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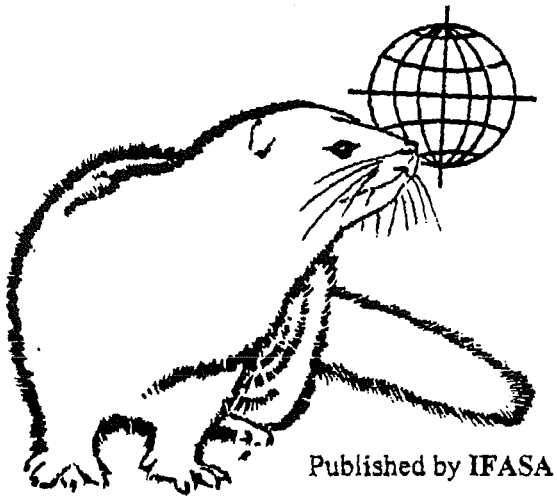

7. Nutrition

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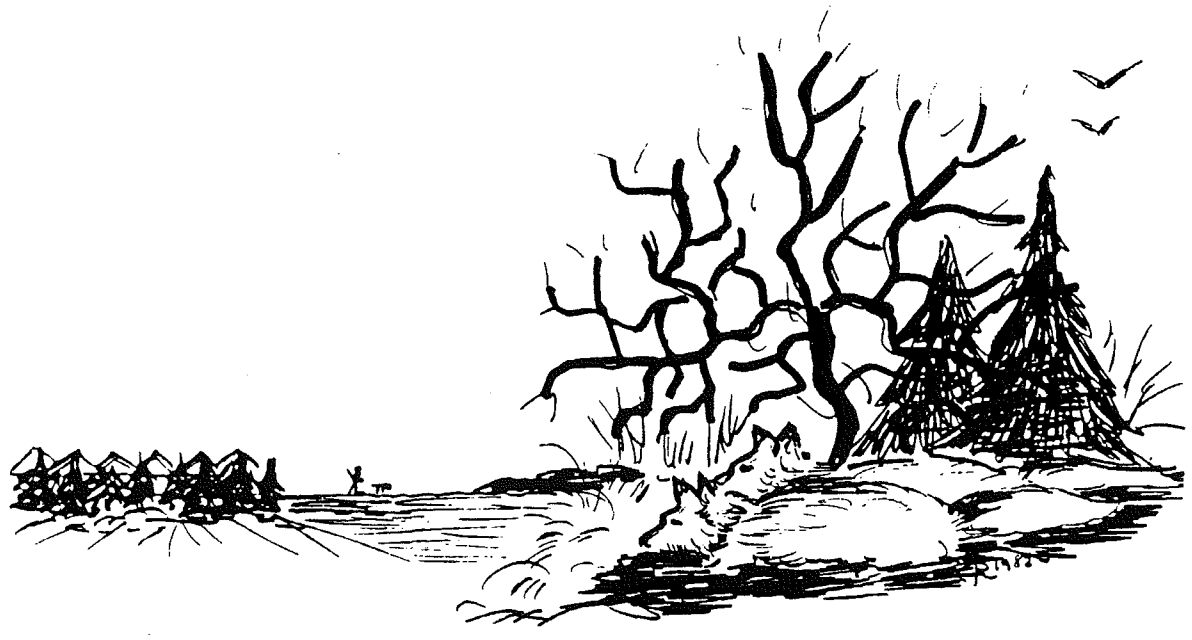

Notes

Scientifur, vol. 22, no. 4

November 1998

This is the last issue of vol. 22, and as you will see, it contains a large number of original reports as well as the abstracts from NJF-seminar No. 295 which was with great success held in Bergen, Norway from September 7 to 9, 1998. Also 27 oral presentations as well as 17 posters were presented to approx. 100 participants, among which were representatives from The Netherlands and Estonia who joined their Nordic colleagues. Approx. 40 percent of the presentations were in English despite the fact that the autumn seminar is mainly meant for the advising and teaching services. Hopefully, the strictly scientific spring seminars will continue to be really international and arranged in co-operation with IFASA. The same can be said about the seminars held around the world, of which we can mention the seminar held in Petrozavodsk, Russia, in September of this year.

Thanks to the contributors with original reports and the hard working arrangement committee of the NJF-seminar, SCIENTIFUR is also with this issue proving its position as the leading actual channel for scientific information regarding fur animal science. Please tell this to those of your colleagues who are still walking in the dark. Direct actual information is much more effective than the idea of - perhaps I shall find the information I need – when searching by your selves. Of course the inter-net search will be more effective as soon as the SCIENTIFUR Index is available here, but still there will be a delay in receiving the abstracts not to mention the very new and current reports. Therefore, until a more radical development has taken place, the printed SCIENTIFUR will stand as the most efficient source of information regarding fur animal research and production.

Here at the end of 1998, it is very important for us to thank all you very helpful contributors for your co-operation also in 1998, a co-operation we hope will continue in the years to come.

We have already received 6 original reports for publication in Vol. 23, No. 1, 1999. In addition we have received one scientific report to be reviewed before publication. After approval in IFASA's Board of Directors and careful language revision by Hanne Artved we have the pleasure to present the final inside cover text on the pages 263 and 264 in the present issue of the revised SCIENTIFUR presentation and the instructions for authors. This text will be found on the cover pages from Vol. 23, No. 1, 1999.

The IFASA board meeting 1998 will be history when you read these lines, as it took place in Montreal, Canada on November 19, 1998. Hopefully, the Internet-Web-side-plans are closer to realisation after this meeting just as some questions regarding the arrangement of the VII INTERNATIONAL SCIENTIFIC CONGRESS IN FUR ANIMAL PRODUCTION to be held in Kastoria in September of the year 2000 will be clarified. You can rest assured that the VII congress will be held, so the time to begin to prepare oneself and find out who is going to pay for the participation is very near.

In the spring of 1998 we sent a letter to all personal members of IFASA and gave them the opportunity to pay the membership fee for 4 years with a discount of 25 percent instead of annual payment. This was a great success, because as many as 2/3 preferred to pay for 4 years. Other members arranged group-payment on a one-year basis, but all in all this operation has been very helpful for the book keeping in the years to come. Thank you for your understanding.

In 1998 we have noted a slight decrease in the number of subscribers to SCIENTIFUR, which has of course not been very good for us. Thanks to the very warm back up by all scientists and the economic support from European and American organisations (EFBA & MFRF) we do, however, look very optimistically on the future.

Thanks to the very comprehensive economic support especially from the European Fur Breeders Association, the board has decided to keep the same prices for IFASA membership and SCIENTIFUR subscription as in the years before i.e.

IFASA Membership:
Personal members: NOK 170.00/year or
NOK 500.00/4 years.
Institutional Membership: NOK 1700.00/year.

SCIENTIFUR SUBSCRIPTION:
IFASA members: NOK 500.00/vol./year
Others: NOK 600.00/vol./year.

The electronic index covering more than 8000 titles of scientific reports on fur animal science and production will be updated in January 1999, and the price for this index consisting of 2 diskettes and a manual will also be obtainable at the same price as in the previous years:

NOK 350.00 for IFASA Members
NOK 550.00 for others
NOK 200.00 for updating.

At the moment, the prices stated in fact represent a reduction of 10 percent because of the weakness of the Norwegian currency against the international currencies. Hopefully, for the country where I live this is a temporary advantage for our customers.

So the clouds on the international economic heaven have had a direct influence not only on skin prices, but also on your price when you pay us in Norwegian Kroner. It is our sincere hope that these clouds will spread again, so hat the sun may shine on the entire earth seen both from the economic and the skin producing side. A positive development for this as well as for the peace and the solution of the hunger catastrophes around in the world will be given a very high priority in our wishes for 1999 and the next century that is just around the corner.

Always optimistic, we have now reached the point when it is time to thank our members, subscribers, contributors as well as EFBA for the economic support and The Fur Breeders Association of Norway for giving us room and comprehensive service in our work with IFASA and SCIENTIFUR.

Also thanks to the "personal" staff of your editor: Dorthe for typing and lay out, Hanne and Marianne for language control and corrections. Also Kristian Johansen at the Oslo Fur Centre is acknowledged for printing and binding of SCIENTIFUR.

With all this we ask you to accept our best wishes for a Merry Christmas and a Happy New year when we are all looking forward to SCIENTIFUR Vol. 23, and the first announcement of the VII International Congress in Kastoria.

Your Editor
Gunnar Jørgensen

SCIENTIFUR – scientific information in Fur Animal Production

SCIENTIFUR, scientific information for those involved in fur animal production, is published by the International Fur Animal Scientific Association (IFASA).

SCIENTIFUR is the contact link between fur animal researchers all over the world and serves as an outlet for scientific and other communication between researchers and others who are interested in the production of fur bearing animals. As such **SCIENTIFUR** will contain reports of scientific and applied nature as well as abstracts of information published elsewhere and information regarding congresses, scientific meetings etc.

SCIENTIFUR is published quarterly, i.e. late February, May, August and November. One year's issues (1 volume) are estimated to total 350 pages covering more than 500 titles of scientific reports.

REPORTS received for publication as Scientific Reports, will be sent out to referees for scientific approval, and will regardless of discipline appear on the first text pages in each issue and will after the main title be marked by an asterisks (*).

Other contributions, e.g. Original Reports, for which the author is responsible for the scientific validity, will occur in the discipline chapter where they belong, from January 1999 (Vol. 23):

1. Multidisciplinary
2. Behaviour and welfare
3. Breeding, reproduction, genetics
4. Nutrition and nutritional physiology
5. Pathology and diseases
6. Fur properties

EDITOR ADDRESS. All kinds of material suited for publication or abstracting in SCIENTIFUR have to be forwarded to the Editor:

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Instructions to Authors

Reports should not exceed 6 printed pages (=12 typewritten A4 pages with double spacing including figures and tables). Additional pages will be charged to the author(s) at NOK 1200,- per printed page. Send manuscript in triplicate to:

SCIENTIFUR
P.O. BOX 145, Økern
N-0509 Oslo, Norway

Please also submit a diskette and a description of the program used. Preferably Microsoft Word files. The software used, the program version number, as well as the format of the diskette should be marked. Remember to supply with 3 print-out copies.

Unless other agreement between Author and Editor has been made, a submitted paper will be received with the understanding that the work has not been published before and is not considered for publication elsewhere and has been read and approved by all authors. Animal experimental methods reported in SCIENTIFUR should meet ethical standards of animal treatment.

Submission of the manuscript by the authors means that the authors automatically agree to assign exclusive **copyright** to SCIENTIFUR if and when the manuscript is accepted for publication.

Manuscripts should be in English; typed double spaced on A4 paper with page and line numbering and consisting of:

Title, which should be concise and informative, and should contain the main key words, but as short as possible.

Author name(s) as well as name(s) and address(es) of departments and institutions to which the work is attributed.

Summary/abstract. Preferably not exceeding 150 words.

Keywords in alphabetical order, if not included in the title.

Text. The text should normally be divided into: Introduction, Material and Methods, Results, Discussion, Acknowledgements and References and follow the internationally accepted rules. Double documentation in both tables and figures will not be accepted.

Illustrations. All graphs and photos are considered figures and have to be labelled on the reversed side of the sheet with number, authors name and indication of orientation. All drawings have to be professionally drafted (photocopies are seldom of acceptable standard); any halftones must exhibit high contrast, and details must be large enough to retain their clarity after reduction in size to single column width (80 mm); 170 mm can be accepted in special cases.

Any colour illustration must be paid by the author. The author may also provide SCIENTIFUR with an agreed number of a double paged sheet with illustrations printed professionally for inclusion in the actual report. Such service can also be made by SCIENTIFUR at the expend of the author.

Tables. Each table should be typed on a separate page, numbered consecutively with Arabic numerals, and have a self-explanatory title. Tables should be planned to fit a final width of 80 or 170 mm.

References should be kept to a pertinent minimum. In the text authors names, not numbers, must be used. The reference list should be arranged in alphabetical order according to the name of the first author; year of publication between the name(s) and the title.

Off-prints. The author(s) receive 25 reprints without charges after publication of the report. Additional reprints will be charged after agreement in the single cases.

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Original Report

Traits of the chinchilla coat structure dependent on season and age

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Abstract

The aim of the study was to evaluate differences in the chinchilla coat at different seasons and ages. The studies were carried out on 189 standard variety chinchilla females, from which hair samples were collected from the rump. The following hair parameters were measured on 50 underhairs and upper hairs: hair height, length, thickness, hair medulla thickness, and percentage of underhair in the coat. After making the calculations, crimpness and waviness of both types of hair were determined as well as the hair medulla content. The obtained results showed that season and age had different effects on the coat traits assessed with the measurements. The thickness of the hair and its medulla clearly increased with age, while crimpness and waviness were independent both of season and age.

Introduction

The most important element of the value of all fur animals, apart from their size, is the quality of their coat, which determines to a great extent the profitability of their rearing. The quality of the coat may be affected by season and age, in which its evaluation is performed.

Despite the fact that development of a chinchilla is basically completed in the first year of its life and it already has the mature type of coat, the latter can still undergo various changes. Barabasz & Jarosz (1977) and Jarosz (1993) demonstrated that the change of the coat is irregular and only few animals obtain the mature type of coat in summer. The problem of season and age is very important for biological and economic reasons. In connection with changes taking place in the organism this may be an element modifying the level of its utility traits. There are no results in the available literature explaining the influence of season, and age in particular, on the quality of chinchilla utility traits. This stimulated the authors of the present paper to take up this problem.

The aim of the study was to assess economically important utility traits of the chinchilla fur in different seasons and age.

Material and methods

Studies were performed in 1994-1996 on standard variety chinchillas coming from an N4 farm at Nowogard (Szczecin Province). The animals had good breeding results and uniform in respect of highly evaluated exterior traits. They included females of the foundation stock; males were not covered in the study since they were not numerous enough for statistical analysis.

The chinchillas were divided into 4 age groups: one-year-old, two-year-old, three-year-old and four-year-old. To minimalize age differences in the

particular groups, a rule was adopted to include in animals born in the middle of each month from the period of 1991-1994. Owing to that, individuals included in the study were uniform in particular age groups with respect to their age. Hair samples were collected from them in the period from January to December 1995.

Preliminary analysis of the coat was performed from 4 places on the body: nape, back, rump, and hip. As a consequence of the laboratory measurements of the coat samples it was found that results obtained from samples collected from the rump approximated most of all the mean values. This place was thus adopted as the representative one for the coat traits and it was decided to collect the hair samples from here. Subsequently, the evaluation of the coat samples collected at the farm from 189 chinchillas was performed.

Laboratory evaluation of the coat traits

The coat samples underwent laboratory evaluation that included the following traits of the underhair and upper hair:

1. *height* – measured from the base to the top on 50 hairs from each group to the nearest 0.1 mm with the help of a stereoscopic microscope;
2. *length* – measured on the same hairs as their height, after they were straightened, and maintaining similar technique and accuracy of the measurement;
3. *crimpness and waviness* – expressed as the percentage of the height to the length of hairs;
4. *thickness* – measured with the use of a lanometer in the middle part of the hair on 50 hairs from each sample to the nearest 1 K;
5. *medulla thickness* – measured on the same hairs as their thickness maintaining similar technique and accuracy of the measurement;
6. *medulla content* – expressed as the percentage of the medulla in hair;
7. *underhair coat percentage* – calculated from the ratio of the weight of the underhair to the weight of hair sample; samples were weighed to the nearest 0.001 g.

The obtained data were analysed statistically with the use of analysis of variance 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, independently of seasons.

The obtained results are presented in tables comprising arithmetic means (x) and confidence semi-intervals for means (I). Significance of differences between pairs of means was marked in tables by these means taking into account different levels of significance ($P<0.05$ or $P<0.01$).

Table 1. Hair traits of one-year-old chinchilla in different seasons

Traits		Seasons							
		winter (n=7)		spring (n=15)		summer (n=14)		autumnal (n=15)	
		underhair $\bar{x}$ ±	overcoat $\bar{x}$ ±	underhair $\bar{x}$ ±	overcoat $\bar{x}$ ±	underhair $\bar{x}$ ±	overcoat $\bar{x}$ ±	underhair $\bar{x}$ ±	overcoat $\bar{x}$ ±
1. height	(mm)	28.8 0.7	31.8 0.9	28.6 0.4	31.6 0.6	28.0[a] 0.5	31.3 0.7	29.5[A] 0.5	31.7 0.6
2. length	(mm)	29.9 0.7	32.2 0.9	29.7 0.5	32.0 0.6	29.0[a] 0.5	31.7 0.7	30.5[A] 0.5	32.1 0.6
3. crimpiness	(%)	96.1 0.4	98.6 0.2	96.4 0.2	98.6 0.1	96.5 0.3	98.9 0.2	96.8 0.4	98.7 0.1
4. diameter	(μ)	15.1 0.5	22.4 1.2	15.2 0.4	22.1 0.8	14.8 0.4	21.0 0.8	15.5 0.4	21.3 0.8
5. diameter of medulla	(μ)	11.2 0.4	16.4 0.8	11.2 0.3	16.4 0.6	11.0 0.3	15.5 0.6	11.4 0.3	15.6 0.6
6. medulla in hair	(%)	73.9 0.6	73.5 0.9	73.5 0.5	74.2 0.4	73.9 0.5	73.8 0.6	73.4 0.3	73.0 0.8
7. underhair in coat	(%)	93.6 1.2		93.9 0.8		92.8 0.8		94.2 0.8	

A,B,C - significant at $P \leq 0,01$; a,b,c - significant at $P \leq 0,05$

Table 2. Hair traits of two-year-old chinchilla in different seasons

Traits	Seasons							
	winter (n=24)		spring (n=14)		summer (n=15)		autumnal (n=13)	
	underhair $\bar{x}$ ±	overcoat $\bar{x}$ ±	underhair $\bar{x}$ ±	overcoat $\bar{x}$ ±	underhair $\bar{x}$ ±	overcoat $\bar{x}$ ±	underhair $\bar{x}$ ±	overcoat $\bar{x}$ ±
1. height (mm)	$27,3^{ABa}$ 0.6	30.1^{Aa} 0.4	29.9^{A} 0.7	31.8^{A} 0.6	28.6^{ab} 0.7	31.0 0.6	30.1^{Bb} 0.8	31.6^{a} 0.6
2. length (mm)	28.3^{AB} 0.5	30.6^{Aa} 0.5	31.0^{Aa} 0.2	32.3^{A} 0.6	29.6^{a} 0.7	31.3 0.6	30.5^{B} 0.7	32.0^{a} 0.6
3. crimpiness (%)	96.2 0.5	98.6^{a} 0.1	96.8 0.7	98.7 0.2	96.0 0.7	97.9^{a} 1.1	96.0 1.7	98.9 0.2
4. diameter (μ)	13.9^{ABC} 0.3	21.8 0.6	15.6^{A} 0.5	22.3 0.8	15.2^{B} 0.4	21.9 0.8	15.2^{C} 0.4	22.2 0.9
5. diameter of medulla (μ)	10.1^{ABC} 0.2	15.6 0.4	11.5^{A} 0.4	16.6 0.6	11.3^{B} 0.4	16.1 0.5	11.2^{C} 0.4	16.3 0.6
6. medulla in hair (%)	72.9 0.5	71.7 0.9	73.7 0.6	74.3 1.2	74.1 0.6	73.5 1.1	73.5 0.6	73.6 1.2
7. underhair in coat (%)	92.0 0.9		93.2 1.2		91.7 1.2		92.6 1.3	

