercial (40% beef with bone, 20% bovine entrails, 40% poultry by-products)

The animals were housed in the balance cages one month before the experiment started. Each experimental stage was divided into two periods – the preparation period and the experimental period. The preparation period lasted seven days and the animals adapted themselves to the new feed ration during this period. The experiment lasted five days. The animals were fed two times daily at 9 and 15 hours. The nutritional value of the feed corresponded with the requirements for the given

age category and the physiological stage of the animals (*Mertin et al., 1994*).

During the experiment the parameters necessary for the calculation of digestibility coefficients of feed rations and the ingredient were studied: feed intake, leftover feed and amount of excrements. The given parameters were observed and samples were taken two times daily, one hour before feeding at 8 and 14 hours.

The direct method was used to calculate fat digestibility in the feed with various proportions of cod fillet by-products, and the indirect method (differential one) was used to calculate the digestibility in the cod fillet by-products (Lichvár *et al.*, 1969). The results were processed mathematically and statistically.

**Results and discussion**

Basic variation and statistical characteristics of fat digestibility in the studied feed are given in Table 2, and the results of 2-way variance analysis with chosen comparisons of feed digestibility are in Table 3.

**Table 2.** Basic variation and statistic characteristics of fat digestibility in studied feed rations of mink (%)

A <sub>1</sub> n = 20			A <sub>2</sub> n = 25			A <sub>3</sub> n = 25		
x	s <sub>x</sub>	v%	x	s <sub>x</sub>	v%	x	s <sub>x</sub>	v%
81.91	0.67	4.12	83.14	0.29	1.77	92.68	0.16	0.86

A<sub>1</sub> basic feed rations, A<sub>2</sub> 41.7%, A<sub>3</sub> 62.5% cod fillet by-products

**Table 3.** Two-way variance analysis with chosen comparisons of feed digestibility

	Groups		Days/groups		Animals	Interac-tions	Error of experi-ment BP : A	Significant comparisons of groups	F ( 1 2 )	
	A		P		B	AB			A	
	14	2	12	60	4	8	48			
M	868,1856		3,3829		25,6940	8,1712	2,7373			
S										
F	256,638**				9,387**	2,9851*		1⊕2*,3**), 2:3**	AB	2,138 2,907

The coefficient of fat digestibility (Table 2) was in the basic feed ration 81.91±0.67%, and in the feed rations with increased proportions of cod fillet by-products 83.14±0.29% or 92.68±0.16%. Differences of arithmetic means between the groups are statistically significant (P<0.01).

**Table 4.** Digestibility of fats in cod fillet by-products

A <sub>1</sub> 41.7%		A <sub>2</sub> 62.5%		Significant comparisons of groups
x	s <sub>x</sub>	x	s <sub>x</sub>	
84.86	1.02	99.14	0.63	2:3**

On the basis of our results we can state that the coefficient of fat digestibility in the studied feed increases dependent on the percentual proportion of cod fillet by-products in the feed (81.91 – 92.68%). The fat digestibility in the cod fillet by-products also differed dependent on the proportion of cod fillet by-products in the feed (Table 4). The proportion being 41.7% - 84.86±1.02%, and with the proportion 62.5% - 99.14±0.63 (P<0.01). The results show the increase of fat digestibility in the tested feed as well as in the cod fillet waste in dependence on its proportion in the feed.

Cod fillet is a highly valuable feed from the viewpoint of fur animal nutrition, and it is suitable to include in the feed with higher proportions of cheap, less valuable feeds. We recommend including cod fillet by-products in the feed for mink during the whole year because it has a high content of crude protein (16.62%) and a low fat content (0.60%).

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### **Effect of feeding level during autumn and winter on breeding weight and reproduction result in single and pair-housed mink**

*Hannu Korhonen, Paavo Niemelä*

The effect of feeding intensity (standard vs. restricted ration) and housing system (males and females kept singly vs. animals kept in male-female pairs) on breeding body condition and whelping was studied in farm standard mink (*Mustela vison*). Dietary interventions lasted from 20 September to 31 January. The maximum body weights of mink fed the standard ration were higher than those fed the restricted ration and the weights of animals housed in pairs were higher than those of animals housed singly. Daily feed intake was only slightly lower for singly-housed mink. Singly-housed females came on heat slightly later than females housed with a male. No statistically significant differences were found in whelping success due to feeding intensity or housing system. Whelping results tended, however, to be best for the females on restricted feeding and housed with a male (4.1 kits/mated female), and poorest for the females fed the standard ration but housed singly (3.4 kits/mated male). The conventional housing set-up, in which males and females are housed in pairs, is therefore recommended, but feeding from autumn onwards should be restricted.

*Agricultural and Food Science in Finland, Vol. 6, pp. 305-313, 1997. 3 tables, 3 figs., 25 refs. Authors' summary.*

### **Hematologic response of adult brown mink to oxidative stress**

*Douglas J. Weiss, Victor Perman, William Wustenberg, Thomas J. Bucci*

We evaluated the response of mink to oral administration of the oxidant compound propylene glycol (PG) to better understand the relative susceptibility of mink red blood cells (RBC) to oxidant injury. Feeding a diet containing 12% PG to 6 mink for 1 w resulted in a 17% decrease in hematocrit, a 21% decrease in RBC count and a 4.8-fold increase in reticulocyte count. A marked increase in Heinz body and eccentrocyte numbers was consistent with oxidative injury to RBC. Because of high food intake, mink ingested

approximately twice the quantity of PG/kg body weight compared to domestic cats fed diets containing 12% PG. Therefore, the severity of the hematologic dyscrasia in mink may be the result of greater intake of PG rather than unique sensitivity of mink RBC of oxidative injury. However, the high food intake and the mink's position at the top of the food chain may increase its exposure to environmental contaminants.