A,B,C - significant at $P \leq 0.01$, a,b,c -significant at $P \leq 0.05$

Table 3. Hair traits of three-year-old chinchilla in different seasons

Traits	Seasons							
	winter (n=11)		spring (n=13)		summer (n=7)		autumnal (n=7)	
	underhair $\bar{x}$ ±	overcoat $\bar{x}$ ±	underhair $\bar{x}$ ±	overcoat $\bar{x}$ ±	underhair $\bar{x}$ ±	overcoat $\bar{x}$ ±	underhair $\bar{x}$ ±	overcoat $\bar{x}$ ±
1. height (mm)	28.1^{a} 0.7	32.5 1.0	29.0^{b} 0.7	32.6 0.9	29.8 1.5	32.2 1.2	30.8^{ab} 1.0	32.9 1.2
2. length (mm)	29.2^{a} 0.8	33.2 1.1	30.1 0.8	33.1 1.0	30.8 1.0	32.5 1.3	31.8^{a} 1.0	33.4 1.4
3. crimpiness (%)	96.3 0.3	98.7 0.2	96.3 0.3	98.6 0.3	96.7 0.4	98.9 0.2	96.7 0.4	98.7 0.3
4. diameter (μ)	13.7^{aAB} 0.5	24.1 0.9	15.9^{A} 0.2	23.9 0.8	15.7^{B} 0.6	22.2 1.1	15.1^{a} 0.7	22.4 1.1
5. diameter of medulla (μ)	10.2^{aAB} 0.4	17.6 0.7	11.6^{A} 0.3	18.0 0.6	11.6^{B} 0.5	16.5 0.9	11.1^{a} 0.5	16.4 0.9
6. medulla in hair (%)	74.1 0.8	73.1^{a} 0.6	74.1 0.8	75.3^{AB} 0.6	73.9 0.9	74.2 0.8	73.5 0.9	73.0^{B} 0.8
7. underhair in coat (%)	92.9^{a} 1.8		94.3^{A} 1.5		88.2^{Aab} 2.1		92.4^{b} 2.1	

A,B,C - significant at $P \leq 0.01$; a,b,c - significant at $P \leq 0.05$

Table 4. Hair traits of four-year-old chinchilla in different seasons

Traits	Seasons							
	winter (n=5)		spring (n=10)		summer (n=7)		autumnal (n=12)	
	underhair $\bar{x}$ ±	overcoat $\bar{x}$ ±	underhair $\bar{x}$ ±	overcoat $\bar{x}$ ±	underhair $\bar{x}$ ±	overcoat $\bar{x}$ ±	underhair $\bar{x}$ ±	overcoat $\bar{x}$ ±
1. height (mm)	27.0^{ABC} 0.7	29.4^{ABC} 0.9	29.5^{A} 0.5	32.9^{A} 0.6	30.0^{B} 0.6	33.0^{B} 0.7	30.4^{C} 0.4	33.1^{C} 0.5
2. length (mm)	28.2^{ABC} 0.8	29.9^{ABC} 0.9	30.7^{A} 0.6	33.5^{A} 0.7	31.8^{B} 0.6	33.4^{B} 0.7	31.4^{C} 0.5	33.5^{C} 0.5
3. crimpiness (%)	96.2 0.4	98.2 0.3	96.1 0.3	98.5 0.2	96.8 0.4	98.7 0.3	96.8 0.2	98.6 0.2
4. diameter (μ)	13.9^{AB} 0.9	21.9 1.4	15.3 0.7	23.5 0.9	16.5^{A} 0.8	23.3 1.1	15.8^{B} 0.5	23.4 0.7
5. diameter of medulla (μ)	10.3^{Aa} 0.6	16.1 1.0	11.3 0.5	18.0 0.7	12.3^{A} 0.6	17.5 0.8	11.7^{a} 0.5	17.2 0.6
6. medulla in hair (%)	74.6 0.9	73.9 1.8	73.9 0.6	76.6 1.2	74.5 0.7	75.1 1.5	73.6 0.5	73.7 1.2
7. underhair in coat (%)	93.9 2.3		93.0 1.6		92.8 1.9		92.9 1.5	

A,B,C - significant at $P \leq 0.01$; a,b,c - significant at $P \leq 0.05$

Table 5. Hair traits of chinchilla of different ages

Traits	Age (years)							
	one (n=51)		two (n=66)		three (n=38)		four (n=34)	
	underhair $\bar{x}$ ±	overcoat $\bar{x}$ ±	underhair $\bar{x}$ ±	overcoat $\bar{x}$ ±	underhair $\bar{x}$ ±	overcoat $\bar{x}$ ±	underhair $\bar{x}$ ±	overcoat $\bar{x}$ ±
1. height (mm)	28.7 0.3	31.6^{ab} 0.4	28.7 0.3	31.0^{AB} 0.7	29.2 0.4	32.6^{Aa} 0.5	29.6 0.5	32.5^{Bb} 0.5
2. length (mm)	29.8^{a} 0.4	32.0 0.4	29.6^{b} 0.3	31.4 0.3	30.3 0.4	33.1 0.5	30.7^{ab} 0.5	33.0 0.5
3. crimpiness (%)	96.5 0.2	98.7^{AB} 0.1	96.4 0.2	$98.7^{CD.}$ 0.1	96.6 0.1	98.7^{AD} 0.1	96.5 0.3	98.5^{BC} 0.1
4. diameter (μ)	15.2 0.3	21.6^{AB} 0.4	14.8 0.2	22.0^{Ca} 0.4	15.0 0.3	23.4^{AC} 0.5	15.5 0.3	23.2^{Ba} 0.5
5. diameter of medulla (μ)	11.2 0.2	15.9^{AB} 0.3	10.9 0.2	$16.1^{CD.}$ 0.3	11.1 0.2	17.3^{CB} 0.4	11.5 0.3	17.3^{AD} 0.3
6. medulla in hair (%)	73.6 0.3	73.7^{a} 0.5	73.5 0.3	73.1^{A} 0.5	74.0 0.3	74.1 0.6	74.0 0.3	74.9^{Aa} 0.7
7. underhair in coat (%)	93.6 0.6		92.3 0.5		92.5 0.8		93.0 0.7	

A,B,C,D - significant at $P \leq 0.01$; a,b,c - significant at $P \leq 0.05$

Results

Underhair

Height

One-year-old chinchillas had the highest underhair in autumn (29.5 mm) and it differed significantly ($P<0.05$) from the underhair height in summer (28.0 mm).

The highest underhair in two-year-old animals was also noted in autumn (30.1 mm) and it differed significantly ($P<0.01$) from the winter underhair (27.3 mm), which was the lowest at that time and differed significantly in respect of its height from the underhair of the remaining seasons.

Three-year-old females had the heighest underhair in autumn (30.8 mm) as well, and it differed significantly ($P<0.05$) from that in winter (28.1 mm) and spring 29.0).

Four-year-old female chinchillas had the lowest underhair in winter (27.0 mm) and it differed significantly ($P<0.01$) from the underhair height of the remaining seasons. The highest underhair was found in autumn being 30.4 mm high.

No significant differences were found for the height of the underhair in animals of different age groups.

Length

The shortest underhair in one-year-old chinchillas was in summer (29.0 mm) and the longest in autumn (30.5 mm). This difference is significant ($P<0.05$). The shortest underhair of two-year-old animals was in winter (28.3 mm) and it differed significantly from that of the remaining seasons. The longest underhair was found in two-year-old chinchillas in spring (31.0 mm, at $P<0.01$). Three-year-old animals had the shortest underhair also in winter (29.2 mm) and it differed significantly ($P<0.05$) from the autumn underhair, which was the longest (31.8 mm). This trait differed in four-year-old chinchillas between winter, when it was the shortest (28.2 mm), and the remaining ones. The longest underhair in these animals was in spring (30.7 mm).

The longest underhair was found in four-year-old chinchillas (30.7 mm) and it differed significantly ($P<0.05$) from that of one-year-old and two-year-old animals (29.8 mm and 29.6 mm, respectively), the latter having the shortest underhair.

Crimpness

This trait did not differ significantly in the analysed animals of different age.

Thickness

This trait differed between seasons in all chinchilla age groups, except for one-year-old animals. The underhair was the thinnest in winter (13.9 K in two-year-old, 13.7 K in three-year-old, 13.9 K in four-year-old animals) and differed highly significantly from that in the remaining seasons. The thickest underhair was in summer (15.7 K in three-year-old and 16.5 K in four-year-old animals) and spring (15.6 K in two-year-old animals) (at $P<0.01$).

The thickness of the underhair did not differ significantly between particular age groups.

Medulla thickness

The medulla thickness differed between seasons in all age groups except for one-year-old animals.

The hair medulla in all these groups was the thinnest in winter (10.1 K in two-year-old, 10.2 K in three-year-old and 10.3 K in four-year-old animals), and the thickest in summer (11.3 K, 11.6 K and 12.3 K, respectively) (at $P<0.01$).

There were no significant differences between age groups with respect to this trait.

Medulla content

No significant differences between seasons and particular age groups were found for this trait.

Underhair coat percentage

Significant differences in the underhair coat percentage occurred in three-year-old chinchillas between summer (88.2%) and spring (94.3%) ($P<0.01$), and between winter (92.9%) and autumn (92.4%) ($P<0.05$).

The greatest number of underhair was noted in the coat of one-year-old chinchillas (93.6%), and the smallest in two-year-old animals.

Upperhair

Height

Four-year-old chinchillas had the lowest upperhair in winter (29.4 mm) and it differed significantly in height from the upperhair of the remaining seasons. The highest upperhair was found in autumn (33.1 mm). Two-year-old chinchillas also had the lowest

upperhair in winter (30.1 mm), and the highest in spring 31.8 mm) (at $P<0.01$) and autumn (31.6 mm) (at $P<0.05$).

The highest upperhair was in three-year-old (32.6 mm) and four-year-old 32.5 mm) chinchillas, which differed significantly from the upperhair of two-year-olds (31.0 mm) and one-year-olds (31.6 mm).

Length
Seasonal differences in the length of the upperhair in particular age groups occurred in two-year-old and four-year-old animals. Two-year-old chinchillas had the shortest upperhair in winter (30.6 mm), and the longest in spring (32.3 mm) (at $P<0.01$). Likewise, four-year-old animals had the shortest upperhair in winter (29.9 mm), and the longest in autumn (33.5 mm) (at $P<0.01$), while the length of the upperhair was similar in spring, summer and autumn.

The value of this trait was distributed in particular age groups in the range from 31.4 mm in two-year-old animals to 33.1 mm in three-year-old ones.

Waviness
This trait in particular age groups differed significantly ($P<0.05$) solely in two-year-old animals between winter (98.6%) and summer (98.9%).

The upperhair of one-year-old and two-year-old chinchillas had the same degree of waviness (98.7%), and it differed significantly ($P<0.01$) from that of four-year-old animals (98.5%).

Thickness
This trait of the upperhair in particular age groups differed solely in four-year-old animals between winter, when it was the thinnest (21.9 K), and the remaining seasons (23.3 – 23.5 K).

The thickest upperhair was found in three-year-old (23.4 K) and four-year-old (23.2 K) chinchillas, and they differed significantly ($P<0.01$) from the upper hair of one-year-old animals (21.6 K).

Medulla thickness
No differences were found with respect to this trait between seasons in particular age groups. Four-year-old chinchillas had the thickest medulla in summer and autumn (17.5 K and 17.2 K, respectively), while it was the thinnest in one-year-old animals (15.5 K and 15.6 K, respectively) at the same time.

The medulla of the upperhair in three-year-old and four-year-old chinchillas was thicker (17.3 K each) than that of one-year-old and two-year-old animals (15.9 K and 16.1 K, respectively).

Medulla content
This trait in three-year-old chinchillas had the largest value in spring (75.3%) and the lowest ($P<0.01$) in winter (73.2%) and autumn (73.0%). The largest content of the medulla was found in the upperhair of four-year-old chinchillas (74.9%), and the lowest in two-year-old ones (73.1%) (at $P<0.05$).

Discussion

The chinchilla coat was changing in particular seasons with the age of the animals. After winter, an intensive replacement of the coat into its summer type took place, confirmed by results of the laboratory analysis of the coat demonstrating that the height of the underhair was the lowest then. The underhair was the longest in autumn and tended to be longer as the animals grew older (from 29.5 mm in one-year-old to 30.4 mm in four-year-old animals). The shortest underhair occurred in winter (27.3 mm in two-year-old, 28.1 mm in three-year-old and 26.5 mm in four-year-old chinchillas), except for one-year-old animals, which had the shortest underhair in summer (28.0 mm). This may testify to the fact that the underhair of the studied animals has attained its development in autumn, that is between 15 September and 15 December. Then, in winter, that is from 15 January to 15 March, the height of the underhair could assume smaller values, since the winter coat has already started its change into the summer one. However, observations of Barabasz & Jarosz (1977) showed that chinchillas reared in an unheated accomodation fully developed their winter coat between 20 February – 15 March.

Laboratory measurements of the height of the upperhair showed differences with respect to this trait in two-year-old chinchillas between winter (30.1 mm), spring (31.8 mm) and autumn (31.6 mm) and in four-year-old ones between winter (29.4 mm and the remaining seasons (32.9 mm in spring, 33.0 mm in summer, and 33.1 mm in autumn).

In the available literature the height of the underhair and upperhair in chinchillas has not been

differentiated yet according to season and age. Jarosz & Rzewski (1993) reported that the height of downy hair on the back was 21-28 mm, and the guard hairs were higher than the downy hairs by 1 to 3 mm. Similar values for that trait were determined by Kazmierczak (1962) and Suchaniak (1991) in their own studies.

It was established on the basis of the performed measurements that the height of the underhair increased only slightly with age, the differences between particular age groups being statistically insignificant (from 28.7 mm in the youngest chinchillas to 29.6 mm in the oldest). On the other hand, the height of the upperhair changed significantly with age and increased by about 1-1.5 mm after the animals completed their second year.

A very important trait of the coat, also in chinchillas, may be a difference between the height of the upperhair and the underhair. Too large values indicate that the upperhairs produce excessively over the underhairs or they bend over on them resulting in an irregular arrangement of the colour, mainly of the voile, and worsening of the coat elasticity, which deteriorates the coat value. As Jarosz (1993) reports, the coat becomes flatter when the upperhair grows excessively over the underhair. A similar statement was made by Utne (1973), who wrote that irregular and too long hairs are a defect.

According to the obtained measurements of the hair height, the smallest difference between the upperhair and the underhair occurred in two-year-old chinchillas. Generally, this difference was the smallest in the autumn coat, but in the oldest chinchillas it was found in the winter one. This may testify to a greater content, more clear colour, more visible voile and better elasticity of the coat in autumn than in other seasons. This may also point to the fact that the coat of one-year-old chinchillas has not yet developed its structure well, but improves in next year. The best coat with respect to the hair height ratio is found in two-year-old chinchillas in autumn.

The next trait determining the coat structure, in particular downiness and heat-preserving abilities of the coat, is the hair waviness and crimpness. This trait did not show any significant changes in the underhair in successive years, which may testify to the fact that heat-preserving abilities of the coat did not change with the chinchilla age. On the other hand, a significant and clearly marked differentiation of that trait was found in the upperhairs, which were more wavy in older animals (three-year-old and four-year-old ones).

The softness of the coat (*Jarosz, 1993*) depends on the hair thickness and length. This trait is of great importance in the organoleptic evaluation of fur (feel), since a soft fur is evaluated more favourably than a coarse one. However, the over-softness of the coat aggravates its elasticity and increases its susceptibility to felting. The chinchilla coat is included among the most delicate of common fur animals due to its very thin hair (*Koegh & Haylett, 1983*). The chinchilla has thinner downy hair (10.1 K) when compared with Angora and Rex rabbits (13.2 – 13.6 K) (*Kazmierczak, 1962*). Also the root hairs are thinner in chinchillas (23.4 K), and comparable only with hairs of the Angora in Grey Rex crossbred rabbits (23.5 K). Pronouncedly thicker root hairs occur in White Rex and Yellow Rex in Angora crossbred rabbits (40.0 K). Jarosz & Rzewski (1993) report that the chinchilla downy hairs are of 13.5 K in diameter in the middle, and guard hairs 30 K.

In the performed studies the thickness of the underhair was 14.8 K in two-year-old chinchillas to 15.5 K in four-year-old ones, while that of the upperhair was 21.6 K in one-year-old animals to 23.4 K in three-year-old ones. On the basis of the findings one can state that the thinnest underhairs in all age groups, except for one-year-old chinchillas, occurred in winter (13.7 – 13.9 K). These hairs were thicker in the remaining seasons being 15.2 – 16.5 K in diameter. It may result from the data on the thickness of the underhair given by Jarosz & Rzewski (1993) that they refer to the winter coat which is characterised by very delicate hair.

However, as no data on season and age differentiation of that trait in chinchillas is available in the relevant literature, any comparison of the obtained values has not been possible.

This trait differed only in one-year-old chinchillas, since it did not show any seasonal differences and being all the year at the level of 14.8 – 15.5 K.

The thickness of the upperhair was at the level of 21.3 – 24.1 K, as given by Kazmierczak (1962), and did not show any statistically significant differences between the studied age groups. Inconsistency

between our findings and those of Jarosz & Rzewski (1993) may result from the fact that the upperhair in the present study included two morphological hair types, the guard hair and root hair. Other authors, however, give only the thickness of the guard hair, not mentioning that of the second type of upperhair, that is the root hair.

Speaking about the hair thickness one should also pay attention to the hair medulla. The thickness of the hair medulla and its ratio to the hair thickness allows us to make a hair classification. As Elbert (1981) and Wilcox (1950) report, the chinchilla has a relatively thick hair medulla that takes up most of the cross section area of the hair, while the hair cortex is very narrow, producing a typical net in the guard hair, the so-called "chequework".

The medulla of the upperhair did not show substantial changes between seasons in animals of different age groups.

The thickness of the hair medulla was found to be most differentiated when comparing particular age groups. This comparison showed that the thinnest upperhair medulla occurred in the youngest chinchillas, and this trait increased with their age.

The medulla content in the examined coat samples was found to be large in all types of hair, and it amounted to 73.5 – 74.0% in the underhair and 73.1 – 74.9% in the upperhair. The medulla content assumed similar values in the underhair in all groups, whereas its value in the upperhair clearly grew larger with the age of the studied chinchillas.

The composition of the coat determines its elasticity and downiness. As Jarosz (1993) reports, it is much-desired to have 30% of the upperhair and 70% of the underhair in the coat: it results from our measurements that the underhair made for as much as 92.3 – 93.6% in the coat of the studied animals, and its proportion does not show any substantial changes with season and age. The obtained results, considerably different from data found in the relevant literature, may arise from different methods used for determination of the coat composition. This trait was established in our studies in respect of weight, not quantitatively.

Conclusion

1. Season and age have different effects on development of the coat traits of standard variety chinchilla females assessed with laboratory measurements.
2. The coat traits assessed with laboratory methods were different in the underhair and upperhair.
3. The coat traits that do not change with age are the hair waviness and crimpness; they may ensure similar heat-preserving abilities of the coat in chinchilla females independently of their age.
4. The thickness of the upperhair and its medulla clearly increased with the age of animals, while the medulla of the underhair was the thinnest in winter independently of age.

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Original Report

Effect of two different caging systems and management technologies on the reproductive performance of Chinchillas (*Chinchilla laniger*)

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Summary

Chinchillas have always produced one of the most valuable furs in the world. One of the basic conditions of profitable breeding is the reproductive performance. Through our investigations we wanted to give an answer to the question: how do different housing systems influence the rate of reproductive performance of chinchillas. Comparing the groups we found differences only at P=10% level significance. We observed that the housing systems may have an impact on the rate of reproductive performance but this is not determining. The results are different from those of other animal breeds because the rough conditions in the chinchillas' original environment made them genetically extremely resistant and they developed an adaptability to extreme conditions.

Introduction

For a very long time the most attractive furs have been produced by chinchillas. Recently the overall quality of chinchilla pelts is better compared to the ones of originally captured animals thanks to the work of breeders. Rising living standards have resulted in increased demands on the special value-retaining products. Furs, like precious metal represent this feature.

The fact that Hungary is a considerable fur producer is a good reason for investigation of the reproduction rate of chinchillas. Also, the price of skin garnments produced has risen steadily for the last years (*Várady, 1997*).

According to the taxonomy categories chinchillas are rodents and belong to the porcupine family. They have relatives only in South America (*Várady, 1989*). Their original homeland is South America, their natural habitat is in the Andes, between the 25-39 southern latitudes where they are found at the height of 2-4,000 meters above sea level. They build their nests close to each other, in mountain-gorges and in caves of severe, rocky regions. The climate is extreme, there is intense sunshine and the amount of rainfall is low (*Dudas et al., 1983*).

It was in 1829 that the first live animal arrived at the Zoo of London. The first experiments for the breeding in captivity were made in 1874 in Chile (*Holdas, 1978*).

Mathias Ferrel Chapnian, who can be considered as the establisher of modern chinchilla breeding, trapped some animals and brought 4 females and 7 males to California, to his farm in Inglewood and began to propagate them. Actually this population

constitutes the basis of the breeding stock all over the world (*Jarosz et al., 1985*).

Chinchillas are twilight and night animals, so buildings with big windows and strong light are not suitable for them. Recently they are kept in compartments without windows, supplied with restricted artificial light, constant temperature and atmospheric conditions (*Várady, 1989*). A suitable chinchilla house is dry, well-isolated, having good ventilation but without draught and it can be heated. Stables can be reconstructed as well, or old-type, well-isolated farm buildings with thick walls can also be utilized (*Potháczky, 1990*).

Many attempts were made for keeping females in free harems and between them the application of passage ways for males was common. This kind of housing and mating system is called polygamous. (*Várady, 1989*). Distribution of deliveries during a year, the effect of season on the average litter size at parturition, weight of the litter and the pre-weaning mortality are amongst the features that are connected with the reproduction and rearing ability of chinchillas which have been studied by Garcia et al. (1996), Lanski (1996); Szatkowska and Sulik, (1996).

Lanski, 1996 found that chinchillas which were born in a litter with smaller size and so having bigger bodyweight would be bigger at weaning (2nd month) and at the date of appearance examination (7th month).

The most dangerous period when rearing young chinchillas is the first week after birth because 70% of the mortality occurs during this interval. Mortality rate can be reduced by changing the housing system and management technology. With growing litter size the weight of each animal and the possibility to be brought up gradually decreases (*Lanski et al., 1997*).

The Aim of the Experiment

For the breeder, in case of economical production, the most important fact is the reproductive performance of the animals. Therefore one should provide the animals with the best environmental conditions, proper quantity and high quality food, because these exterior factors have a great effect on the reproductive performance.

Our scientific investigations were performed on the farm of Wagner and Co. Ltd in Koppánymonostor. We sought the answer to the following question: what kind of effect has the different housing technologies on the reproductive performance of the population.

This study is very important because the reproduction rate has great influence on the number of pelts produced per breeding animals.

The following questions were posed and traits evaluated when comparing two different housing and management technologies:

- The frequency of parturition per female breeders in a year
- What correlation exists if any between the litter size and the housing technologies
- Distribution of parturition considering the date of parturition
- The distribution of sexes among young chinchillas
- The distribution of litter size at parturition
- The correlation between the date of parturition and the litter size
- The number of stillborn young chinchillas and the rate of pre-weaning mortality
- The correlation between the mortality rate and the litter size

Material and Method

Our investigations were carried out at the farm of Wagner and Co. Ltd in Koppánymonostor. Chinchillas have been housed and bred on this farm since 1978. At the moment there are 500 mothers and all together 4,000 chinchillas could be housed there. 50% of the breeding stock originates from the Bowen Farm in USA and the rest originates from Western Europe. From the 3 blood-lines that are bred all over the world, the farm breeds a line of German-Swiss origin. Previously a bedding-tray system was used and now the Californian type battery-system is common.

The dimensions of the battery-unit were: 40 centimeters wide, 50 centimeters deep and 40 centimeters high. The material of the battery is spot-welded grid galvanised with zinc. Separation walls are made of laminated furniture panel. The part of the battery at the bedding tray system is the bedding

tray that contains shavings and the animals live here. Every unit has a sand bath. On this farm there are used only shelf system sand-baths. At the battery-housing system there are no bedding trays. The batteries can be managed only from the front.

Chinchillas are placed in three-storey batteries in a big closed room with windows and the room can be heated in the winter. The rate of relative humidity is 60-80%. The animals are given chinchilla feed and high quality meadow hay ad libitum. Water for drinking is available as the animals require it using an automatic drinker. A polygamy reproductive method is used.

The comparison was made within the population of the same stock but not within the same generation. The different housing and management technologies were not used parallel at the same time but one after the other. In the case of the bedding tray system we compared the data of years 1992-93 and 1995-1996. In the comparison the data of the year 1994 are not found because the change of housing type was made this year and any change in the stock's performance would not have given a real picture of the population.

Results and discussions

Data of parturition in the two different housing systems were collected: number born loss due to abortions, number of stillborn and the pre-weaning mortality rate are shown in Table.1

Table 1. Summarised indices of reproductive performance in different housing and management technologies

Description	Bedding-tray		Battery-housing	
	1992	1993	1995	1996
Total number of parturition	616	561	756	639
Total number of born chinchillas	1 063	946	1 399	1 160
Proportion of males (%)	53,52	55,07	54,18	53,7
Proportion of females (%)	46,47	44,92	45,81	46,29
Rate of abortions (abortions/total of parturition*100) (%)	1,78	0,53	0,39	0,93
Stillborn percentage (%)	5,83	4,43	8,07	4,13
Pre-weaning mortality (%)	13,35	12,68	9,22	11,81
Average litter size at birth	1,64	1,54	1,81	1,73

Examining the average litter size at birth per month and frequency distribution of parturition we can see that the most occurred in the period from March till May and from July till September (Fig. 1). The second period shows lower litter size than the first peak (Table. 2).

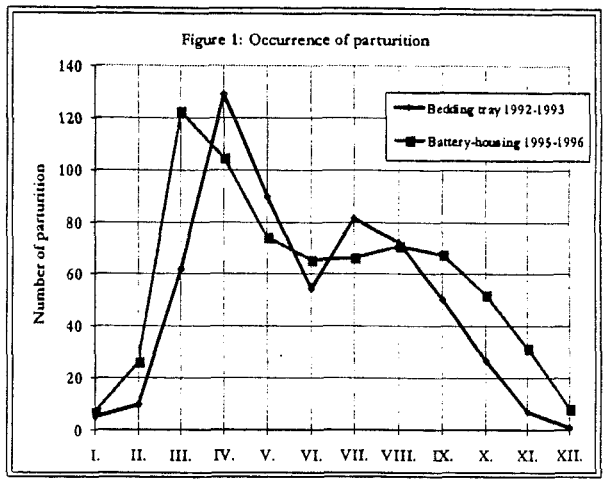


Table 2. Litter size of one parturition per months with different housing technologies

Month	Bedding-tray		Battery-housing	
	1992	1993	1995	1996
January	1,77	1,00	1,50	1,73
February	1,88	1,00	2,22	1,99
March	1,75	1,78	2,04	2,05
April	1,94	1,62	1,89	1,95
May	1,92	1,91	1,95	1,85
June	1,85	1,94	1,96	1,95
July	1,71	2,00	1,94	1,80
August	1,64	1,32	2,01	1,78
September	1,32	1,39	1,71	1,85
October	1,17	1,24	1,38	1,34
November	1,12	1,33	1,62	1,14
December	-	2,0	1,50	1,33
Average	***1,64***	***1,54***	***1,81***	***1,73***

The figures show that the yield of parturition was better if the animals were housed in batteries.

The analysis of distribution and the average shows that the stock is homogenous.

The aim of our investigation was to analyse the correlation between the different types of housing and management technologies and reproductive performance. We carried out significance analysis as well. We used the analysis of variance, (Table 3), the T- test and the Bartlett's test.

Table 3. Analysis of variance

Source	SS	DF	MS	Fvalue	Pr>F si n.F.
Total	4.6516936E+00	46			
Between groups	3.7503275E-01	1	3.7503275E-01		
Within groups	4.2766609E+00	45	9.5036908E-02	3.95E+00	0.0503(+)

Bartlett's test

Group	SS	DF	Distribution	Chi²
1992	2.5254609E+00	22	0.339	26.573NS
1996	1.751200E+00	23	0.276	18.427NS
Total	--			

Comparing the two groups we found that the correlation was only significant at the P=10% level. The results prove that the housing systems might have some effect on the reproductive performance of chinchillas but this is not statistically important.

It is very important to evaluate the average litter size at parturition, because the aim of the breeder is to produce the greatest possible number of progenies (Table 4).

According to Swedish surveys in the case of 184 farms and 5,000 mothers the average number of chinchilla offspring is 1.91 born litter. 34% are born as singles, 44.6% are born as twins, and 17.7% as triplets and 3.2% four and 0.3% more (*Deutsche Pelztierzüchter, 1987*).

Table 4. Proportion of litters by litter size categories at parturition and housing systems

Litter size	Bedding tray	Battery-housing
One	43,85	38,76
Two	41,66	40,86
Three	12,51	17,81
Four or more	1,97	2,56

Bedding-tray = proportion of litters by size categories in 1992-1993

Battery-housing = proportion of litters by size categories in 1995-1996

The table shows that bedding-tray housing the rate of litter size with one or two offspring was higher than those with four. In battery housing the proportion of the litters with one or two offspring was lower and the number of parturitions with three offspring increased.

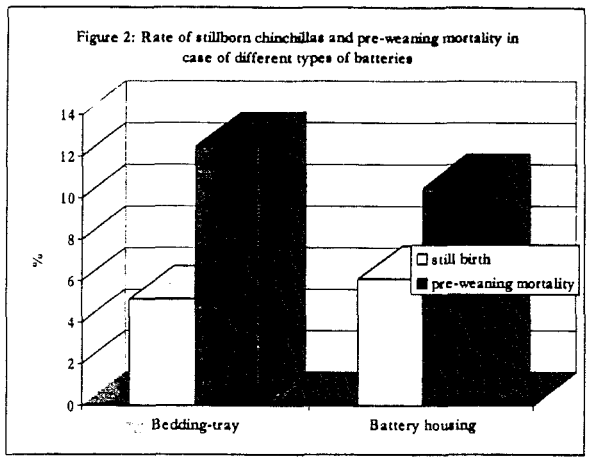
Parturition seems to be continuous throughout the year, but most of them occur during the period of March to May as well between August to October. The first period is better than the second one.

In litters with two or more offspring we could observe the same as mentioned before with the difference that the second period falls onto August and September, so it seems to be shorter. Parturition with three litters covers the period from March to July but with a great drop in June. In the other months it showed a sporadic occurrence.

Parturition with four or more offspring can be observed in the period of March to July. It is very important that there were no parturition of this size between late autumn and early spring.

According to references the average litter size per parturition is 2.03 (Anon, 1989), 1.75 (*Neira et al., 1989*) and 1.94 (*Szakowska and Sulik, 1966*). Considering the percentage of litters with different sizes we have found results similar to our

investigation (*Neira et al., 1989 and Anon, 1989*). Mothers can be featured through the average litter litter size or the rate of mortality. When calculating mortality rate we distinguished between stillborn ones and those that died before weaning. Figure 2 shows the results of the comparison.



The figures show that the number of stillborn was higher in battery housing but the rate of pre-weaning mortality decreased.

Studying the rate of mortality as a unit (Fig.3) we could observe that the rate of mortality was higher in bedding tray housing. In battery housing the rate of mortality is lower and the rate of weaned and skinned animals was higher. Figure 4 shows the correlation between the rate of mortality and litter size.

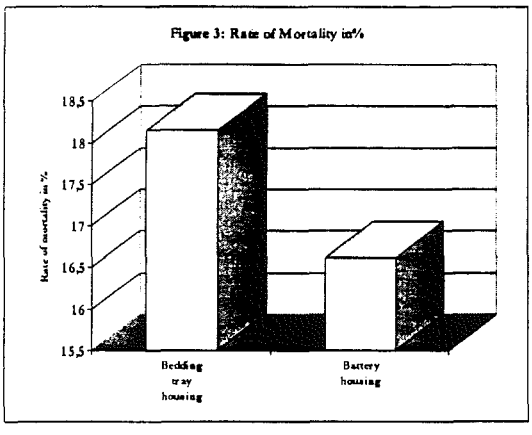
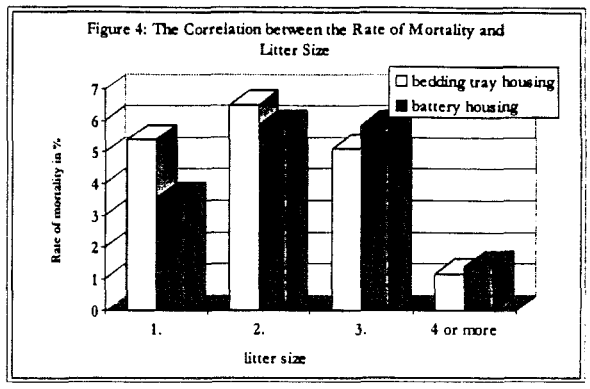


Figure 4 shows a similar trend in the distribution of litter size in the two housing systems. In battery housing the higher rate of parturition of three of four was followed by a higher rate of mortality. But in bedding tray housing the rate of mortality was much lower with litter sizes of one or two.

The litter size at parturition gives information on the rate of weaning. A litter size of two is the most beneficial because of the lowest rate of mortality. As a result only two chinchillas can be reared in litters of three or four as well. Therefore it is no use to raise the litter size in case of small stocks.



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SECOND NATURE

The Animal-Rights Controversy

Alan Herscovici

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Original review

Management and welfare in mink

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Introduction

In a previous paper, the significance of the cage environment to the welfare of the farm mink was discussed (*Hansen, 1998*). This paper deals with the daily management which decides how the mink are thriving in the cages and sheds offered to them on the farms. Good management may in some cases make up for unfortunate housing conditions, whereas optimum design of the farm may result in lower requirements with regard to management. Inexpedient application may ruin the welfare in an otherwise well-designed environment, if for instance many kits are placed in a standard mink cage. It may therefore be difficult to separate the effect of management and environment and a certain overlapping cannot be avoided. The still increasing productivity of our mink, especially in the form of increasing litter size and increased growth makes still higher demands on management as well as environmental conditions if the welfare of the mink is to be ensured. The development of management in mink production primarily took place on the basis of production results obtained in practice or on experimental farms. Hence there is a risk that the welfare of the animals was not always considered sufficiently. In many areas the factors giving high productivity and good welfare interac, but in some areas there is no or even a negative correlation. A good production result is therefore no guarantee of good animal welfare on the farm. If welfare was included in the evaluation of management, production and welfare could be weighed against each other, so that both could be given as much consideration as possible. Another combination of management factors might give better welfare with the same productivity and work load.

In mink production the natural annual rhythm of the animals with regard to heat, mating, whelping, nursing, weaning and growth is followed. As welfare problems are often caused by deviations from the natural life rhythm of the animals, good conditions exist of ensuring the welfare of the mink on the farms. The problem lies in finding the environment and management which best consider the requirements of the farm mink, but no basic production conditions prevent this from being done.

In this paper, management means all the different management routines required to run a mink farm. The most obvious are feeding, bedding, mucking out etc. which take place all year round. Other routines are connected with a specific production period, as for instance evaluation of testes, mating, moving of females, counting and weaning of kits. It is characteristic to mink production that management routines differ very much between the different production periods throughout the year with regard to content as well as work load. This is what makes it exciting to be a mink farmer, but it also means that it takes many years to build up experience in each specific production period. There is therefore a need for a general accumulation of

knowledge and experience about the production and welfare consequences of management and housing conditions.

One among many definitions of welfare is that it consists of "negative and positive experiences by the animal" (*Simonsen, 1996*). An important element is therefore that the animals are not exposed to negative experiences such as hunger, thirst, heat/cold, disease or fear. Positive experiences are more diffuse, but the difinition as well as the word welfare in itself indicates that freedom from the above mentioned problems is not enough. For mink, welfare might be enhanced by more stimuli in their daily life. Another significant point is that it is the experience of the animal that counts not our idea of what the animal experiences. Methods for measuring the experiences of the animals are needed to evaluate welfare. As the animals cannot express their experiences directly, these measuring methods must be indirect. It is generally accepted that the evaluation of animal welfare must at least build on a combination of recordings of physiology, behaviour and health. In agricultural research several experiments are done to evaluate welfare at herd level. The project "Development of an ethical account in animal husbandry" works with a welfare evaluation based on a description of housing, management, behaviour and health in cattle and pig herds. By comparing the different indicators it is possible to evaluate the development in animal welfare over time within a specific herd *(Sørensen & Sandøe, 1995)*.

In general, shortcomings in management might threaten the welfare of mink, but in some situations and periods of the year the risk will be greater than in other periods. In the following, a number of examples show how the daily management affects the welfare of the mink. The examples illustrate how the farmer himself may make an effort to improve welfare and how an extra effort may alleviate the effect of conflicting interests between productivity and welfare.