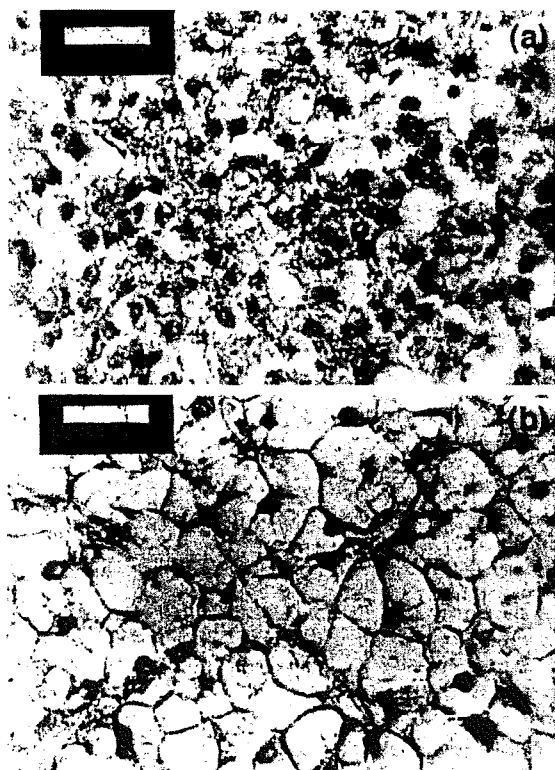
*Vet Human Toxicol 36 (2), pp. 109-111, 1994. 1 table, 12 refs. Authors' summary.*

### **The impact of raw material freshness and processing temperature for fish meal on growth, feed efficiency and chemical composition of Atlantic halibut (*Hippoglossus hippoglossus*)**

*Anders Aksnes, Harald Mundheim*

Quality of fish meal is determined both by freshness of the raw material used and by nutrient digestibility due to different processing conditions of the fish meal. Pilot plant, experimentally produced fish meals were used to investigate separately these quality factors in long term growth experiments with Atlantic halibut. The results were compared with those obtained using commercial fish meals. The effects of fish meal quality on growth, feed efficiency and chemical composition of the fish were studied. The first experiment studied the biological effect of using two fish meals made from fresh raw material, in four diets varying in protein digestibility, as measured by a standardised assay using mink ( $DC_{\text{mink}}$ ) as the test animal. The second experiment studied the biological effect of using two fish meals produced under the same processing conditions, but varying in raw material freshness in four experimental diets. The level of biogenic amines in the fish meals and diets were used to assess the raw material freshness. The third experiment was performed similarly by using six commercial fish meals varying in both  $DC_{\text{mink}}$  and cadaverine (CAD). Experiments 1, 2 and 3 started with 17 g, 214 g and 7 g halibut, respectively, and lasted for 208, 152 and 481 days until the fish were about 120 g, 500 g and 400 g. The halibuts were hand fed to obtain close to satiation feeding. Generally the fish showed good growth, high feed efficiency (FE) and good survival during the experimental periods. The first experiment showed a significant linear correlation between  $DC_{\text{mink}}$  and

specific growth rate (% per day) (SGR) and FE. Similarly, experiment 2 revealed a significant negative relation with the fourth exponential of cadaverine ( $CAD^4$ ) in the diets ( $g\ kg^{-1}$ ) both for SGR and for FE. The experiment with the commercial fish meals also showed dependencies both on  $DC_{mink}$  and dietary level of CAD. The impact of the dietary level of CAD on growth and FE was very much less in the commercial fish meals than in the experimentally produced fish meals, while dependency on  $DC_{mink}$  was somewhat lower. Both raw material freshness, as evaluated by the level of biogenic amines and processing conditions as measured by  $DC_{mink}$ , are useful and important for the assessment of fish meal quality for halibut. Reduced fish meal quality due to digestibility was compensated for by increased feed intake. This was not the case when fish meal quality was reduced due to raw material spoilage.



**Fig. 1.** Microscope picture (1000x magnification) of hepatocytes, 5  $\mu m$  section stained with HES. (A) Liver from fish given Diet 5 (fresh, raw material). (B) Liver from fish given Diet 8 (spoiled raw material).

*Aquaculture* 149, pp. 87-106, 1997. 7 tables, 1 fig., 25 refs. Authors' abstract.

### The ferret as a model for evaluation of the bioavailabilities of all-*trans*- $\beta$ -carotene and its isomers

Wendy S. White, Katrina M. Peck, Edward A Ulman, John W. Erdman

The objective was to develop the ferret as a model for evaluation of the bioavailabilities of natural and synthetic  $\beta$ -carotenes in foods. For these studies, a low carotenoid purified diet was formulated that produced excellent food intake and adequate growth. After consuming the diet for 16 d, ferrets were randomly assigned to one of three groups. For a 10-d period, they ingested a standardized amount of all-*trans*- $\beta$ -carotene (18  $\mu mol/L$ ) from either carrot juice, a test beverage of  $\beta$ -carotene beadlets dispersed in fruit juices, or a control beverage of  $\beta$ -carotene beadlets dispersed in water. Accumulations of all-*trans*- $\beta$ -carotene in the sera, livers and adrenals of ferrets that consumed the carrot juice were significantly lower ( $P < 0.02$ ) compared with those of ferrets that consumed the test or control beverages. The content of a *cis*-isomer component relative to that of all-*trans*- $\beta$ -carotene was higher in each  $\beta$ -carotene beadlet-fortified beverage than in the liver and adrenal tissues of ferrets that ingested the beverage; the *cis*-isomer was not measurable in sera. The content of all-*trans*- $\beta$ -carotene relative to that of all-*trans*- $\alpha$ -carotene, a structural isomer, was higher in carrot juice than in sera of ferrets that ingested the juice. We conclude that 1) all-*trans*- $\beta$ -carotene is less bioavailable from carrot juice than from  $\beta$ -carotene beadlet-fortified beverages, and 2) there are apparent bioavailability differences between isomers of  $\beta$ -carotene in ferrets.