Watering and feeding

Water supply

Irrespective of the design of the watering system it is the responsibility of the farmer to make sure that the mink are every day offered drinking water in adequate amounts and of good quality. The system must therefore be checked daily and especially in cases of reduced appetite in general or in certain individuals. The quality of water from the waterworks is checked regularly, whereas water from own water supply should be analysed at least once a year. Irrespective of water supply, it might be a good idea to analyse the water offered to the mink, i.e. from a valve farthest out in the system. This will show if the water keeps its quality throughout the watering system.

The mink's need for drinking water depends on the water content and composition of the feed, the ambient temperature, the actual production period etc. The requirement is thus much higher in nursing females than in barren females and in animals on dry feed compared to wet feed. In every day life it is assumed that a watering system with drinking nipples is sufficient to ensure the water supply of the mink. This is, however, not always the case and if so the farmer must interfere with supplementary measures to ensure production as well as welfare. Critical periods would typically be:

- Hard frost when the water freezes – it must be thawed several times a day or water must be offered in a drinking cup. In cases of extreme cold which hardly occurs in Denmark it has been reported that the mink may freeze on to drinking bowls of metal. In such cases the mink's need for liquid can be covered by snow.
- In the nursing period – extra water is mixed into the feed and feed is given on the lid of the nest box when the kits start eating 4 weeks after birth. Supplementary water is given in a drinking cup, kit bowl, or as dripping water etc. It has been shown that both the kits and the female drink more often when supplementary water supply is established even though it can only be seen in the growth rate in years with ambient temperatures above 20-25°C during daytime in the nursing period (*Møller & Lohi, 1989*). It has been said that mink kits in nature will lick water from the female's wet pelt when she has been swimming, but we have never succeeded in confirming this despite intensive observations of experiments with water trays and showers (*Hansen, 1990; Møller & Hansen, 1993*).
- At weaning – it must be observed whether the kits have learned to use the drinking nipples before the female is removed. If not, a water cup,

kit bowl, etc. must be offered until they have learned.

- In case of high temperatures – mink know better how to keep the warmth than to get rid of it. In hot weather the mink try to avoid too high a body temperature by keeping quiet, lying with so large a surface as possible and by evaporating water through breeding. Occasionally death occurs if the animals lie in the sun. The farmer must therefore ensure sufficient drinking water and aim at having shadow in the sheds, wake up mink lying in the sun and maybe lower the temperature by water atomization or showering. The use of showers will reduce the temperature for a short time, cool off the animals that use it and in general activate the mink (*Møller & Hansen, 1993*).
- In case of high water temperatures – in sunlit hoses the water can get as much as 45°C warm or more. In watering systems without circulation, many farmers therefore turn the water on at the end of the system so that there will be fresh water for all the mink. It may also be a good idea to let out old stagnant water to avoid bacterial growth especially in hot weather. The mink do, however, not mind drinking water as hot as 40°C (*Møller, 1988*), so if the water does not go bad, the mink do not care. As cold water makes the mink drink fewer times, and as warm water is absorbed more quickly from the stomach, it may be an advantage that the water is not too cold.

Slimming of breeding females during the winter

As breeding females are not selected until after live animal grading in November, all females are fattened for the pelting season. It has therefore become tradition to slim the females up to 30% compared to their weight in November to facilitate flushing before mating. There is no documentation in research to prove that heavy slimming of the females has any effect, and flushing just presupposes that the females are hungry when the flushing starts. This can be obtained by 14 days of restrictive feeding prior to flushing 4-5 days before start of mating (*Tauson, 1985*). It may be natural for mink to use up their fat deposits in the winter period, but a weight loss removing the entire fat reserve of approx. 30% of the body weight in November must be stressing to the females.

Problems of welfare and ethics especially occur with the combination of too thin females and frosty weather which makes it very difficult to make the skinny females eat sufficient feed to maintain body weight and temperature. In Denmark it has been found that the medium temperature in January, February and March can explain 48% of the variation in deaths in the period (*Møller, 1992*). One of the reasons is assumed to be a large variation in the activity of the animals and hence in energy consumption. As the activity seems to increase further with restrictive feeding, some mink may get into a vicious circle when they loose weight quickly.

Females loosing a lot of weight (approx. 30%) tend to have poorer whelping results than females loosing a moderate amount of weight (10-15%) (*Tauson & Alden, 1984*), but it is uncertain whether the effect is caused by a large weight loss or by a high weight in November. Due to limited group sizes, statistically significant differences in whelping results have only been found as an exception when examining the significance of weight development and flushing. A project has just been initiated at the Danish Institute of Agricultural Sciences in order to clarify whether a more moderate slimming than what is usual in Denmark may give just as good or even better whelping results. In relation to a weight loss of 30%, fewer deaths in the winter and fewer problems with greasy kits on the farms in question should at the same time be expected.

It is thus uncertain whether there is a real contradiction between litter size and welfare, until the significance of slimming to behaviour, activity and especially litter size has been clarified. In any case, production as well as the welfare of the animals will be considered through an individual feed allocation based on weekly evaluations of the body condition of each individual female throughout the winter. This way females loosing weight quickly can be given additional feed, so as to avoid a weight loss endangering the welfare of the females.

Feeding and feed placement in the nursing period

Just like water supply, feeding in the period until weaning is important to the welfare of the kits. In large litters, it will be difficult for the female to produce enough milk for the kits, and their own feed intake is therefore essential right from the moment

they start eating at the age of 4 weeks. If the kits cannot reach the feed, the female will try to cover their need by moving feed down to them *(Møller, 1993)*. This was, however, not enough to cover their requirement which resulted in a lower growth and a higher frequency of saliva licking, fighting and mortality in kits that could not reach the feed *(Møller, 1996)*. The usual practice of feeding on the lid of the nest box and of feeding several times a day in this period thus ensures the welfare of the kits as well as of the females. It is essential that there is food on the wire all the time. In order to avoid dirty nests, it is important that feeding on the nest box does not start too early, as the kits neither eat nor are capable of transforming mink feed until they are 4 weeks old.

Feeding in the growth period
Allocation of feed ad libitum throughout the growth period means that especially the organs of the male kits are exploited completely. For some of the kits the limits are crossed and sporadic deaths occur caused by urinary disorders, thrombosis or welfare disease. Even though the extent of the problems varies and can be reduced with increased knowledge and better management of the feed composition etc. the farmer himself may help by reducing the amount of feed. As this will in general give smaller pelts, it is only done when the problem occurs, and other solutions to this problems are therefore neecessary.

Handling

Handling in general
Handling in general will be stressing for the mink on a short time basis. Depending on how often and how they are handled, this may affect the welfare of the animals. Some cases show that animals that have been weighed frequently react more confidently than animals that have not been weighed on some farms *(Møller & Hansen, 1988)* which seems to indicate that handling in connection with weighing may be regarded as something positive by the mink. It has not been examined what the quality of this positive handling consists of. It is more important that it happens quietly and safely than whether a glove, a trap or a pair of tongs is used. On some farms the farmer can open the lid of the nest box and take out the mink, whereas others are used to catching the mink in a trap in front of the hole of the nest box or with a pair of tongs. The moving of animals on the farm is often done most gently and safely in a trap, but mink should *not* be carried by the tail.

Early handling of mink kits may have a positive effect on the minks' later conception of handling. No difference in the effect of presumed positive and negative handling has been found, and in ordinary farm practice the effect is equalized during the month of September *(Hansen et al., 1992; Houbak, 1991)*. It has been proved that for instance foxes and cattle can distinct between persons with different colours of clothing performing positive and negative forms of handling *(Bakken et al. 1993; Munksgaard et al., 1997)*. If something similar can be said for large mink kits, it might be avoided that an unpleasant vaccination will negatively affect the mink's experience in connection with later handling.

Weaning and separation
The optimum weaning time depends on several conditions. The behaviour of the animals and their various physiological expressions of stress may tell when weaning is regarded as stressing for the kits as well as the female. Litters weaned altogether between 6 and 10 weeks are not affected very much, whereas kits placed singly at the age of 6 to 10 weeks react very much. The behaviour of the kits (activity and calling sounds) and blood values (eosinophil counts) indicate that the stress of weaning decreases from the age of 6 to 10 *(Houbak & Jeppesen, 1988; Jeppesen et al., 1988; Malmkvist et al., 1977)*. Apparently the female is stressed when she is separated from the kits at the age of 6 weeks, whereas it will be even more stressing for her to stay with the kits until they are 8 or 10 weeks old, when the weaning results in a decrease in the stress level *(Jeppesen et al. 1988)*. As the female reacts to the calling sounds of the kits after weaning, she should be moved to another section of the farm.

Especially in large litters, the kits are a stressing factor for the female who may develop nursing disease and die if the kits are not weaned and the female treated. It may therefore be necessary to wean the kits as early as the age of 5 weeks if the female is very stressed. The females almost stop eating in the days after weaning *(Sørensen et al., 1997)*. Some farmers have experienced that it may be an advantage to leave a male kit with the female when weaning females with the risk of nursing disease. Litters that have to be weaned early must undergo special treatment in the form of feed with a extra high water content and water

outside the nest box. Weaning at the age of 5 weeks is damaging to the growth rate, but with special treatment kits in good condition will get over this and even be bigger at pelting than kits weaned later (*Neil, 1984*). The need for additional water and an increased water content in the feed is due to the fact that mink kits only learn to drink from the water nipples at the age of 6 weeks. (*Møller & Lohi, 1989*).

Weaning is also of importance to the later properties of the kits. Female kits weaned and placed singly before the age of 8 weeks mated normally, whereas the corresponding male kits mated more poorly the earlier they had been isolated. If the kits are placed in pairs, male and female, no difference in mating willingness or capability is found between mink weaned at the age of 6, 8 or 12 weeks *(Hansen, 1987)*.

It can be concluded that the choice of weaning time is a compromise between consideration for the kits and the female. For the sake of the welfare of the animals, the best weaning time is 7 to 8 weeks after birth, whereas the risk of nursing disease may in an emergency justify weaning as early as 5 weeks after birth. The litters should be kept together for a period or placed one male and one female together after weaning to ensure normal behavioural development, and the female should not be in a position to get in contact with the kits after weaning. Ordinary Danish farm practice is thus in good agreement with factors related to production as well as welfare.

Killing

In mink production, many of the stressing situations discussed in connection with the killing of other domestic animals are avoided. The mink are killed in a box immediately in front of the cage and thus avoid transportation. They are anaesthesized with CO_2 or CO until they are dead and this happens fast and without reactions indicating fear or other forms of discomfort (*Enggaard Hansen et al., 1989*). It is essential that the CO_2 concentration is 100% before the killing starts and that the mink are killed individually in a trap or with sufficient intervals so that unconsciousness has set in before the nest animals is placed in the box.

The assistant/keeper

The management factors mentioned so far are comparatively easy to record or measure, e.g. how much weight the females lose during the winter, whether the watering systems is working and how many animals are in the cages etc. These conditions are important, but another factor in management is equally important or maybe even more important, but difficult to measure. That is the "quality" with which the management is performed and which depends on the qualities of the mink manager. Such qualities in the manager could be:

- his attitude towards animals – does he regard them as individuals or as "production units"
- his personality and attitude towards the animals – is he calm and secure and thus predictable to the animals or anxious and nervous and unpredictable to the animals
- his ability to observe and spot the signals of the animals – is "something" wrong in the shed, e.g. a false sound, smell, behaviour or something else requiring an examination or an action. It may be decisive both to the success of the treatment and to the welfare of the animals if sick or injured animals are found early or late in the process. This is for instance often the case with greasy kits.

These "soft" qualities decide *what* is observed, *when* it is observed and *how* the reaction is. They are therefore of great importance to people responsible for animals, but they are also qualities of which we know very little as they are difficult to handle scientifically. To the individual farmer is may also be more interesting how these qualities could be improved. In general, curiosity and interest in the animals you work with combined with the daily care of the animals will be a sound foundation for development of the qualities mentioned in the management.

Breeding for behaviour - welfare

Leaving out fearful animals from breeding has had the result that the mink has become less fearful and easier to handle since the domestication of the mink started. It has primarily happened indirectly by not using the most difficult animals in the breeding work. There is, however, still large differences in the temperament of the mink, between individuals as well as on the individual farm. It is therefore still possible for the farmers to consider the welfare of the mink by including the behaviour of the animals in the breeding work.

Discussion

Concurrently with the increasing focus on the welfare of our production animals, welfare has also increasingly been included in the daily management routines on the mink farms. This development is certain to continue and must be expected to result in a more deliberate evaluation of the consequences of management and housing for welfare. As mentioned in the introduction, this will cause no problems in the areas where productivity and welfare go hand in hand. Nor will it be a problem to motivate to an extra effort in areas where the welfare can be improved without influencing the production. Where it may be necessary to discuss and weigh between different considerations will be in cases where considerations with regard to production may come into conflict with the consideration for the welfare of the mink. What does selection after size mean to the welfare of the mink? How to avoid for instance leg disorders and other health problems as seen in other sectors of animal husbandry? Do larger mink need slimming prior to the mating season? These questions are already being discussed, and there are, therefore, good possibilities to weigh the many different considerations and choose a strategy instead of being forced to change the strategy when it appears that some important considerations were overlooked.

In the concrete weighing between the consideration for production and welfare, it is difficult for welfare to compete with immediately understandable factors such as skin length, price and litter size. The development of a method for welfare evaluation of mink production is therefore necessary in order that the consequences of management and housing conditions to production and welfare can be evaluated on equal terms.

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Distribution of technetium 99m-labeled red blood cells during isoflurane anesthesia in ferrets

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Objective. To address the physiologic mechanism of isoflurane-associated reduction in hematologic variables in ferrets.

Animals. 6 young adult female ferrets.

Procedure. Distribution of ^{99m}Tc-labeled autologous erythrocytes was measured by serial in vivo imaging. Data were recorded in 4 ferrets, using a gamma camera, immediately prior to anesthesia, 15 minutes after 2% isoflurane anesthesia in O_2 via endotracheal tube, 1 minute prior to and throughout a 10-minute phenylephrine infusion, 20 and 40 minutes after termination of the phenylephrine infusion, and 45 minutes after termination of anesthesia. Blood indices were also measured at times that paralleled those for imaging. One ferret served as a conscious control (no anesthetic administration), and another as an isoflurane control (no phenylephrine administration).

Results. In ferrets under anesthesia, splenic radioactivity increased from baseline of 10.2 ± 2.0% to 38.4 ± 3.2% (mean ± SEM; $P<0.05$) of the injected dose. Splenic radioactivity decreased to 13.4 ± 3.8% of the injected dose during phenylephrine infusion and to near baseline for the recovery image. Splenic radioactivity in the conscious control remained constant throughout the study, whereas that of the anesthetized control was persistenly increased throughout administration of isoflurane. Percentage reduction of the 15-minute sample values, compared with baseline values for all hematologic indices, was: RBC count, 33% ($P<0.05$); hemoglobin concentration, 34% ($P<0.05$); hematocrit, 35% ($P<0.05$); and plasma protein concentration, 20% ($P<0.05$). All RBC variables returned to within 7 to 14% of baseline by 45 minutes after termination of anesthesia.

Conclusion. Isoflurane anesthesia causes splenic sequestration of RBC in ferrets that is partially reversed by phenylephrine infusion or termination of anesthesia. Thus, investigators and clinicians should be cautious when interpreting hematologic findings in isoflurane-anesthetized ferrets, and accordingly, fluid treatment and transfusion should be planned.

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Embryo cryobanking for conserving laboratory and wild animal species

Sergey Amstislavsky, Tamara Amstislavskaya, Michael Stein, Leonid F. Maksimovsky, Arkady L. Markel, Yulia G. Ternovskaya, Dmitry V. Ternovsky

Genotype markedly affected the post-thaw survival and quality of mouse and rat's embryos. The percentage of viable embryos after freezing - thawing was highest in ISIAH rats and hybrid ICR x CBA/ lac mice and lowest in WR/y mice. An original model of rat embryo transfer has been developed in this study. Embryos of rats with inherited stress induced arterial hypertension (ISIAH strain) were transferred to normotensive Wistar rats. Cryopreservation of these embryos was used in some trials. Blood pressure was significantly lower in the living offspring developed from ISIAH embryos transferred to Wistar females as compared to donor ISIAH rat strain, but only in the cases when cryopreservation of embryos was used. The influence of embryo cryopreservation on phenotypic expression of some physiological characteristics in the living offspring after transfer of these embryos should be taken into account in embryo freezing programs. Nowadays, there is an urgent need to save endangered species. The possibility of stoat (*Mustela erminea*) and ferret embryos being successfully cryopreserved has been shown in this study. The viability of frozen-thawed embryos was evaluated by culturing them in vivo (stoat) or using fluorescein diacetate technique (ferret). We hope that these results will make it possible to create embryo cryobanks of endangered carnivorous species.

Scandinavian Journal of Laboratory Animal Science, 23, SUP1, pp. 269-277, 1996. 4 tables, 4 figs., 29 refs. Authors' summary.

The effect of genotype and physiological condition on the content of some minerals in the fur of coypu females

D. Mertin, K. Süvegova, P. Fl'ak, P. Svatko, I. Tocka

Six female coypus of different mutations - standard, Greenland, silver and white - were included in a trial conducted in the Research Institute of Animal Production at Nitra. The animals were housed in halls, in one-storey cages with pools. They received granular feed mixture KK, and alfalfa and fodder beet as saturation supplement. Water from pools was used for drinking. The objective of the trial was to determine Ca, K, Na, Mg, Fe, Zn, Cu, Mn, Co concentrations in the fur of female coypus in certain body regions, in the central dorsal and ventral regions, and in relation to the physiological condition (stage): 1. primiparas, age 8 months - fur maturity stage, 2. females on the day of delivery, 3. females on the day of weaning. Fur samples were taken by clipping under halothane anesthesia. One sample consisted of about 2 g of fur. Element contents were determined by the method of atom absorption spectral photometry. Three measurements of each sample were done. The results were subjected to mathematico-statistical processing by two-factor analysis of variance. Ca concentrations in the coypu fur were 1 220.45 in the dorsal region and 1 409.07 mg/kg dry matter in the ventral region. The concentration was highest in standard coypus. Maximum concentrations were observed after delivery. K concentrations amounted to 404.43 in the dorsal region and to 195.01mg/kg dry matter in the ventral region. The concentration was highest in standard coypus. Maximum values were recorded in the dorsal region after delivery and in the ventral region after weaning. Na concentrations were 244.48 and 125.43 mg/kg dry matter in the dorsal and ventral regions, respectively. Maximum concentrations were observed in white coypus. Na concentration was highest in the dorsal region after delivery and in the ventral region after weaning. Mg concentrations were 584.50 in the dorsal region and 601.93 mg/kg dry matter in the ventral region. It is interesting that the highest concentration of this element was recorded at the age of 8 months while the lowest at the time of weaning. Fe concentrations were 139.97 and 128.70 mg/kg dry matter in the dorsal and ventral regions, respectively, with the maximum value in standard coypus. Fe concentrations showed their increase in relation to the physiological condition. Zn concentrations were basically identical, 152.85 in the dorsal region and 152.93 mg/kg dry matter in the ventral region. The highest Zn concentration was observed in white coypus. Zn concentrations were also balanced with respect to comparison of physiological conditions. Cu concentrations were 6.29 in the dorsal region and 6.87 mg/kg dry matter in the ventral region; the highest concentration was observed in Greenland coypus. The lowest concentration was measured after delivery. Mn concentrations in the coypu fur were 2.46 and 3.90 mg/kg dry matter in the dorsal and ventral regions, respectively. Substantially lower Mn concentrations were observed at the age of 8 months. Co concentrations were 0.71 in the dorsal region and 0.65 mg/kg dry matter in the ventral region. These concentrations at the age of 8 months and at the time of delivery were basically identical with the higher values at weaning. It can be concluded from the results that mineral composition of the fur of adult female coypus varies in relation to age, genotype and physiological condition.