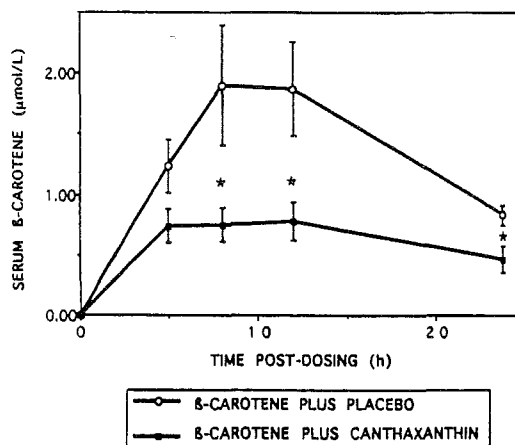
*J. Nutr.* 123, pp. 1129-1139, 1993. 5 tables, 3 figs., 60 refs. Authors' summary.

### Interactions of oral $\beta$ -carotene and canthaxanthin in ferrets

Wendy S. White, Katrina M. Peck, Tiffany L. Bierer, Eric T. Gugger and John W. Wedman, Jr.

Interactive effects of an oral dose of equal quantities of  $\beta$ -carotene and either canthaxanthin or lycopene on serum and tissue  $\beta$ -carotene accumulations were investigated in domestic ferrets. Like humans, ferrets absorb a substantial portion of ingested  $\beta$ -

carotene intact and accumulate it in tissues. After the ferrets ingested a low carotenoid purified diet for 13 d, they were randomly assigned to one of two groups of six animals. One group was dosed with  $\beta$ -carotene (10 mg/kg body weight) and the other with  $\beta$ -carotene and either canthaxanthin (Experiment 1) or lycopene (Experiment 2) (10 mg/kg body weight for each). In Experiment 1, ferrets that received a combined dose of  $\beta$ -carotene and canthaxanthin had serum  $\beta$ -carotene concentrations that were significantly lower at 8, 12 and 24 h post-dosing ( $P < 0.05$ ), compared with those that received an individual dose of  $\beta$ -carotene; liver, adrenal and kidney  $\beta$ -carotene concentrations were also significantly reduced. In Experiment 2, ferrets that received a combined dose of lycopene and  $\beta$ -carotene had lower serum and tissue  $\beta$ -carotene concentrations than in those that received  $\beta$ -carotene alone; the differences were not statistically significant with the exception of serum  $\beta$ -carotene concentrations at 24 h post-dosing. The results suggest that, at the doses given, a concurrent oral canthaxanthin dose has a specific antagonistic effect on the bioavailability of a  $\beta$ -carotene dose in ferrets.



**FIGURE 2** Serum  $\beta$ -carotene concentration-time curves of ferrets given either an individual oral dose of  $\beta$ -carotene (10 mg/kg body wt) or a combined dose of  $\beta$ -carotene and canthaxanthin (10 mg/kg body wt of each) (Experiment 1). Values are group means  $\pm$  SEM,  $n = 6$ . Differences between groups at each time point were analyzed by multivariate repeated-measures ANOVA, \* $P < 0.05$ .

*J. Nutr.* 123, pp. 1405-1413, 1993. 2 tables, 5 figs., 51 refs. Authors' abstract.

### Effect of feed chalk addition to diet containing preserved blood on some performance traits of polar foxes (*Alopex lagopus*)

M.O. Lorek, A. Gugolek

The study was carried out on 96 young foxes from the post-weaning period to slaughter. The animals were divided into 3 groups, 32 each, with the same share of both sexes. Group I was fed a diet without blood. In the diets for groups II and III 40% of the meat feed was supplied by protein from preserved blood. To the diet for group III, feed chalk was added at 3% of the total diet value.

The increase of pH in the feed caused by the addition of feed chalk did not influence significantly the studied parameters.

*Acta Academiae Agriculturae ac Technicae Olstenensis. Zootechnica (Poland), No. 37, pp. 161-168, 1992. In POLH, Su. ENGL. 4 tables, 7 refs. Authors' summary.*

### Effect of fox-fat supplement to mixtures for growing chicks on layers' productivity

Aniela Zglobica, Stanislaw Wezyk

Studies were carried out on a total of 2100 Astra S chicks divided into 5 experimental groups. During growth (0-20 wks) feeding was diversified as follows: control chicks (group 1) were fed DKM-1 mixture (0-8 wks) and DKM-2 (9-20 wks). Chicks of groups 2-5 were fed diets formulated from local feeds supplemented at various time with 2% fox-fat. During the laying period, viz., from 21-64 weeks of growth 1200 hens and 140 cocks were fed the same mixture of DJ-1 type. Every day the number and weight of laid eggs, feed conversion at weekly intervals and health conditions were noted. At 34 and 62 weeks of growth an egg quality estimation was made.

The results showed a non-significant increase in the body weight of chicks fed mixture supplemented with fox-fat in an amount from 1601.3 to 1688.2 g at 20 weeks of growth, and a decrease in feed intake from 9.342 to 9.080 kg compared to the control.

Also a significantly higher utilization of fat-fortified mixtures (from 5.52 to 5.71kg) was found compared to mixtures without fox-fat (6 kg).

Experimental hens displayed a 4.5% higher egg production per layer at the initial stage (hen/house) and by 3.6% per layer per day (hen/day), and a lower feed utilization per day by 0.7-1.4% and a lower conversion per egg by 1.1-2.0%. In the groups of experimental hens a decrease was found in egg weight as well as deterioration of egg-shell strength and thickness.

*Roczniki Naukowe Zootechniki 18, 1-2, pp. 207-218, 1991. In POLH, Su. ENGL, GERM, RUSS. 6 tables, 15 refs. Authors' summary.*

**Effect of fat concentrate supplemented diet on body conformation and fur quality in polar foxes**

*M.O. Lorek, A. Gugolek*

Studies were carried out on 60 young polar foxes from weaning to slaughter. The animals were divided randomly into two groups of equal numbers of females and males. One group was fed a standard diet, the other received feed in which 50% of the cereals were substituted with 30% fat concentrate.

The experimental animals improved their external conformation and fur quality compared to the control group.

*Acta Academiae Agriculturae ac Technicae Olstenensis. Zootechnica (Poland), No. 38, pp. 247-253, 1993. In POLH, Su. ENGL, RUSS. 3 tables, 11 refs. Authors' summary.*

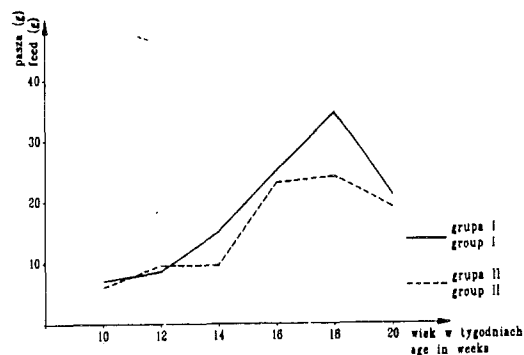
**Effect of diet supplemented with fat concentrate on weight gain and feed conversion efficiency in foxes**

*M.O. Lorek, G. Gugolek*

The objective of the studies was to determine rate of growth of young Polar foxes on the basis of body weight gains and feed use. 50% of cereal components in the feeds were substituted with 30% fat concentrate.

The experimental material consisted of 60 Polar foxes aged 8-20 weeks, randomly divided into two groups of equal number of males and females. The animals were fed ad libitum. Group I, control, received standard feeds, and in group II 50% of cereal components were substituted with fat concentrate.

It was found that fat concentrate improved weight gains while feed use was lower than in the control group.



**Fig. 1.** Consumption of feed per 1 g body gain.

*Acta Academiae Agriculturae ac Technicae Olstenensis. Zootechnica (Poland), No. 38, pp. 239-246, 1993. In POLH, Su. ENGL, RUSS. 3 tables, 1 fig., 7 refs. Authors' summary.*



*Original Report***An epizootic of pseudorabies in ranch mink***J.R. Gorham, G.R. Hartsough\*, D. Burger**Agricultural Research Service, U.S. Department of Agriculture, and the Department of Veterinary Microbiology and Pathology, Washington State University, Pullman, WA, USA 99164-7040.**\*Deceased***Summary**

An epizootic of pseudorabies in ranch raised mink occurred following feeding of raw pork lungs. Five hundred twenty mink died (2% of the herd) during a 6-7 day period. The pseudorabies virus isolation was confirmed by inactivation with chloroform, pathogenicity for rabbits, and neutralization with specific anti-pseudorabies serum, and intranuclear inclusions in cell cultures.

Epizootics of pseudorabies (PR) in mink have been reported in most mink-raising areas of the world (1,2,3). More recently, there have been reports from the Netherlands (4), Korea (5), Sweden (6), Japan (7) and in North America (present report).

Pseudorabies was diagnosed on an Ohio mink farm that had a total mink population of 1100 breeder males, 5500 breeder females, and 24,000 kittens. A total of 525 mink (approximately 2%) died over a 6-7 day period. The attack rate for males, females and kittens was similar. The case/fatality rate approached 100%.

The approximate losses recorded by the mink farmer were as follows: 58 dead (Oct. 11), 100 dead (Oct. 12), 100 dead (Oct. 13), 100 dead (Oct. 14), 100 dead (Oct. 15), 50 dead (Oct. 16), and 17 dead (Oct. 17, 18 and 19).

Affected mink were anorexic for one day prior to the onset of clinical signs. Other prodromal signs were excessive salivation and depression or excitement. Muscular tremors and varying degrees of posterior paralysis followed. Death occurred within 12 to 24 hours after the first signs were observed. Most traumatic injuries were probably caused by chewing a posterior foot, leg, or tail and were noted in less than 1% of the dead mink.

The carcasses were in good nutritional condition. The necropsy findings on ten mink that were examined were similar. Small hemorrhages were seen in the lungs, heart, mediastinum, and the serosa of the stomach and intestines. The pleural cavity contained a substantial quantity of blood-tinged fluid, and the lungs were congested and edematous. Because of marked postmortem decomposition, tissues were not processed for histologic examination.

The spleens and proximal spinal cords of three affected mink (nos. 1, 2 and 3) were removed and used to prepare 10% w/v tissue suspensions in minimum essential medium (MEM) containing 500 µg/ml each of streptomycin, gentamycin, and 500 IU of penicillin. Tissue suspensions were inoculated (0.5 ml) onto 25 cm<sup>2</sup> monolayers of the rabbit (LCCRK<sub>1</sub>) kidney cell line. After 2 hours absorption at 37°C the inocula were removed, and

the monolayers washed twice with MEM and then fed with MEM containing 2% fetal calf serum. Cell cultures inoculated with the spleen and spinal cord suspensions from two of the mink (no. 1 and 2) exhibited focal cytopathic effects (CPE) between 48 and 96 hours after inoculation. No CPE was observed in the cell cultures that were inoculated with the tissues from mink 3.

Three New Zealand white rabbits were inoculated intramuscularly with 0.5 ml of pooled spleen and spinal cord suspensions from mink nos. 1, 2, and 3. On the third day post-inoculation (PI), two of the rabbits were found dead and rabbit no. 3 was moribund and died with convulsions during handling. Suspensions prepared from the spleens and brains from the three rabbits were inoculated onto Madin Darby bovine and rabbit kidney cell (LCCRK<sub>1</sub>) cultures. Focal lesions surrounded by multinucleated polymorphic syncytia containing several nuclei were observed at approximately 48 hour PI. Formalin-fixed monolayer cell cultures, stained with hematoxylin and eosin, syncytia containing intranuclear inclusions were found surrounding the lesions.