Zivocisna Vyroba, 42 (4), pp. 149-157, 1997. 2 tables, 26 refs. In SLOVAK, Su. ENGL. Authors' summary.

Seasonal and circadian changes in activity rates of adult farm blue foxes

Hannu Korhonen, Paavo Niemelä

The present paper reports systematic activity rates obtained from year-round video recordings of farmbred blue foxes *(Alopex lagopus)* housed singly in conventional wire-mesh cages (107 cm wide x 110 cm long x 70 cm high). Subjects were 9 males and 13 females. Mean whole-year activity rates were slightly higher in males (394 ± 116 min/24 h; mean ± SD) than females (349 ± 111 min/24 h). Significant ($P<0.001$) seasonal variations were found in the activity rate of both sexes. Females were most active in May (539 ± 157 min/24 h) and males in June (471 ± 128 min/24 h). Lowest activity rates were in September. Activity rates of males, in particular, tended to increase at the approach of the breeding season in March. Seasonal activity patterns of farmed foxes resembled that of foxes living in the wild. Circadian activity was concentrated on farm work hours (0800-1600) in winter, but not in

summer. Typically farmed blue foxes were most active between sunrise and sunset. Diurnal pattern of farmed foxes is markedly different to wild foxes which typically exhibit a more nocturnal pattern of activity.

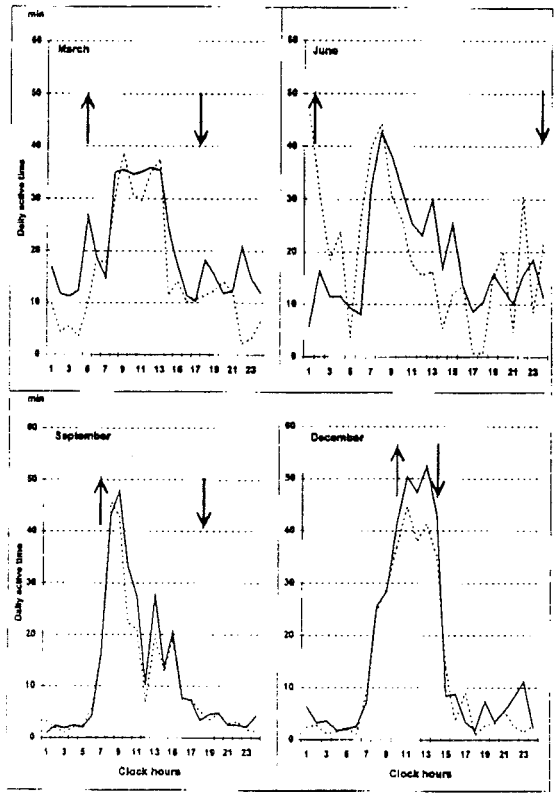


Fig. 3. Examples of circadian rhythm of activity in males and females during four different months. Sunrise and sunset are marked with arrows. Broken lines are female activity curves.

Agricultural and Food Science in Finland, Vol. 7, pp. 21-29, 1998. 3 figs., 35 refs. Authors' summary.

Pelt production in different districts

H.A. Kulbotten

In 1994-95, the production of silver fox and blue fox pelts in Norway totalled 58,823 and 225,396, respectively, and the production of Scanbrown and Scanblack mink pelts (from males) was 21,497 and 34,938. Data are tabulated by district and by pelt size, quality and price.

Norsk Pelsdyrblad 70, 4, pp. 10-11, 1996. 4 tables. In NORG. CAB-abstract.

A mutation in the lipoprotein lipase gene associated with hyperlipoproteinemia type 1 in mink: Studies on lipid and lipase levels in heterozygotes

Anna Lindberg, Knut Nordstoga, Bjørn Christophersen, Roger Savonen, Arie Van Tol, Gunilla Olivecrona

Severe hypertriglyceridemia was previously observed in mink. Affected animals had no detectable lipoprotein lipase activity, but normal amounts of lipoprotein lipase protein in post-heparin plasma. We have now cloned CDNA for lipoprotein lipase from normal mink and identified a single point mutation in the affected animals which most likely explains the deficiency of active lipase. The mutation is located in exon 6 and results in a Pro214Leu substitution. In heterozygote mink the levels of lipoprotein lipase activity and mass in post-heparin plasma were lower than in normal mink, but could not be used to identify carriers of the mutation. In some tissues (heart, muscle, kidney and lung), lipoprotein lipase activity was decreased to about 50%. In adipose tissue there seemed to be a mechanism to compensate for the mutation, resulting in increased mass and approximately the same activity of lipoprotein lipase as in animals not carrying the mutation. Mink had high lipoprotein lipase activity and mass in kidneys, although the levels of MRNA in kidney were many fold lower than in adipose tissue. Mink had very low levels of cholesteryl ester transfer protein activity in plasma. This may contribute to the high levels of HDL in this animal species.

International Journal of Molecular Medicine 1, pp-529-538, 1998. 4 tables, 7 figs., 49 refs. Authors' summary.

Lipoprotein lipase deficiency with pancreatitis in mink: biochemical characterization and pathology

Björn Christophersen, Knut Nordstoga, Yan Shen, Thomas Olivecrona, Gunilla Olivecrona

A severe hyperlipemia in mink, with a pattern that suggested recessive inheritance, was observed at a farm in Norway. On a normal mink diet, affected animals had grossly elevated levels of plasma triglycerides which decreased towards normal on a low-fat diet. Normal mink had the main part of their plasma cholesterol in the HDL fraction. Affected mink, although severely hypertriglyceridaemic, had almost normal levels of both LDL and HDL. Affected mink frequently had lipogranulomas in the mesentery and the pancreas. The lipogranulomatous tissue contained spaces filled with an amorphous, sudanophilic substance with many foamy macrophages in the fibrous tissue between the lesions. Separation of postheparin plasma on heparin-agarose revealed that the affected mink had no detectable lipoprotein lipase activity but normal activity of hepatic lipase. Both normal and affected mink had inactive lipoprotein lipase protein in pre- and post-heparin plasma. This protein, which eluted before the active lipase from heparin-agarose, probably corresponds to lipase monomers. The presence of lipoprotein lipase mass in the affected mink, but no activity, indicates that there might be a point mutation in the lipase gene. The mink provide a new animal model for studies on pancreatitis induced by hypertriglyceridemia and on lipoprotein metabolism in the lipoprotein lipase-deficient state and show features similar to those found in human hyperlipoproteinemia type I.

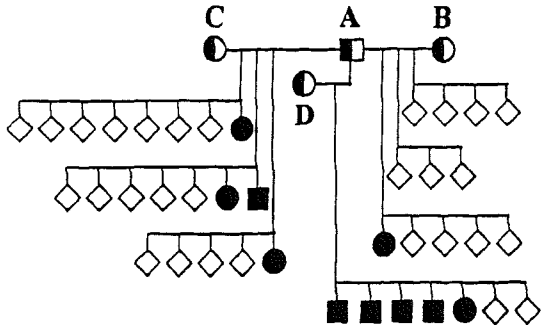


Fig. 4. Family tree from mink colony with hyperlipidemia. The male A (◧) and the females B, C, and D (◐) had previously had offspring with hyperlipidemia but were not hyperlipidemic themselves. A was the brother of B. C and D were his daughters after mating with another female. Not all mink females such as D are successfully impregnated each season. We cannot explain why as many as 5 of her 7 kits were hyperlipidemic at blood sampling at 2 months of age. We cannot exclude the possibility that some kits that may have died in the neonatal period were removed by the keeper and thus not registered; (■, ●) male and female offspring with hyperlipidemia; (◊), offspring without hyperlipidemia.

Journal of Lipid Research, Vol. 38, pp. 837-846, 1997. 1 table, 6 figs., 33 refs. Authors' summary.

Structure of mink immunoglobulin γ chain cdna

Alexander M. Najakshin, Eugenij S. Belousov, BorisYu. Alabyev, Jesper Christensen, Torben Storgaard, Bent Aasted, AlexanderV.Taranin

Two CDNA clones, encoding mink Ig γ chains were characterized. The pIGG47 clone contains a part of the leader segment, VDJ and C regions, and pIGG14 contains a part of the J and a complete C region. The clones differ by only four nucleotides in the C region, and they most probably represent allelic variants of the same gene. The V gene segment of pIGG47 was found to be highly similar to human VHIII subgroup sequences; there was 86-87% similarity for the whole V gene segment and 91% for the VHIII specific regions (codons 65-87). Southern blot analysis demonstrated that a high proportion of mink VH genes is VHIII related. The V gene segment used as a probe revealed 19-23 bands in mink DNA under stringent conditions. This is in agreement with our previous data showing that a high proportion of mink Ig contains an 'alternative' binding site for protein A, a feature common to VHIII-related molecules. According to Southern blot analysis there may be 5-7 Cγ genes at the mink IgH locus.

Developmental and Comparative Immunology, Vol. 20, no. 4, pp. 231-240, 1996. 1 table, 4 figs., 49 refs. Authors' abstract.

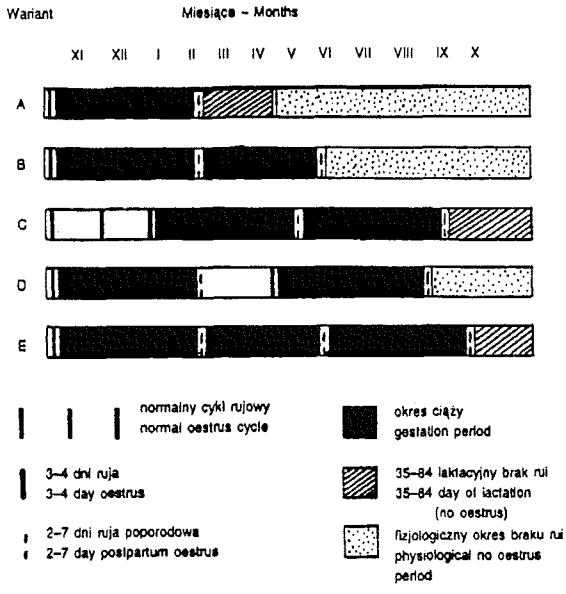
Comparison of various systems of reproductive utilization of chinchilla exemplified by selected farms

M. Sulik, B. Barabasz

The aim of this study was to analyse the systems applied on chinchilla farms with regard to utilization and to define the optimal one. Observations were conducted on 3 chinchilla farms, situated in the north-western region of Poland, in 1986-1991. Every farm had breeding stock of 20-40 females. The authors calculated the mean numbers of whelping females for the study period and the farm, and of born and weaned kits, with respect to the reproductive system used.

The following conclusions can be drawn:

1. On the farms under study variant A (one whelping per year) was applied most frequently: on farm I - it comprised 23,8%, on farm II - 46,4% and on farm III - 50,1% of females.
2. In order to obtain high reproductive performance indices for chinchilla females, a better use should be made of their reproductive ability and attempts should be made to obtain a minimum of two whelpings per year. Also favorable might be the utilization of females according to variants C and D.



Ryc. 1. Schemat wariantów występowania rui, ciąży, laktacji i jałowości u samic szynszyli
Fig. 1. Schematic presentation of variants of incidence of oestrus, gestation, lactation and inter-gestation period

Zeszyty Naukowe Akademii Rolniczej im Hugona Kollataja w Krakowie, Zootechnika, No. 30, pp. 159-166, 1995. In POLH, Su. ENGl. 3 tables, 1 fig. Authors' summary.

Original Report

Steroidogenesis in neonatal blue fox (*Alopex lagopus*)

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Summary

The steroidogenic potential of gonads and adrenals from neonatal blue foxes of both sexes was analysed. Gonads and adrenals from 10-day-old pups were incubated without added hormones or with hCG or ACTH respectively for 3 h, and the media were subsequently analysed by RIA for testosterone, progesterone, estradiol and cortisol. Plasma levels of ACTH, serum levels and gonadal and adrenal contents of testosterone, progesterone, estradiol and cortisol were also measured by RIA. Body, gonadal, adrenal weights and ano-genital distances were determined in blue fox pups at the same age. Ovaries produced small quantities of testosterone and progesterone, and ovarian steroid production was not stimulated by hCG, while testes produced 20-25 times more testosterone than ovaries, and testicular testosterone and progesterone production were increased significantly by hCG. Testosterone and estradiol were not detectable in the serum of both sexes. Adrenals from neonatal pups produced cortisol and progesterone, and there were no sex differences in adrenal steroid production. ACTH did not cause an increase in adrenal cortisol and progesterone production except progesterone production in males. Adrenals produced progesterone 10-15 times higher than gonads in both sexes. Our results indicate that in 10-day-old fox pup gonads and adrenals are active in the steroid production. The higher testosterone productions by neonatal testes suggest the major role of neonatal androgen in sex differentiation of masculine phenotype during the early postnatal period in blue foxes. Our findings have shown a weak adrenal sensitivity to ACTH suggesting an adrenal hyporesponsive period in blue fox neonates.

Introduction

The blue fox (*Alopex lagopus*) is the most popular object for fur farming and has been farmed since the beginning of century in many countries. Despite a long history of breeding in captivity, the reproductive endocrinology of this species has been investigated very scantily. Attention was focused first of all on the hormonal regulation of estrus cycle and pregnancy, and seasonal variations of pituitary and gonadal hormones (*Moller, 1980; Smith et al., 1985, 1987; Mondain-Monval et al., 1988; Noier, 1989; Valberg, Mondain-Monval, 1992; Mondain-Monval et al., 1993*). The artificial conditions of captivity typical for modern fur animal production requires knowledge of the

development aspects of fox endocrinology to improve the welfare and productivity of this species.

As known, the fetal and early postnatal periods are very important for sexual differentiation and formation of adrenocortical stress response *(Desjardins , 1981; Sapolsky, Meaney, 1986; Saez, 1994; Sokka, Huhtaniemi, 1995; Mann, Fraser, 1996)*. Fetal testosterone production increased during late pregnancy and, in many species, in early postnatal development has great physiological significance for male sexual differentiation, and fetal and neonatal androgens are responsible for masculinization of the reproductive system and the developing brain, including neuroendocrine control of gonadotrophic secretion, sexual and social behaviours (*Desjardins , 1981; Saez, 1994; Mann, Fraser, 1996*). Moreover, a number of studies have shown that disturbances of the early postnatal development of pituitary-gonadal axis by neonatal administration of estrogen or androgen to both sexes, immunisation against GnRH, treatment with GnRH antagonists or stress conditions may result in impairment of the pituitary-gonadal function, decreased fertility or infertility and abnormal sexual behaviour in adults (*Sapolsky, Meaney, 1986; Kolho et al., 1988; Pinulla et al., 1993; Brown et al., 1995*).

The studies of the pituitary-adrenal axis in the neonatal rat have shown the existence of a stress hyporesponsive period with reduced pituitary-adrenal response to stress stimuli (*Guillet et al., 1980; Sapolsky, Meaney, 1986; Walker et al., 1986*). The adaptive significance of the hyporesponsive period is related to the protection of the brain during the postnatal development against higher levels of glucocorticoids that are deleterious to its growth (*Sapolsky, Meaney, 1986*). During this period the adrenal cortex is capable of synthesising the low amount of steroids and the hypothalamus-pituitary-adrenal system possesses lower responsiveness to stress (*Guillet et al., 1980*). The stress hyresponsive period in the rat neonate is transient, after two weeks of life the activity of the pituitary-adrenal axis and the responsiveness to stress increase progressively to near adult level (*Sapolsky, Meaney, 1986; Walker et al., 1986*). To our knowledge, the pattern of gonadal and adrenal steroid secretions in the fetal and neonatal periods have not been described in blue foxes. In the silver fox, a species taxonomically closely related to the blue fox, it was reported that fetal gonads and adrenals are able to produce high level of steroids and response to stimulation in last third of pregnancy (*Osadchuk, 1994, 1997*). In the present report, we examined the steroidogenic potential of neonatal gonads and adrenals, their responses to *in vitro* stimulation by hCG or ACTH respectively, and sexual dimorphism in steroid production and serum sex and corticosteroid levels during the second week of life in the blue fox.

Materials and methods

Six blue fox (*Alopex lagopus*) vixens which reproduced successfully the previous year were chosen for the study from the population bred on the Research Fur Farm at the Agricultural University of Norway. All vixens were housed and fed according to the traditional management routines. Near the time of parturition, births were recorded daily in the morning. The day of birth was designated day 1 of life. Litters were left undisturbed until they were used in the study.

At 10 days of age about 50% of the cubs (total n=34) in each litter (half of each sex) were selected randomly. Animals were decapitated as soon as they were removed from the maternity cage between 0900-1100 h to minimise variation due to circadian rhythmicity. The cubs were weighed. The gonads and adrenals were dissected and weighed; ano-genital distance was recorded for each animal. Samples of trunk blood were collected for preparing plasma (for ACTH determinations) and serum (for steroid determinations). The serum and plasma were frozen and kept at -20^0 C before assaying for hormones.

To the purpose of measurements of steroid contents, the gonads and adrenals from 5 pups of each sex were stored in saline and kept at -40^0 C. After thawing, they were homogenised in saline and the homogenates were used for steroid assays. To investigate the *in vitro* steroid production and response to hCG or ACTH, the gonads and adrenals from 12 pups of each sex were incubated for 3 h at 37^0 C in Eagle's medium in a shaking water bath. The medium was presaturated with a gas mixture of 95 % oxygen and 5 % carbon dioxide. The medium

for one adrenal was supplemented with 200 mIU synthetic $ACTH_{1-24}$ (Synacthen, CIBA-GEIGY AG, Basel, Switzerland), while another adrenal served as the control. By analogy with adrenals, one gonad was incubated in the presence of 2.5 IU hCG (Sigma, St Louis, MO USA), and another gonad was also taken as control. After incubation, the medium was frozen and stored for measurement of steroid production.

The steroid levels in serum, gland homogenates and incubation media, and ACTH levels in plasma were determined directly without any preliminary extraction or chromatography by sensitive RIAs using commercial kits (Orion Diagnostica, Espoo, Finland for steroids and Diagnostic Products Corporation, Los Angeles, CA USA for ACTH). The sensitivities of the methods were 8 pg/ml for ACTH; 0.03 ng/ml for testosterone; 5.5 pg/ml for estradiol; 0.09 ng/ml for progesterone and 2.5 ng/ml for cortisol.

The testosterone assay had an intra-assay coefficient of variation of 3.8-7.5% and an inter-assay coefficient of 4.8-7.0%. The percentage cross-reactivity of the testosterone antiserum at the 50% binding level has been established as follows: testosterone 100%; 5α-dihydrotestosterone 4.5%; methyltestosterone 0.45%; 5-androstendiol 0.02%; cortisol 0.006%; 17α-estradiol 0.012%; progesterone 0.01%.

The intra-assay coefficient of variation for the estradiol method was 2.9-9.7% and the inter-assay coefficient was 2.3-10.2%. Cross-reactivity of the estradiol antiserum was for estradiol 100%; estrone 0.97%; estriol 0.44%; progesterone <0.05%; cortisol <0.001%; testosterone <0.001%.

The progesterone assay had an intra-assay of 2.9-5.8% and an inter-assay coefficient of 4.7-5.1%. Cross-reactivity of the progesterone antiserum was for progesterone 100%; pregnenolone 3.9%; 11-deoxycosterone 0.38%; cortisol <0.01%; androgens and estrogens <0.01%.

The cortisol assay had an intra-assay coefficient of variation of 1.7-4.1% and an inter-assay coefficient of 4.3-90%. The percentages of cross-reactions show the specificity of the cortisol antiserum used: cortisol 100%; corticosterone 0.2%; 11-deoxy-cortisol 0.4%; prednisolone 29%; progesterone, androgens and estrogens <0.1%.

Mean ± s.e.m. values were calculated for body, gonadal and adrenal weights; ano-genital distances, serum or plasma hormonal levels, gonadal or adrenal hormonal contents and *in vitro* hormonal production by gonads or adrenals. Student's t-tests were conducted for statistical analysis of the data. Differences between the control and treated by ACTH or hCG groups were described by the use of paired Student's test. ANOVA program of Statistica for Windows was used. Only differences significant at $p<0.05$ are reported.

Results

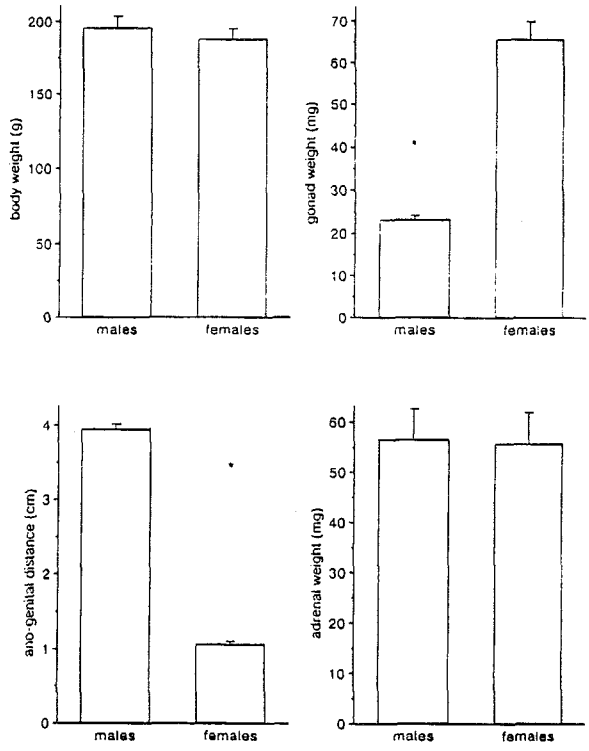

Figure 1. Body and organ weights, and ano-genital distances for neonatal blue foxes. The animals were killed at 10 days of age. Values are mean ± SEM of measurements from 17 animals. Asterisks designate significant differences between sex groups ($p < 0.001$; Student's t-test).

The weights of body and organs, and the ano-genital distancies in 10-day-old blue fox pups are presented in Figure 1. There were no significant differences in the body and adrenal weights between sexes, but

significant sex differences were observed in the gonad weights ($t=9.58$, $p<0.001$) and the ano-genital distances ($t=36.27$, $p<0.001$). The weight of testes (23.22±1.04 g) was lighter than that of ovaries (65.74±4.31 g). In contrast, the ano-genital distance for blue fox males was higher than that for females (3.95±0.07 cm for males vs 1.07±0.04 cm for females).

The serum cortisol and plasma ACTH levels in male and female blue foxes did not differ significantly, but the progesterone level in males was higher than in females ($t=2.78$, $p<0.01$, Figure 2). Testosterone and estradiol were not detected in fox serum by RIAs used. The serum testosterone and estradiol concentrations both in male and female pups were lower than limits of determinations even if the steroids were extracted by ethyl ether from serum samples of volumes approximately 1 ml (data not shown).

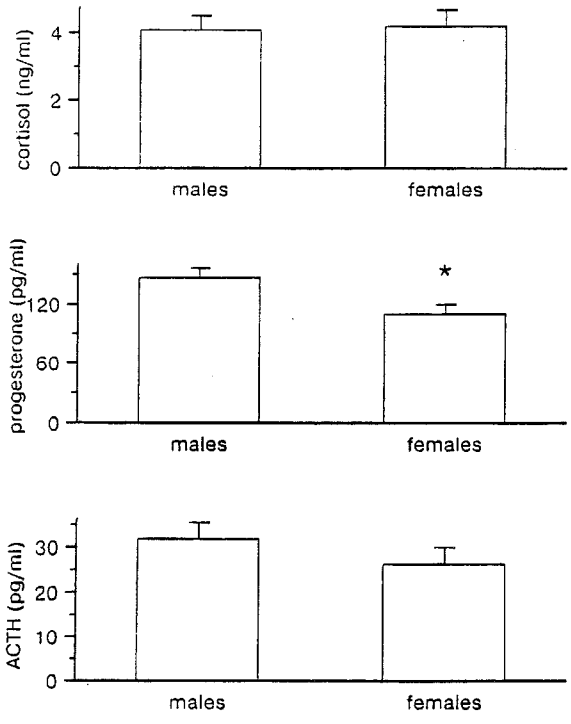

Figure 2. Serum concentrations of progesterone and cortisol, and plasma concentrations of ACTH for neonatal blue foxes. The animals were killed at 10 days of age. Values are mean ± SEM of measurements from 17 animals. Asterisk designates significant difference between sex groups ($p < 0.01$; Student's t-test).

The *in vitro* testicular testosterone production in blue fox pups was much higher than the ovarian testosterone production (2.54±0.73 vs 0.18±0.06 ng/gonad/hour respectively, Figure 3). Similar sex differences were observed in the gonadal testosterone content (Figure 4). The intragonadal testosterone content ranged between 6.37±1.77 and 0.42±0.02 ng/both gonads for males and females respectively. The significant sex differences in the *in vitro* gonadal progesterone production were not established, while the intragonadal progesterone content was lower in testes than in ovaries due to the higher ovarian weight ($t=3.45$, $p<0.05$; Figure 4).

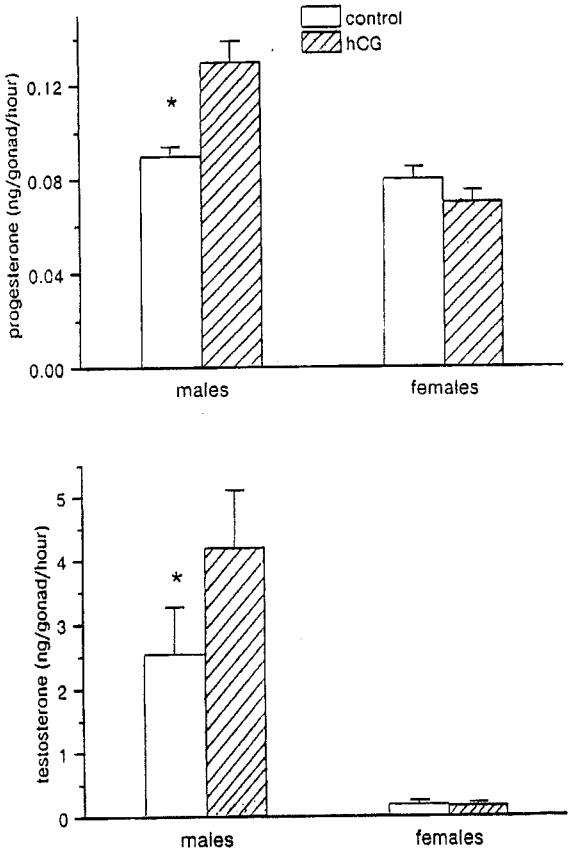

Figure 3. Control and hCG-stimulated (2.5 IU/gonad) *in vitro* gonadal production of testosterone and progesterone for neonatal blue foxes. The animals were killed at 10 days of age. Values are mean ± SEM of measurements from 12 animals. Asterisks designate significant differences between control and hCG groups (p at least < 0.05; paired Student's t-test).

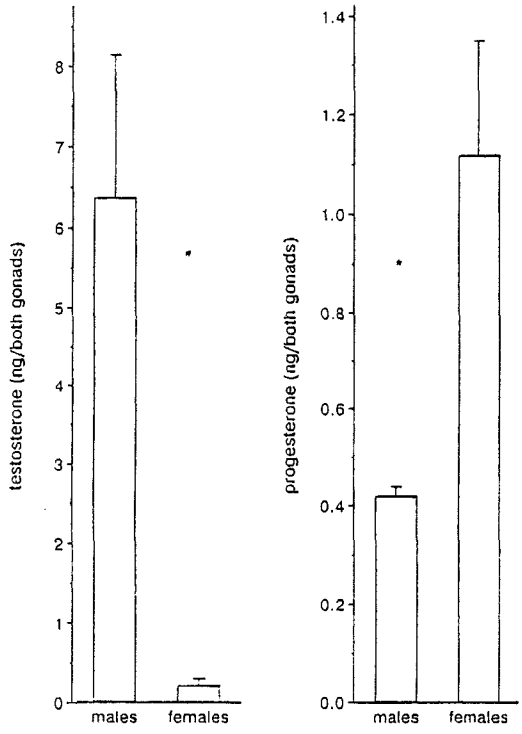

Figure 4. Intragonadal contents of testosterone and progesterone for neonatal blue foxes. The animals were killed at 10 days of age. Values are mean ± SEM of measurements from 5 animals. Asterisk designates significant difference between sex groups (p at least < 0.05; Student's t-test).

Figure 3 illustrates the *in vitro* testosterone and progesterone responses of the gonads to hCG treatment in 10-day-old pups. The results showed that there was a significant increase in both testicular steroids after hCG treatment (for testosterone t=8.17, p<0.001; for progesterone t=3.94, p<0.05), while the same dose of hCG was unable to stimulate a measurable steroid response in female pups. We did not observe the effect of hCG on the *in vitro* estradiol production by the ovaries (43.51±3.46 in control vs 39.28±3.13 pg/ovary/hour after treatment, the data are not shown in the Figures).

The *in vitro* adrenal cortisol and progesterone production in blue fox pups are given in Figure 5. No significant sex differences in basal adrenal cortisol and progesterone production were observed. The same results were obtained for the intraadrenal cortisol and progesterone contents (Figure 6).

Moreover, the statistical analysis of the data showed that the ACTH treatment in the dose of 200 mIU per adrenal failed to increase the adrenal cortisol and progesterone production in both sexes, and only a slight but significant increase of the progesterone production after the ACTH addition was observed in the male pups (0.69±0.19 in control vs 1.01±0.25 ng/adrenal/hour; t=2.31, p<0.05; Figure 5).

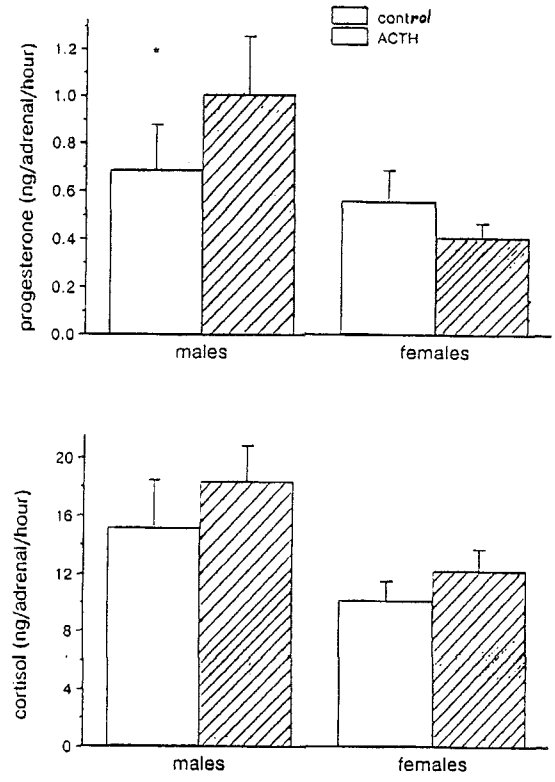

Figure 5. Control and ACTH-stimulated (200 mIU/adrenal) *in vitro* adrenal production of cortisol and progesterone for neonatal blue foxes. The animals were killed at 10 days of age. Values are mean ± SEM of measurements from 12 animals. Asterisk designates significant difference between control and ACTH groups (p < 0.05; paired Student's t-test).

The comparison of the *in vitro* progesterone production between gonads and adrenals in both sexes (compare Figures 3 and 5) has shown that the amounts of progesterone produced by the adrenals is approximately 7 times greater than that produced by the gonads (for adrenals: 0.69±0.19 ng/adrenal/hour in males and 0.56±0.13 in females;

for gonads: 0.09±0.004 ng/testis/hour in males and 0.08±0.005 ng/ovary/hour in females). The progesterone contents in the adrenals were 70-170 times greater than those in the gonads (for adrenals: 74.52±21.17 ng/both adrenals in males and 76.16±15.33 in females; for gonads: 0.42±0.02 ng/both gonads in males and 1.12±0.23 in females; compare Figures 4 and 6).

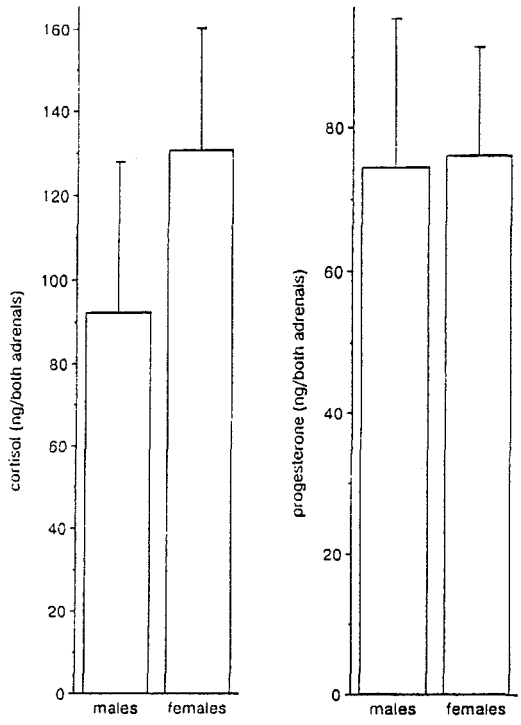

Figure 6. Intraadrenal contents of cortisol and progesterone for neonatal blue foxes. The animals were killed at 10 days of age. Values are mean ± SEM of measurements from 5 animals.

Discussion

The present study for the first time provided information on hormonal status in new-born male and female blue foxes at day 10 of life. The results suggest that the gonads and adrenals of blue fox pups are very active in secreting steroid hormones during the neonatal period. We have established great sex differences in the testosterone gonadal content and production, in the gonadal testosterone and progesterone responses to hCG and also in ano-genital distance, a sex-related and testosterone dependent indication. At 10 days of age the *in vitro* testicular testosterone production was 14-fold higher than the ovarian production, while the testicular testosterone content exceeded the ovarian approximately 30 times despite a 3-fold smaller size of testes in comparison to the ovaries. The *in vitro* testicular testosterone and progesterone productions responded markedly to hCG, while statistically significant steroid responses of the ovaries to gonadotrophin were not found. These results demonstrate that the ovarian responsiveness to gonadotrophin is not fully developed in neonatal blue foxes and perhaps develops independently of the onset of steroidogenesis. This is probably due to the weak capacity of female neonates to produce gonadal steroids in comparison with males. In this regard, our results for the blue fox are quite similar to ones reported for the rat (*Huhtaniemi et al., 1992*). Furthermore, in the rat it has been established that the main reason for the sex difference in steroidogenic activity of fetal and neonatal testes and ovaries is related to the absence of gonadotrophin receptors in developing ovaries. They began to operate in the rat ovary only on day 4-7 of postnatal life for FSH and on day 5-9 for LH (19, 20).

In the present study the elevated testicular steroidogenic activity was observed during the early postnatal period in the blue fox. The *in vitro* testicular testosterone production in blue fox males is somewhat higher compared with the fetal testosterone production by testes in silver foxes at the end of prenatal life (*Osadchuk, 1994*) and much lower than in adult silver fox males during the reproductive season (*Osadchuk, 1993*). There is no doubt that neonatal testosterone in blue fox males may be involved in sexual differentiation and has organisational effects on the reproductive system and developing brain mechanisms that control gonadotrophin secretion, and sexual and aggressive behaviours. Our results suggest that, in the blue fox, the first days after delivery can represent a critical period of sensitivity to masculinising effects of androgens similar to the rat or mice that are born in the same extent of maturity as foxes (*Saez, 1994; Mann, Fraser, 1996).*

This study has investigated the activity of pituitary-adrenal system in the blue fox at day 10 of the neonatal period using direct measurement of plasma

ACTH, serum cortisol and progesterone, and the adrenal response to ACTH *in vitro*. The data obtained indicate that the adrenals in the blue fox are able to produce corticosteroids at this age, but the level of adrenal steroidogenic activity is lower than that of fetal adrenals in silver foxes (*Osadchuk, 1997*). Moreover, it is apparent from these results that, in contrast to embryonic and adult silver foxes (*Oskina, 1996; Osadchuk, 1997*), the neonatal blue fox adrenals did not respond to ACTH *in vitro* except for the weak response in the male progesterone production. It is interesting to speculate on the failure of the adrenal response at the early postnatal period in blue foxes because this situation resembles a stress hyporesponsive period in the rat which is also characterised by reduced basal levels of corticosterone and a decreased capacity to secrete corticosteroids in response to stress or ACTH (*Guillet et al., 1980; Sapolsky, Meaney, 1986; Walker et al., 1986*). A recent report of Elnif and Sangild, who revealed a reduced adrenal responsiveness to exogenous ACTH in the mink at 4 weeks of postnatal life (*1996)* should be also mentioned. It is believed that blue fox pups also experience a hyporesponsive period in their early postnatal life that helps animals to survive the stress conditions without the severe consequences for the organism due to elevated levels of corticosteroids and ACTH (*Sapolsky, Meaney, 1986*).