The virus isolates were rendered non-infectious after treatment with 1/10 volume of chloroform for 30 minutes, and were neutralized by a porcine hyperimmune serum against pseudorabies virus. The neutralization assays were performed by incubating mixtures of serial 2-fold dilution's of hyperimmune serum with 200 TCID<sub>50</sub> of each isolate for 4 hours at 22°C. The 50:1 plaque reduction titers ranged from serum-dilution 1:32 to 1:64, and were in the same range as neutralization titers obtained with a reference BUK strain of pseudorabies virus supplied by Dr. R. Skoda, Czechoslovak Academy of Sciences, Bratislava (8). Spinal cords removed from three mink (nos 1, 2, and 3) and a spleen removed from mink no 3 served as the inocula for cell cultures. These cultures were plaque-purified and used to prepare viral DNA. Four DNA preparations were tested for restriction enzyme fragment length polymorphism (RFLP) by cleaving them with the restriction enzymes Hind III, Bam HI, and Sal I. Electrophoresis in 0.6% agarose gels revealed identical genome structures for the four isolates. Restriction fragment polymorphism is known to occur among pseudorabies virus strains and has been used for

epidemiologic tracing of pseudorabies virus strains. Since we demonstrated that the four isolates obtained from this outbreak had identical fragment profiles, we assumed that a single RFLP-type was responsible for this outbreak.

Because of a favorable price, the involved mink farmer incorporated raw pork lungs (approximately 12%) as part of the ration for his mink. The other ingredients of the ration included ocean fish, poultry byproducts, and cooked eggs. The rancher was advised that the lungs should be cooked at 190°F for 30 minutes before being added to the ration to prevent possible pseudorabies virus contamination. Cooking of the pork lungs for the prescribed time was discontinued after approximately one year because of the inconvenience of the procedure. After feeding uncooked pork lungs for 120 days, the deaths of PR occurred.

Because of the prevalence and persistent nature of the PK virus in hogs, we would anticipate frequent outbreaks of PR to occur in mink on ranches which practice feeding of raw pork offals. But raw pork byproducts are not commonly fed to mink in the United States. Furthermore, mink farmers are also cautioned not to feed pork byproducts to pregnant mink because of the potential danger of abortions caused by *Salmonella* spp.

The feeding of pork byproducts has been the suspected infectious source of most PR worldwide outbreaks with few exceptions. For example, in the Netherlands, seven outbreaks diagnosed as PR in which pork byproducts were ruled out as an infectious source because only poultry offal was fed to the mink. Because of the proximity of these mink farms to large pig breeding establishments, aerosol transmission of PR-virus was suspected (4). Mink are susceptible to PR when the inoculum was given by drops into the nares (9) or by the oral route (10).

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**Plant-derived vaccine protects target animals against a viral disease**

Kristian Dalsgaard, Å. Uttenthal, T.D. Jones, F. Xu, A. Merryweather, W.D.O. Hamilton, J. P.M. Langeveld, R.S. Boshuizen, S. Kamstrup, G. P. Lomonosoff, C. Porta, C. Vela, J. I. Casal, R.H. Meloen, P.B. Rodgers

CVPs as the basis for vaccine development. The epitope used occurs in three different virus species - MEV, canine parvovirus, and feline panleukopenia virus- and thus the same vaccine could be used in three economically important viral hosts - mink, dogs, and cats, respectively.

*Nature Biotechnology, Vol. 15, pp. 248-252, 1997. 1 table, 4 figs., 34 refs. Authors' summary.*

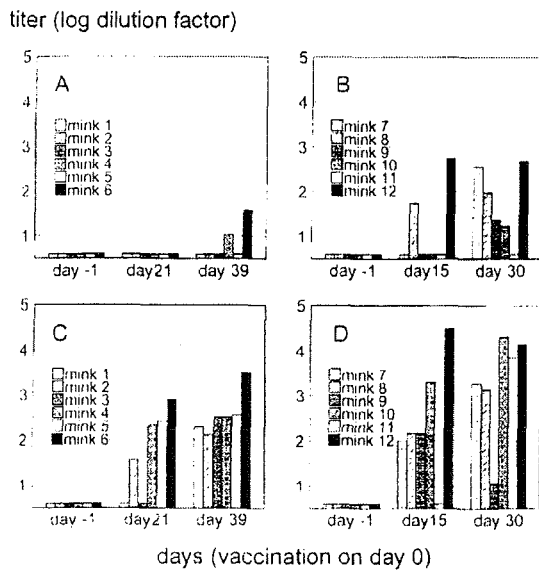


Figure 4. Antibody titers in individual mink after vaccination with low- and high-dose of CVP-Parvo1. (A) and (B), Anti-peptide antibody titers; (C) and (D) Anti-CPMV antibody titers. In (A) and (C), the results from the same six animals in the low-dose experiment are displayed; in (B) and (D) idem for six animals in the high-dose experiment. Vaccination was performed at day 0. Challenge was performed at day 28 and day 23 in the low- and high-dose experiments respectively. All control animals receiving no vaccine or the commercial inactivated vaccine remained negative in these enzyme-linked immunosorbent assays. The lowest serum dilution tested in each animal was 1/10. Titers are presented as log of dilution factor.

**Vaccination of black-footed ferret (*Mustela nigripes*) x siberian polecat (*M. eversmanni*) hybrids and domestic ferrets (*M. putorius furo*) against canine distemper**

E.S. Williams, S.L. Anderson, J.Cavender, C. Lynn, K. List, C. Hearn, M.J.G. Appel

An inactivated canine distemper vaccine with adjuvant and a modified-live virus (MLV) vaccine were evaluated using black-footed ferret (*Mustela nigripes*) x Siberian polecat (*Mustela eversmanni*) hybrids as surrogates for endangered black-footed ferrets. For comparative purposes, we also vaccinated domestic ferrets (*Mustela putorius furo*) with the MLV vaccine. Response to vaccination was measured by clinical observation, hematology, dynamics of serum virus neutralizing antibodies, and challenge with virulent canine distemper virus. No clinical signs attributable to the vaccines were observed. Transient leukopenia occurred in hybrid ferrets that received MLV vaccine and there was marked lymphopenia for approximately 52 days post-vaccination. Lymphopenia was present for approximately 21 days in domestic ferrets vaccinated with MLV vaccine. Neutralizing antibodies against canine distemper virus were detected 14 days post-vaccination in hybrids receiving MLV vaccine and most titers were >1:1024 for the 791 days of the study. Antibody titers in hybrids vaccinated with the inactivated vaccine were significantly lower. All eight hybrid ferrets that received MLV vaccine survived challenge with virulent canine distemper virus without clinical disease. However, one of seven hybrids vaccinated with the inactivated vaccine developed canine distemper and was euthanized; two other hybrids became clinically ill but survived. The MLV vaccine may be useful in prevention of canine distemper in black-footed ferrets, but until additional studies of efficacy and safety are