No sex differences existed in the adrenal weight, the cortisol or ACTH levels, and the *in vitro* basal adrenal production or content of cortisol and progesterone at 10 days of age in blue fox pups. Somewhat similar data on silver fox embryos at late pregnancy (*Osadchuk, 1997*) has been presented. But, contrary to the above, clear sexual differences in adrenal glucocorticoid function have been demonstrated for neonatal and adult silver foxes (*Naumenko et. al., 1987; Oskina, 1996*).

The present study has shown the leading role of the adrenals in progesterone production during the neonatal period in blue foxes. Similar data have reported for silver fox embryos (*Osadchuk, 1998).* It has been also demonstrated that the adrenals of adult silver foxes produce progesterone in quantities that are comparable to those in ovaries *(Osadchuk, 1993).* It is possible that fox adrenals may act as the source of progesterone that can serve as a precursor for sex steroid biosynthesis in gonads. On the other hand, the adrenal progesterone secretion is increased by stressful stimuli in adult animals and could suppress gonadotrophin release by feedback mechanism *(Piva et al., 1973; Cooper et al., 1995).* Adrenal progesterone must therefore be taken into consideration when the interrelationship between adrenal and gonadal systems is investigated.

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Original Report

Endocrine thyroid gland, adrenal cortex and gonadal functions in fur animals in the postnatal period and reproductive season

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Summary

Complex research into endocrine thyroid gland, adrenal cortex and gonadal functions in dark-brown and coloured mink, Polar fox and silver fox in relation to physiological condition, the postnatal period, influence of the season and species was carried out. The radioimmunological method was used to investigate the hormones – triiodothyronine (T_3), thyroxine (T_4), cortisol, testosterone, progesterone and estradiol-17β in the serum of peripheral blood of the animals on various fur farms. High thyroid, cortisol and estradiol hormone levels were recorded in cubs aged two-four months. The peak of triiodothyronine, cortisol and testosterone activity coincided with the beginning of the mating period. Animals with impaired reproductive systems showed reduced levels of thyroid and sexual hormones. High correlation coefficients between the intensity of growth and values of triiodothyronine, thyroxine, cortisol and testosterone were recorded in mink aged 2 and 4 months.

Introduction

There exist but few papers (*Boissin-Agasse et al., 1982; Rajs, 1987; Rais & Bieguszewski, 1991*), reporting on physiological variations of T_3, T_4 and cortisol in the blood of farmbred fur-bearing animals. According to the data obtained by Boissin-Agasse et al. (1982) the highest thyroxine values in mink occurred in the spring (13.6±0.1 ng/ml). The second peak of T_4 activity was reached in animals in October – November while the lowest thyroxine level in blood was noted in December through April. The thyroxine level in blood was also found to increase in coypu during the cub growth (*Jelimek et al., 1982*). It was shown that nitrogen deficiency can delay the growth of winter coat in Polar fox, while after injecting T_4 the hair growth was considerably improved (*Bieguszewski & Szymeczko, 1979*). The results obtained by Pilbeam & Travis (1979) show a definite trend of elevated cortisol levels during summer and winter fur moults in mink. The article presents some results of complex research on hormonal activity of thyroid gland, adrenal cortex and gonads in mink, Polar fox and silver fox in relation to physiological condition and the postnatal period.

Material and methods

The research was made on healthy dark-brown) and coloured mink (*Mustela vison,* blue fox (*Alopex lagopus*) and silver fox (*Vulpes vulpes* Desm.) males and females 1-10 months old and mature 2-3 year-old animals in various periods of the reproductive cycle. Peripheral blood tests were made in the postnatal ontogenesis period (June-February), during the mating season (March-April), pregnancy and lactation (April-June) and after weaning.

Changes in the intensity of growth were studied in cubs. Steroid hormones in the serum were radioimmunoassayed using a commercial kit of RIA produced by the farm "Beloris" in Belorusia. The date obtained were analysed by using Student's-test.

Results and discussion

It was established that in the postnatal ontogenesis period the thyroid activity of thyroid gland function is not stable. Thus, dark-brown (Standard) mink and 2-months-old Polar fox showed high triiodothyronine values in blood, 2.24±0.17 and 2.28±0.16 nmol/l on average. Thyroxine activity in the animals was also high and was to 87.2±8.8 nmol/l in mink, and 100.8±10.4 in Polar fox (Fig. 1). In September, T_3 levels declined and did not exceed 0.7±0.2 in wild (Demi-buff) mink, and 1.4±0.2 and 1.9±0.3 nmol(l in standard mink and Polar fox, all 4-5 months of age, respectively.

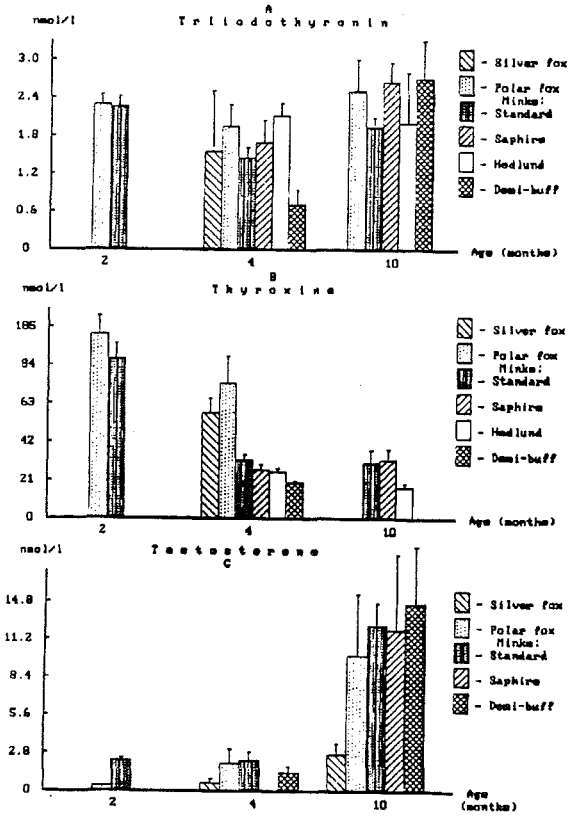

Fig. 1. Thyroid and testosterone hormone levels (A,B,C) in the blood serum of Silver fox, Polar fox and various mink in the postnatal period.

Thyroxine activity in standard and coloured mink 4 months of age was reduced more than threefold ($P<0.01$, Fig. 1), while in Polar fox T_4 activity levels remained high (74±14.7 nmol/l). In healthy 4-month-old silver foxes, thyroxine blood content did not exceed 58±7.8 nmol/l, and in weak cubs traces of thyroxine were detected. Triiodothyronine values in the blood of weak fox-cubs were also low and made up 0.87±0.03 nmol/l, while in healthy animals the T_3 level was twice as high ($P<0.01$).

In February triiodothyronine activity was increased in sapphire, standard, wild mink and Polar fox (10 months of age); its value remained stable in white (Hedlund) mink as compared with those in the animals aged 4 months. Increases in triiodothyronine values in February probably coincided with the onset of the mating season. Essential changes in thyroxine values in mink aged 10 months were not observed (Fig. 1). In the spring, during pregnancy and in the lactation period biological T_3 activity was insufficiently reduced both in mink and Polar fox ($P<0.05$), and thyroxine levels remained within 25±4 - 50±8 nmol/l. Judging from their results, Kasprzak et al. (1993) have come to the conclusion that triiodothyronine activity in mink is considerably higher than that of thyroxine in all seasons as T_3 decreases in 5-year old animals greatly affects physiological processes in the organism. Peripheral blood tests in the mink which lost their embryos (parturition pathologies) showed that T_3 levels did not exceed 0.90±0.13 nmol/l while T_3 activity in pregnant mink and safely-whelped mink was 2- or 3 fold higher.

The values of the sex hormones testosterone and progesterone values during early postnatal ontogenesis were not high. The analysis of the data obtained recently has shown that testosterone activity values in mink and Polar fox males, 1-4 months of age occur within 0.3 – 2.8 nmol/l (Fig. 1). At the age of 10 months, testosterone activity values are found to increase considerably: 10-14 nmol/l, which supports the results obtained earlier (*Sirotkina, 1992*). In late February, silver fox males showed a three-fold lower (2.7±0.7) level of testosterone in the blood, which is likely to be connected with the end of the mating season. The dynamics of estradiol values in fur bearing animals in postnatal ontogenesis was not well-expressed. High estradiol concentration in the blood was reported in Standard mink (340±28 pmol/l) which can be explained by an increased activity of endocrine function of the ovaries in the first months

of life on account of intensive maturing. Later, starting from October, estrogenic activity was reduced ($P<0.01$), and in early March its level was found to increase in mink at 10 months of age. According to our data, estrogen synthesis in polar foxes starts to increase later than in Polar fox females 10 months of age were found to be within 260-320 pmol/l. Only prior to insemination in March, did estrogenic activity grow three-fold (873±86, $P<0.01$). In silver fox, the first peak values of estradiol activity were detected as late as at the end of December (450±94 pmol/l). This is probably connected with an earlier onset of the mating season in the fox. The research into hormonal function of the ovaries throughout pregnancy has shown that the peak values of progesterone activity were reached in fox (Fig. 2), and those in mink – in early April, i.e. in the second half of pregnancy. In pregnant Polar fox females, progesterone values were lower in early April. In non-inseminated Polar fox females, progesterone activity remained 5-6 times lower than in pregnant females (5.4±1.4 nmol/l, $P<0.001$).

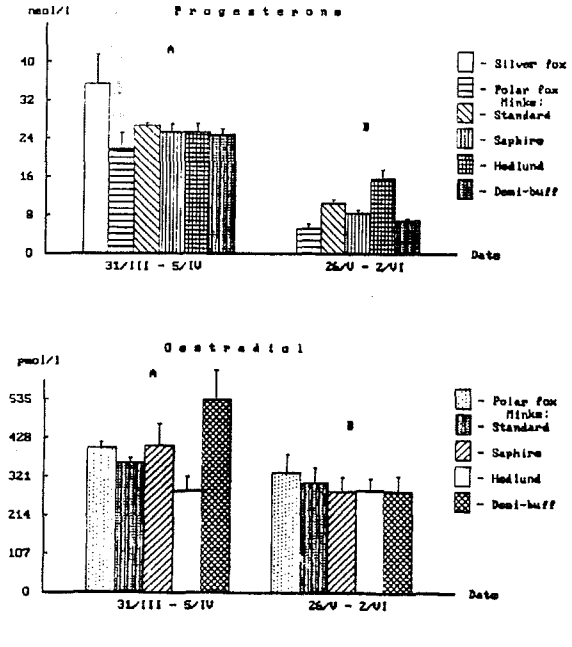

Fig. 2. Progesterone and estradiol dynamics in the blood serum of Silver fox, Polar fox and various mink during pregnancy (A) and lactation (B).

After whelping and in the post-lactation period, the progesterone level in mink was reduced to 7-16 nmol/l, and in Polar fox to 3-5 nmol/l. It was also found that progesterone and estradiol values in females with safe parturition and those with parturition pathologies seemed to be insignificant. This evidence supports our previously obtained data (*Savcheno et al., 1987; Sirotkina, 1997*). Describing seasonal changes in the plasma thyroxine and estradiol values in Polar fox, Smith et al. (1984) note that the maximal values of thyroxine activity are reached immediately after the reproductive season while those of estradiol in the mating season. According to our data, the highest blood thyroxine values were reached in Polar fox cubs 2 months of age. Smith et al. (1984) report that thyroxine and estradiol significance (their regulating and controlling functions in the reproductive process) in Polar fox is only partially understood.

The hormonal function of the adrenal contex during the maturing kit was detected to have periods of rise and some fall in blood corticosteroids values. Thus, in Standard mink, cortisol concentration was rather high (58±3 ng/ml). The average cortisol level in mink 4-5 months of age remained stable; in Polar fox its value was thrice as low (Fig. 3).

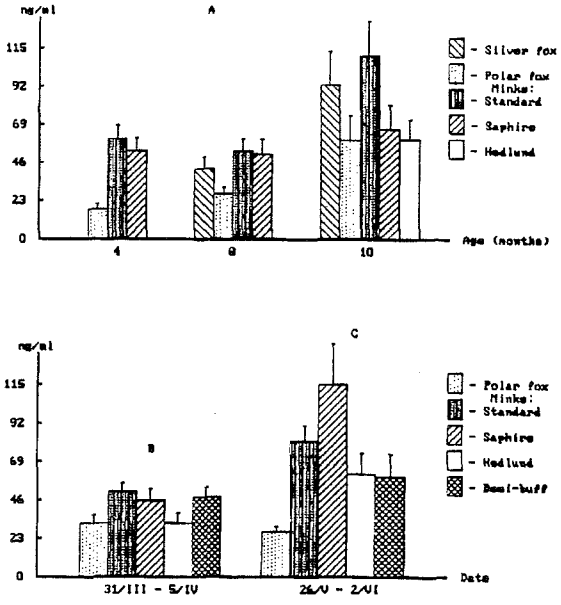

Fig 3. Cortisol concentration in the blood serum of fur animals during the postnatal period (A), pregnancy (B) and lactation (C).

In mink 8 months of age, changes in cortisol activity were insignificant; in Polar fox and silver fox 10 months of age, cortisol activity reached its peak

values; in white mink, sapphire mink and Polar fox, its value did not exceed 60 ng/ml. Throughout pregnancy and in the lactation period, white and wild mink showed high cortisol activity (Fig. 3). In dark-brown and sapphire mink, fluctuations ranged from 80±9 to 114±14 ng/ml. Unlike mink, cortisol values in Polar fox were reduced in the period of lactation ($P<0.01$).

Correlation coefficients were determined in mink to find relations between hormonal values and the body mass growth. A strong correlation was found between triiodothyronine and the body mass in mink 2 and 4 months of age ($r=0.60$; 0.75), and thyroxine values and the body mass in animals 4 months of age ($r=0.85$). A strong correlation was also found between testosterone and thyroxine ($r=0.62$); negative correlation was found to occur between cortisol and the body mass ($r=-0.47$), between the hormones T_3 and T_4 and cortisol values in kits 4 months of age ($r=0.57$; $r=0.27$); the correlation between thyroxine and cortisol was not very strong.

Thus, the peak values of thyroxine, triiodothyronine and cortisol activity in blood were found in animals 2 months of age. In animals aged 4 and 5 months, synthesis of thyroid hormones was decreased. High cortisol values in mink were recorded in mink aged 2-8 months; in Polar fox cortisol activity was twice as small. The peak cortisol and testosterone values in mink, Polar fox and silver fox coincided with the onset of the mating season (February – March). Cortisol activity in mink also remained high in the lactation period, while in Polar fox cortisol values were decreased. Testosterone secretion in males decreased during the active time of the mating period (March) and at the end of the reproductive season (April). The majority of infertile mink and Polar fox males showed lower testosterone concentration in blood serum.

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Original Report

Indices of thiamine metabolism in oxythiamine deficiency in the polar fox

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Summary

By introducing a thiamine anti-metabolite – oxythiamine - to polar foxes we studied its effect on specific indices of thiamine metabolism: the activity of transketolase, size of thiamine diphosphate-effect, and total thiamine and thiamine diphosphate levels in the blood. Parenteral introduction of oxythiamine caused an acute vitamin deficiency in animals expressed as functional changes in thiamine-dependent blood indices. At the same time, when injecting anti-vitamin in a dose of 8 mg/kg, the changes occurred rather smoothly, and in a dose of 23 mg/kg, a fast reaction was observed; but considerable biochemical changes in thiamine metabolic indices accompanied by typical clinical symptoms were observed in both cases.

Introduction

In the study of the role of vitamin B_1 (thiamine) in organism viability it is very important to find how various environmental factors influence the development of its status in the organism and, in the first run, to investigate adaptive responses of the organism to its deficiency. Thiamine deficiency can be induced by introducing its anti-metabolite, oxythiamine (OT), in the organism which becomes, like the vitamin, part of the natural set of reactions and disturbs normal metabolic activity.

A series of experiments on modelling oxythiamine deficiency in fur animals was first set up at the Laboratory of Ecological Physiology of Animals of the Karelian Research Centre, RAS (*Petrova et al., 1992; Izotova et al., 1994*). This research aimed at a further study of specific changes of some thiamine-metabolism indices in the animal and reproduction of a visible picture of biochemical disturbances by modelling oxythiamine deficiency.

Materials and methods

The effect of acute oxythiamine B_1-deficiency on the metabolic indices of thiamine was studied on young polar foxes. Two groups of animals were created. The OT was injected in doses of 8 mg/kg body weight (group 1, n=12) and 23 mg/kg body weight (group 2, n=6). The initial background of the indices under study was tested in all animals before injections; the blood of group 1 animals was tested at 4, 24, 48 and 72 hrs; that of group 2 at 3 and 6 hrs.

Some indices, such as the enzymatic activity of transketolase (TK), size of thiamine diphosphate-effect (ThDP-effect), and total thiamine and thiamine diphosphate (ThDP) levels in the blood, were used to characterize thiamine metabolism. The TK activity was defined by Bruns et al. (1958) method modified by Kon' and Kondratyeva (1982). The size of the ThDP-effect was estimated by a rise of TK activity after pre-incubating blood assays with thiamine diphosphate (*Dreyfus & Lundquist, 1962*). Total thiamine was defined by a generally accepted fluorimetric method, while ThDP, with enzymes, by using yeasty apopiruvatdekarboxylase (*Ullrich, 1970*). All obtained results were computed statistically. The significance of differences was tested using Student's test.

Results and discussion

Supervision has shown that half of the animals in group 1 developed symptoms of vitamin deficiency 4 hrs after OT had been injected in a dose of 8 mg/kg. The animals had muscular tremors and showed anxiety; at 7 hrs, typical neurological symptoms were developed: irregular breath, paralysis of extremities, uplifted head. Twenty-four hrs after the injections, visible symptoms disappeared though the animals remained apathetic. Notwithstanding the visible deficiency symptoms, the TK activity during supervision remained practically unchanged, and the size of ThDP-effect even tended to decrease. At the same time, the total thiamine level in the blood of group 1 polar foxes decreased 4 hrs after injection ($p<0.001$), then increased (Table 1) and 72 hrs after beginning the experiment, it exceeded an initial level by 43.5% ($p<0.001$). The tendency of changes in co-enzymic form of thiamine, ThDP, was different: with a high initial background, 4 hrs after injecting OT, the ThDP content decreased and continued to fall gradually reaching its lowest value at the end of the experiment ($p<0.001$).