The successful expression of animal or human virus epitopes on the surface of plant viruses has recently been demonstrated. These chimeric virus particles (CVPs) could represent a cost-effective and safe alternative to conventional animal cell-based vaccines. We report the insertion of oligonucleotides coding for a short linear epitope from the VP2 capsid protein of mink enteritis virus (MEV) into an infectious cDNA clone of cowpea mosaic virus and the successful expression of the epitope on the surface of CVPs when propagated in the black-eyed bean, *Vigna unguiculata*. The efficacy of the CVPs was established by the demonstration that one subcutaneous injection of 1 mg of the CVPs in mink conferred protection against clinical disease and virtually abolished shedding of virus after challenge with virulent MEV, demonstrating the potential utility of plant

completed, use of the inactivated vaccine is appropriate.

*Journal of Wildlife Disease* 32 (3), pp. 417-423, 1996. 1 fig., 28 refs. Authors' abstract.

**Pyogranulomatous peritonitis associated with *Nocardia* sp.-like organisms in a raccoon (*Procyon lotor*)**

Amir N. Hamir, Charles E. Rupprecht

During 1992 raccoons (*Procyon lotor*) were live-trapped in northeastern Pennsylvania (USA). In one of these animals a localized pyogranulomatous peritonitis was seen. Grossly a large mass with a central area of liquifactive necrosis was present in the anterior abdomen. Microscopically the lesion contained multiple colonies of filamentous organisms with histomorphologic and histochemical characteristics resembling *Nocardia* sp. This appears to be the first report of *Nocardia* infection in the raccoon.

*Journal of Wildlife Diseases*, 32 (2), pp. 373-375, 1996. 3 figs., 10 refs. Authors' abstract.

**Neuronal vacuolation in raccoons (*Procyon lotor*)**

A.H. Hamir, J.R. Heidel, R. Picton, C.E. Rupprecht



**Fig. 1.** Brain stem (facial nucleus); raccoon No. 1. Note the presence of one or more vacuoles in the neuronal perikaryon. HE. Bar = 100µm.

Microscopic vacuolar changes in neuronal perikaryon are described in two free-ranging raccoons (*Procyon lotor*) from different geographic

locations in the United States. Both animals were negative for rabies and scrapie-associated antigens. Microscopically, lesions were not seen in the neuropil. Neuronal vacuolations have previously been documented in brains of normal animals and in diseases such as rabies and prion-associated encephalopathies. Although experimental transmission of a spongiform mink encephalopathy has been documented in raccoons, a naturally occurring spongiform encephalopathy has not been described in this species. The presence of neuronal vacuolations in the raccoons is novel and requires further investigation to elucidate the mechanism of this phenomenon.

*Vet Pathol* 34, pp. 250-252, 1997. 1 fig., 15 refs. Authors' abstract.

**Protective vaccination of ferrets against canine distemper with recombinant pox virus vaccines expressing the H or F genes of rinderpest virus**

Leslie Jones, Edgar Tenorio, John Gorham, Tilahun Yilma

**Objectives.** To investigate the ability of rinderpest virus (RPV) antigens, expressed in pox virus vectors, to protect against canine distemper virus (CDV) infection in ferrets.

**Animals.** Ferrets (*Mustela putorius*; n=27) with no previous exposure to CDV.

**Procedure.** Ferrets were inoculated intradermally with recombinant vaccinia viruses expressing the H gene of RPV, the F gene of RPV, the H and F genes of RPV, or a fowlpox virus recombinant expressing both genes. Two ferrets were vaccinated SC with CDV vaccine as positive controls, and 1 group was left unvaccinated as a negative control. Blood was obtained from ferrets biweekly; antibody titer to RPV was detected by ELISA, and CDB antibody titer was measured by serum neutralization testing and ELISA.

**Results.** Partial protection was seen in all groups, with vRVFH vaccination being the most protective (60%).

**Conclusions and clinical relevance.** A single inoculation with a vaccinia virus expressing the H

and F genes of RPV was able to protect 60% of the vaccinated ferrets challenge exposed with a high dose of CDV. These results indicate the ability of RPV antigens expressed by vaccinia virus to protect ferrets against a related morbillivirus. Further, they document the safety and efficacy of a recombinant vaccinia virus vaccine for ferrets. Such vaccines may be useful given the susceptibility of ferrets to CDV and the problem of maternal antibody interfering with vaccination of young animals.

*Am J Vet Res, Vol. 58, No. 6, pp.590-593, 1997. 3 tables, 15 refs. Authors' summary.*

**Immunohistochemistry of pancreatic islet cell tumors in the ferret (*Mustela putorius furo*)**

*G.A.Andrews,N.C. Myers III, C.Chard-Bergstrom*

Twenty-two pancreatic islet cell tumors and normal pancreatic islets from ferrets were evaluated by immunohistochemistry for expression of the peptide hormones insulin, somatostatin, glucagon, and pancreatic polypeptide (PP) and the neuroendocrine markers chromogranin A (CgA) and neuron-specific enolase (NSE). In normal pancreatic islets, the majority of cells stained strongly with CgA and NSE. A cells, B cells, D cells, and PP cells stained strongly with glucagon, insulin, somatostatin, and PP, respectively. All 22 tumors stained with CgA and NSE. The proportion of cells within tumors staining for CgA was variable, but more than half of the cells stained positively in 18 of the tumors. The intensity of staining for CgA was strong (reactivity equivalent to or greater than normal islet cells in adjacent tissue) in 11, moderate in six, and weak in five of the tumors. All tumors stained for NSE, with  $\geq 50\%$  of the cells staining in 19 of them. The intensity of staining for insulin was strong in 12, moderate in seven, and weak in one of the tumors.

Approximately  $\leq 1\%$  of the cells in 15 of 22 tumors stained for somatostatin, five tumors stained for pancreatic polypeptide, and three tumors stained for glucagon. These data indicate that the majority of islet cell tumors of ferrets express immunohistochemically detectable insulin. CgA and NSE are both useful general markers for such tumors, including those that are insulin negative. Commercially available antisera to CgA, NSE, insulin, glucagon, somatostatin, and PP work well in

formalin-fixed, paraffin-embedded tissue for immunophenotyping islet cell tumors in the ferret.

*Vet Pathol 34, pp. 387-393, 1997. 3 tables, 10 figs., 41 refs. Authors' summary.*

**Ultrastructural study of Aujeszky's disease in foxes (*Alopex lagopus*)**

*Nuria Aleman, Maribel Quiroga, Sonia Vazquez, José M. Nieto, Flora Guerrero*

Blue foxes were inoculated orally with Aujeszky's disease virus. After different intervals and during autopsy tissue from the brainstem and trigeminal nerve were obtained and prepared for electron microscopy. Cytopathological changes of the cell structure were observed in both glial and nerve cells. In addition to degenerative changes of glial cells and neurons, remarkable alterations of the myelin sheath were detected. The vascular system is also involved in this disease, showing the endothelium of capillaries structural changes.

*Proceedings Beitr. Elektronenmikroskop, Direktabb. u. Analyse v. Oberfl., 29, pp. 223-230, 1996. 7 figs., 20 refs. Author's abstract.*

**Experimental Aujeszky's disease in blue foxes (*Alopex lagopus*)**

*M.I. Quiroga, S. Vazquez, M. Lopez-Pena, F. Guerrero, J.M. Nieto*

Blue foxes were inoculated orally with Aujeszky's disease virus. Several foxes were killed at the onset of clinical signs and other animals spontaneously died. The incubation period ranged from 3 to 6 days and was followed by a short illness characterized by anorexia, depression and coma. At autopsy, no specific gross findings were observed. Microscopically, lesions included a non-suppurative meningoencephalitis with neuronal necrosis, gliosis, neuronophagia and mononuclear cell cuffing. Viral antigen was detected by immunoperoxidase technique.

*J. Vet. Med. A., 42, pp. 649-657, 1995. 1 table, 5 figs., 35 refs. Authors' summary.*

### Distribution of Aujeszky's disease virus in experimentally infected mink (*Mustela vison*)

M. Isabel Quiroga, M. Lopez-Pena, S. Vazquez, J.M. Nieto

Eight mink (*Mustela vison*) were inoculated orally with Aujeszky's disease virus (ADV). Three mink were killed at the onset of clinical signs and the other mink died spontaneously after inoculation. The incubation period ranged from 72 to 96 hours and was followed by a short illness characterised by increasing salivation, vomiting and retching, depression and coma. Microscopically, lesions were confined to the brain stem and consisted of a discrete non-suppurative encephalitis. Viral antigen was detected by an immunoperoxidase technique predominantly in association with specific lesions, although sometimes it was found within non-altered areas in the brain stem. Virus isolation confirmed the presence of ADV in the central nervous system. Fibrinoid degeneration of vessel walls was present in pharynx, larynx and myocardium in association with haemorrhages. Microthrombi were observed in heart and brain.

*Dtsch. tierärztl. Wschr.* 104, pp. 147-150, 1997. 1 table, 6 figs., 29 refs. Authors' summary.

### Pathogenicity of strains of *Pseudomonas aeruginosa* from furbearing animals

O.B. Litvinov, V.P. Ryutova

Vaginal smears from 89 Arctic foxes and 36 silver foxes (all apparently healthy) yielded 9 strains of *Pseudomonas aeruginosa*, all pathogenic for mice.

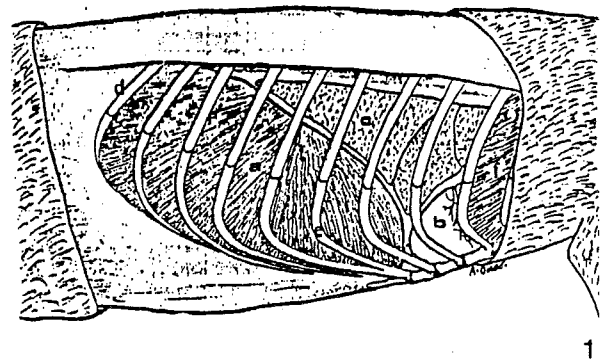
*Krolikovodstvo i Zverovodstvo*, No. 6, pp. 23-24, 1995. 1 table. In RUSS. CAB-abstract.

### Some morphological studies on the diaphragm of the ferret (*Mustelo furo*)

H.M. Nousseur

The right crus of the ferret's diaphragm originated from the bodies of the second, third and fourth and the left crus from the bodies of the second and third lumbar vertebrae. The latter crus was divided into

medial and lateral crura, where the aortic hiatus was located between them. The oesophageal hiatus was situated between the two crura. The tendinous center of the diaphragm was represented by three narrow lines in the form of Y shape. The costal part of the diaphragm was attached to the medial aspect of the 10th to 14th costal cartilages. The pericardiophrenic ligament extended from the pericardium at the level of the interventricular notch of the heart and passed caudally in the form of a cord to join the thoracic surface of the diaphragm. The diaphragm was supplied through A phrenica cranialis and Rr.Phrenici of the 10th to 13th. Aa. intercostales dorsales. It was drained through Vv. phrenicae dextrum et sinistrum, in addition to 10th to 13th Vv. intercostales and a branch which drained the lumbar part then joined V. azygos. The phrenic nerve was originated from the ventral branches of the 5th, 6th and 7th cervical spinal nerves on both sides.



**Fig. 1.** The right lateral wall of the trunk of a ferret showing diaphragm (a), heart (b), right lung (c), last (14th) rib (d) and 9th costal cartilage (e). M. intercostalis externus (f).

*Assiut Veterinary Medical Journal (Egypt)*, Vol. 28 (55), pp. 1-12, 1992. 5 figs., 18 refs. Authors' summary.

### Lymphosarcoma in a raccoon (*Procyon lotor*)

Amir N. Hamir, Cathleen A. Hanlon, Charles E. Rupprecht

A case of lymphosarcoma in a captive adult female raccoon (*Procyon lotor*) from northeastern Pennsylvania (USA) was observed in 1991. Prior to its death the raccoon had lost weight. At necropsy the carcass was in poor body condition and had pale

mucous membranes. The thoracic and abdominal lymph nodes were enlarged, soft, and pale tan. Microscopically, there was effacement of normal lymph node architecture by sheets of mononuclear cells. These were well-differentiated small lymphocytes with distinct cell borders. Nuclei of these cells were darkly stained and mitotic figures were frequently seen. Similar but lesser numbers of neoplastic cells were seen in the parenchyma of liver, spleen, and the pancreas. Since the neoplasm involved several organs, we propose that the condition was of multicentric origin. Gross lesions, histopathologic findings and the organs involved differed from a previously described case of lymphosarcoma in a raccoon.

*Journal of Wildlife Disease*, 32 (4), pp. 670-673, 1996. 4 figs., 11 refs. Authors' abstract.

#### Capillariasis in the trachea of a raccoon

A.N. Hamir, C. Hanlon, C.E. Rupprecht

Cross-sections of nematodes were seen in histologic sections of trachea from a raccoon (*Procyon lotor*) collected in Virginia (USA); they occupied epithelium and contained unembryonated, bioperculated eggs characteristic of the genus *Capillaria* (= *Eucoleus*). A mild inflammatory cell infiltrate in the lamina propria subjacent to the nematode was the only apparent host response. This is the first report of capillariasis in the trachea of raccoons.

*Journal of Wildlife Diseases* 33(4), pp. 880-881, 1997. 2 figs., 9 refs. Authors' abstract.

#### Polycystic kidney disease in a raccoon (*Procyon lotor*)

Amir N. Hamir, Lin Klein

During March 1988, a case of bilateral polycystic kidney disease (PKD) occurred in an aged raccoon (*Procyon lotor*) at a zoo in Wilmington, Delaware (USA). Prior to its death, the raccoon had no clinical signs. On necropsy there was bilateral enlargement of kidneys which, on cut sections, had many variable sized fluid-filled cystic cavities.

Endometrial hyperplasia with presence of multiple variable-sized cysts were also seen in the uterus of this raccoon. Microscopical examinations were characteristic of an end-stage renal failure due to PKD. Neither PKD nor cystic endometrial hyperplasia appears to have been previously described in this species.

*Journal of Wildlife Diseases* 32(4), pp. 674, 677, 1996. 2 figs., 16 refs. Authors' abstract.

#### Synovial sarcoma in a ferret. Rapid tumour formation in a laboratory ferret

M.H. Lloyd, C.M. Wood

Synovial sarcomas are a common soft tissue cancer in humans and have also been described in cattle and horses but have been reported only rarely in other species. In a short communication on p 627, Maggie Lloyd and Caroline Wood report the first identification of this condition in the ferret. The animal was a two-and-a-half year old male at a biomedical research centre. The case was unusual in the rapid growth of the tumour which formed a 4 cm by 6 cm mass around the right stifle joint and had apparently developed over a 48-hour period. Radiographic and clinical findings suggested a malignant neoplasm and the animal was euthanased. Histological examination identified the tumour as a synovial sarcoma. The high mitotic index and the anaplastic appearance of parts of the mass explained the rapid growth of the tumour and the sudden appearance of clinical signs.

*Veterinary Record* 139, pp. 627-628, 1996. 3 photos, 16 refs. Editor VET. REC. presentation.

#### *Helicobacter mustelae*-associated gastric adenocarcinoma in ferrets (*Mustela putorius furo*)

J.G. Fox, C.A. Dangler, W.Sager, R.Borkowski, J.M. Gliatto

*Helicobacter pylori* in humans is associated with active, chronic gastritis, peptic ulcer disease, and most recently has been linked epidemiologically to gastric adenocarcinoma. A related organism,



*Helicobacter mustelae*, naturally infects ferrets and also causes a persistent gastritis, a precancerous lesion, and focal glandular atrophy of the proximal antrum. In this report, we document the clinical presentation and histopathologic confirmation of *H. mustelae*-associated gastric adenocarcinoma in two middle-aged male ferrets. The ferret appears to be well suited to study the pathogenesis of naturally occurring *Helicobacter* sp.-induced gastric adenocarcinoma.

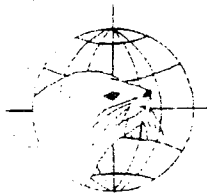
*Vet Pathol* 34, pp. 225-229, 1997. 7 figs., 14 refs. Authors' abstract.

### Demodicosis in ferrets (*Mustela putorius furo*)

C. Noli, H.H.A. van der Horst, T.- Willemsse

This report describes the clinical signs, diagnosis, and therapy of demodicosis in ferrets. Two ferrets (*Mustela putorius furo*) were presented with a history of local alopecia and pruritus after repeated treatment with a glucocorticoid-containing ointment for recurrent ear mite infections. Skin scrapings and biopsies revealed adult mites and larvae of *Demodex* spp., which were measured according to current classification techniques. Treatment with amitraz was effective and did not cause noticeable side effects. To the authors' knowledge this is the first report of demodicosis in ferrets.

*The Veterinary Quarterly*, Vol. 18, No. 1, pp. 28-31, 1996. 2 tables, 3 figs., 13 refs. Authors' summary.



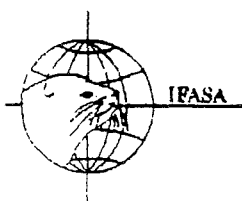
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