Table 1. Dynamics of thiamine metabolic indices in polar fox blood in OT-deficiency, M±m

Time of research after OT-injection, hr	TK, mkmol/s/l	ThDP-effect, %	Total thiamine, mkmol/l	ThDP, mkmol/l
Group 1				
Initial data	11.76±0.39	17.14±3.09	0.326±0.016	0.151±0.012
4	11.57±0.23	13.43±2.52	0.280±0.060	0.119±0.002
24	11.73±0.20	13.67±1.70	0.294±0.009	0.110±0.004
48	11.74±0.21	15.34±0.94	0.544±0.015*	0.109±0.004*
72	11.88±0.21	15.08±1.11	0.577±0.017*	0.088±0.004*
Group 2				
Initial data	11.77±0.34	19.34±4.47	0.427±0.22	0.098±0.006
3	11.19±0.28	24.93±5.00	0.400±0.010	0.100±0.004
6	8.36±0.36*	69.42±7.55*	0.582±0.022*	0.157±0.009*

* difference is authentic as compared with initial data

Group 2 of the polar foxes, already 3 hrs after injecting OT in a dose of 23 mg/kg, developed visible symptoms of anti-vitamin effect: irregular breath, lameness in the rear extremities, weakness, and neck stretching. The TK activity changed slightly in that period. Six hrs after beginning the experiment, the TK activity was found to decrease, and the ThDP-effect increased up to 69% which spoke for heavy deficiency. The clinical picture became more acute: all animals were lying breathing irregularly and hoarsely. At the same time, the total thiamine and ThDP contents in the blood of group 2 polar foxes were insignificantly lower 3 hrs after the OT injections, while 6 hrs later a sharp increase in their level was observed which in both cases was higher than the initial level ($p<0.001$).

Thus, research into the effect of acute oxythiamine deficiency on the polar fox organism has shown that the deficiency reveals itself in changes of thiamine-dependent functional activity indices as a response to the anti-metabolite. However, the tendency of total thiamine and ThDP changes in blood of the polar foxes varied under the effect of OT injections in these doses.

It is considered that oxythiamine is unable to penetrate a hemato-enzephalic barrier, and oxy-thiamine deficiency is noted for weakly pronounced

clinical symptoms (*Rindi et al., 1963; Larin et al., 1987*). But our experiment has shown heavy metabolic disturbances in the animals of both groups. The animals had clinical symptoms of various strength. The symptoms were testified by metabolic disturbances occurring under B_1 deficiency development. The disturbances were responsible for selective inhibition of functional activity of TK – a key enzyme of thiamine metabolism, as well as for redistribution of both thiamine and its co-enzymal form.

The experiment has shown that the TK activity and ThDP-effect remained practically unchanged while injecting OT in a low dose as TK is known to react weakly even to high-concentrated oxythiamine diphosphate in tissues (*Voskoboev & Chernikevich, 1987*). Inhibition occurred at a level of total thiamine and its phosphorylated form, and was more intensive at the first stage of the experiment. Then, under the effect of the anti-metabolite, the vitamin concentration went simultaneously with the decrease in the level of co-enzymal form with less expressed chemical affinity to protein than anti-coenzyme. The ThDP level was lowered during experiment, and remained authentically reduced 3 days after beginning the experiment, thus reflecting a prolonged effect of OT. This OT dose obviously stimulated adaptive mechanisms, and was responsible for redistribution in tissue vitamin reserves and including them into metabolic processes (*Petrova et al., 1992*). Besides, the experiment was carried out under the conditions when the animals had easy access to their food containing some thiamine capable to actively compete in the reaction of thiamine kinase formation of thiamine diphosphatic ethers and anti-thiamine. High tissue thiamine concentration in the organism, which exceeds the animals requirements for it, limits the formation of oxythiamine diphosphate and, probably, the OT introduction has a prolonged inhibiting effect on the TK activity (*Vinogradov, 1995*).

Three hours after the OT injections in a dose of 23 mg/kg, the TK activity, total thiamine concentration, and ThDP changed insignificantly but 6 hrs later the levels of total thiamine and ThDP were found to grow alongside with authentic lowering of the enzymic activity. The effect of a high OT dose can be assumed to cause the need of fast thiamine-pool restoration at the expense of its redistribution from depositing organs and, obviously, due to an increase in activity of the enzyme of thiamine synthesis, thiamine kinase, responsible for raising the level of total thiamine and total ThDP. However, a decrease in the TK activity was also observed. The protein-bound form ThDP as part of TK is known to be a relatively constant index (*Chernikevich et al., 1995*) and, consequently, the enzymic activity becomes inhibited only 6 hrs after introducing OT. Here, reaction disbalance can be observed. It is expressed by a considerable TK activity decrease and a simultaneous growth of the ThDP concentration. At the present time, the fact in question cannot be duly expressed. It is only obvious that a high dose of OT can be responsible for irreversible changes, and the organism compensatory systems are unable to independently cope with them.

Thus, the research undertaken allows us to conclude that the polar fox is less sensitive, compared with the mink, to thiamine antimetabolite, oxythiamine, but more sensible in comparison with the laboratory animals.

Acknowledgements

We wish to express our thanks to Dr. I. P. Chernikevich from Institute of Biochemistry of Belorussian Academy of Sciences (Grodno) for his help in our research.

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Screening of ALAT-levels in Swedish farmed mink in 1997

Eva Aldén, Ulf Persson, Bertil Järplid, Torbjörn Mejerland

Liver functions, fatty liver - symptoms of and reasons for development is discussed. In Swedish mink feed the fat fraction can get rancid. The proportion of fish fat to total fat is recommended to be up to 60%. Depending upon the quality of the unsaturated fat, especially fish fat, differentiated recommendations of choline chloride additions are made especially during autumn. Commercial antioxidants are seldom used. Slaughter by-products both from cattle, swine and poultry are used raw and unprocessed. The same is valid for fish and filleting scrap from fish. It's not usual that metabolizable energy from protein is less than 30% during autumn but might occur and the percentage of metabolizable energy from protein is slowly decreasing on an average basis. In connection with pelting 1997 ALAT was analyzed in blood plasma of young males and females from three farms. Two farmers made their own feed and one bought feed from a central kitchen which was the only one who added choline chloride. In 15 out of 25 animals the livers were visually graded, histologically examined and chemically analyzed. During autumn the feed mixtures had moderate energy contents (the highest was 5,8 MJ metabolizable energy per kg) and average distribution of metabolizable energy, % from protein, fat and carbohydrates respectively 28,5-51,5-20, 31-46-23 and 36-43-21. Fishfat, as % of total fat was ca 35, 25-35 and ca 45. Chicken fat made up at least 50 % of total fat in all mixtures. No liver was graded more than slightly-moderately fattened. Analyzed fat contents in the livers were low (max 6,7 %) and analyzed ALAT-activities in plasma were regarded as normal. ALAT-activities and fatty livers are recommended to be more carefully followed and supplemented by post mortem studies of a more comprehensive material. The capability of the mink liver to recover ought to be studied.

Internal Report, National Veterinary Institute, Dep. of Fur Animals, Uppsala,. Sweden, 1997. 8 p, 2 tables, 10 refs. Authors' summary.

Effect of whey-fat concentrate content in rations on some utilization indices of mink

Manfred O. Lorek, Andrzej Gugolek

The aim of the research was to determine the effect of whey-fat concentrate on body weight gains and quality of mink furs in the weaning period before slaughtering of females.

120 young mink consituted the studied material. They were divided at random into two equal groups, each including the same number of females and males. The animals of the experimental group were given rations containing whey-fat concentrate in the proportion of 10% - in July and August, and 5% - in September and October. The experimental group was characterized by higher final body weight and better parameters of fur evaluation.

Acta Acad. Agricult. Tech. Olst, Zootechnica, No. 45, pp. 199-207, 1996. In POLH, Su. ENGL. 3 tables, 14 figs., Authors' abstract.

Determination of *tris*(4-chlorophenyl)methanol and *tris*(4-chlorophenyl)methane in fish, marine mammals and sediment

Jacob de Boer, Peter G. Wester, Erik H.G. Evers, Udo A. Th. Brinkman

Tris(4-chlorophenyl)methanol (TCP) and *tris*(4-chlorophenyl)methane (TCPMe) were determined in aquatic organisms and sediment by a method based on Soxhlet extraction, gel permeation chromatography, fractionation over silica and gas chromatography|mass spectrometry (GC|MS) analysis. TCPMe was identified as the 4-substituted isomer after synthesis of this compound. TCP could be determined by GC|MS with negative chemical ionisation (GC|NCI-MS) with a detection limit of 0.02 g kg-' and a recovery of 90%. TCP concentrations in marine mammals from the North Sea and Dutch Wadden Sea ranged from 0.2 to 2 mg kg-', and those in marine and fresh waterfish samples from 0.005 to 0.4 mg kg-' on a lipid wt basis. TCP concentrations in two Rhine delta sediment samples were 1.2 and 3.0 μg kg-' dry wt,

respectively. TCPMe concentrations, determined by GC|MS with electron impact (GC|EI-MS), were 10-50% of the TCP concentration in all samples analysed.

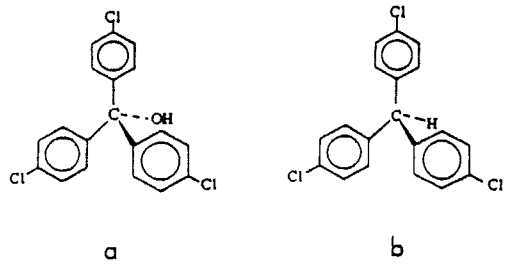


Fig. 1. Structures of (a) TCP and (b) TCPMe.

Environmental Pollution, Vol. 93, No. 1, pp. 39-47, 1996. 5 tables, 6 figs., 17 rfs. Authors' summary.

Clearance of chylomicrons following fish oil and seal oil feeding

Michael Søberg Christensen, Bok-Cheng Mortimer, Carl-Erik Høy, Trevor G. Redgrave

The aim of this study was to examine the effects of n-3 polyunsaturated fatty acids (PUFAS) of different marine origins on the metabolism of chylomicrons following a single ingestion of oil. Two oils both rich in n-3 PUFAs but differing with respect to the intramolecular structure of the triglycerides (TGs) were compared, the first a fish oil with the *sn*-2 position of TGs enriched with n-3 PUFAs and the second a seal oil with the n-3 PUFAs located in the *sn*-1/3 positions of the TGs. Radiolabeled rat mesenteric lymph chylomicrons were prepared following intragastric administration of the respective oil in which [^{3}HI-cholesterol and [^{14}Cl-palmitic acid were dissolved to label the lymph chylornicrons cholesterol and triglycerides, respectively. After intravenous injection of chylomicrons into unanesthetized rats, removal from plasma of radiolabeled cholesterol and palmitate, and uptakes of radiolabels by the liver and spleen were measured. The disappearance of cholesterol label was faster following injection of seal oil chylomicrons compared with fish oil chylomicrons whereas there were no differences in the disappearance of palmitate label. The recovery of palmitate label in the liver after 30 min was significantly higher following injection of fish oil chylomicrons compared with seal oil chylomicrons. Our data demonstrate that the metabolism of chylomicrons is affected by the intramolecular structure of the TG in the dietary oils rich in n-3 PUFAs but the mechanism by which the metabolism is affected is yet unknown.

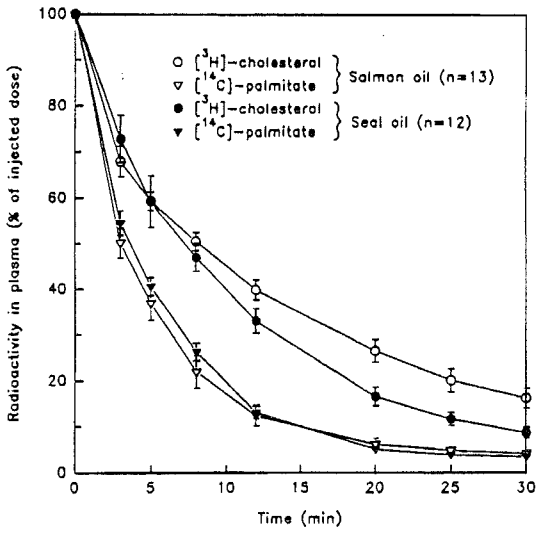
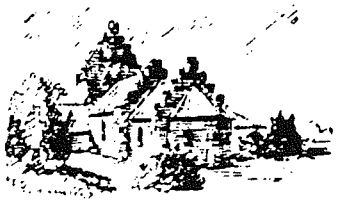


Fig. 2. Removal of radiolabeled cholesterol and palmitate from blood plasma of recipient rats injected chylomicrons that were obtained from donor rats fed either fish oil or seal oil.

Nutrition Research, Vol. 15, No. 3, pp. 359-368, 1995. 2 tables, 2 figs., 40 refs. Authors' abstract.



Original Report

Activity of antioxidant enzyme and the LDH isoenzyme spectrum in organs of mink with Aleutian disease.

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Summary

The key enzymes responsible for antioxidant (AO) protection, superoxidase dismutase (SOD) and catalase, and the isoenzymic spectrum of lactate dehydrogenase (LDH) in various organs in mink suffering from Aleutian disease (AD) were investigated. Changes in the activity of SOD and catalase, and shifts in the SOD/catalase ratio in sick mink have been found. The SOD/catalase ratio in the liver, kidneys, heart and lungs correlated with the level of blood serum gamma globulin. The activity of "pure" isoenzyme LDH-1 in the spleen, heart and kidneys decreased while a relative content of LDH-5 in the liver increased. The activity of AO enzymes, the SOD/ catalase ratio coefficient and the change in the blood serum isoenzyme spectrum of LDH can be used for testing the lesions in organs of mink with AD.

Introduction

Aleutian disease in mink (AD), or parvovirus infection, is a chronic contagious disease that can result in heavy losses in farm-bred fur-bearing animals (*Slugin, 1975*). AD is a disease where a number of organs and systems of the organism get involved in the pathological process. AD is known to cause disturbances in the cell-membrane structure, thus resulting in an increase of intracellular enzymes in the blood serum. This is accompanied by disturbances of protein, carbohydrate and fat metabolism and reflected in changes in a large number of the blood serum enzymes - transaminases, alkaline phosphatase, cholinesterase and lactate dehydrogenase (*Meldo et. al., 1978; Berestov, Kozhevnikova, 1981; Pekkanen et al., 1982,1984*).

According to Ellis (1994), antioxidant enzymes play an important role in AD pathogenesis. SOD and catalase keep the processes of lipid peroxidation (LPO) at a stationary level and prevent the cell-membrane lipids from oxygen active forms. SOD and catalase activity have been found to change in the process of postnatal onthogenesis (Ilyukha, 1995) but there are few data on these enzyme changes in mink suffering from AD. At the same time, the activity of SOD and catalase in mink with AD could serve as an important index characterizing the state of cell membranes. Changes in the isoenzymic profile of the key enzyme of glycolysis, LDH, is thought to be a good test showing the biomembrane state in the organism. This is linked with intracellular isoenzyme compartmentalization. The isoenzymic spectrum of the LDH in mitochondria is known to be opposite to that of cytozol. Different spacial localization of LDH-1 and LDH-5 in the cell allows it to stimulate alternative ways of glycolysis: LDH-1, consisting of

B-submits, catalyses the glycose aerobic oxidation to a larger extent while LDH-5, consisting of A-subunits, is responsible for the anaerobic pathway of glycolysis. Research into isoenzymic LDH spectra in the organs allows not only to determine the way of glycolysis in them but also to find, by studying changes in the blood serum LDH molecular spectrum, the disturbance rate in the cell biomembranes of the infected organs.

The present studies have been undertaken to find changes in the activity of key enzymes responsible for antioxidant protection and LDH isoenzyme spectrum in the organs involved in the pathological process in mink with AD, as well as to connect these changes with the disease stage and the degree of disturbances in the organism.

Materials and methods

Adult standard farm-bred mink of both sexes were studied. The material was obtained at the pelting period. The groups of 10 healthy and 20 sick animals were selected by the CIEP test. The blood serum gamma-globulins were determined by electrophoresis in all mink. The tissue samples (heart, lungs, liver, kidneys, spleen, skeletal muscle) were frozen and stored at -25°C. The homogenates of these tissues were prepared in 0.05M phosphate buffer, pH 7.0. They were centrifuged at 6000 g for 15 min, and supernatants were assayed for enzymes and proteins. SOD activity was determined by a modified adrenochromic method (*Fridovich, 1975*), and catalase activity was assayed spectrophotometrically according to the amount of decomposed hydrogen peroxide (*Aebi, 1984*). The activity of the enzymes was calculated per 1 g raw tissue and 1 mg protein (*Lowry et al., 1951*). Multiple molecular forms of lactate dehydrogenase in blood and organ extracts were analysed by agar gel electrophoresis (*Wieme, 1959; Meldo et al., 1987*).

Results and discussion

Changes in the SOD and catalase activity were significant in all organs of sick mink though the values and direction of these changes differed (Table 1). In the mink with the progressive form of the disease (positive CIEP reaction, gammaglobulin level higher than 21%) a specific SOD activity was found to increase by 21-25.7% in all the organs except the lungs and skeletal muscle as compared with the healthy animals, while in the lungs it was reduced by 44%. At the same time, catalase specific activity in the liver, lungs, skeletal muscle and spleen of sick animals lowered by 6-30%, and in the heart and kidneys it grew up by 7-10%. As a result of these changes in the activity of the key antioxidant enzymes, a growth by a third of the SOD/catalase ratio in the liver and spleen, by 11% in the kidneys, by 11% in the heart and skeletal muscle was observed, with a simultaneous decrease of this index in the lungs, as compared with healthy mink. A considerable increase of the SOD/catalase ratio in the spleen, liver and kidneys is likely to be connected with disturbances in these organs in mink with AD. A similar increase in the SOD/catalase ratio in the kidney was described earlier *(Ellis, 1994)*. However, the differences between the values presented by the author and those determined may be explained by the fact that the experimental animals were at various stages of the disease at the time of research.

It is interesting to note a considerable increase in the catalase activity in the skeletal muscle of mink with AD. The mink muscle catalase ability to become active under certain conditions can serve as a species-specific index typical for the semi-aquatic predators under consideration. It is responsible for producing additional oxygen in the muscle tissue at its deficiency which can be caused both by adult mink immersion into water (*Galantsev, 1977*) and locomotion development in early ontogenesis (*Ilyukha, 1995*).

Considerable changes in the SOD and catalase activity in mink with AD show that this enzymic system has been involved in the pathological process since its very beginning. At initial stages of the disease, changes in the enzymic activity are likely to be related to the adaptive response of the organism while at later stages they may reflect the disturbance rate in the organs and tissues. At an initial stage the kidney function is not essentially disturbed. Glomerulonephritis and plasma-cell infiltration in their tissues can be observed, but at later stages (*Slugin, 1975*). This results in the changes in the activity of antioxidant enzymes and intensifies LPO reactions.

Table 1. Changes of the SOD and catalase-specific activity and their ratio in various organs of mink with AD (% in comparison with the healthy animals, mark specifies direction of changes).

Organs	Measured parameters			
	Protein content	**SOD**	**Catalase**	**SOD/Catalase**
Liver	-2.30	+21.77	-11.48	+31.03
Kidney	-9.18	+26.43	+9.92	+11.61
Lung	+15.0	-44.00	-30.00	-6.96
Skeletal muscle	-1.90	-4.84	-30.43	+18.05
Spleen	-8.91	+20.58	-6.82	+34.48
Heart	-2.40	+25.71	+7.40	+17.83

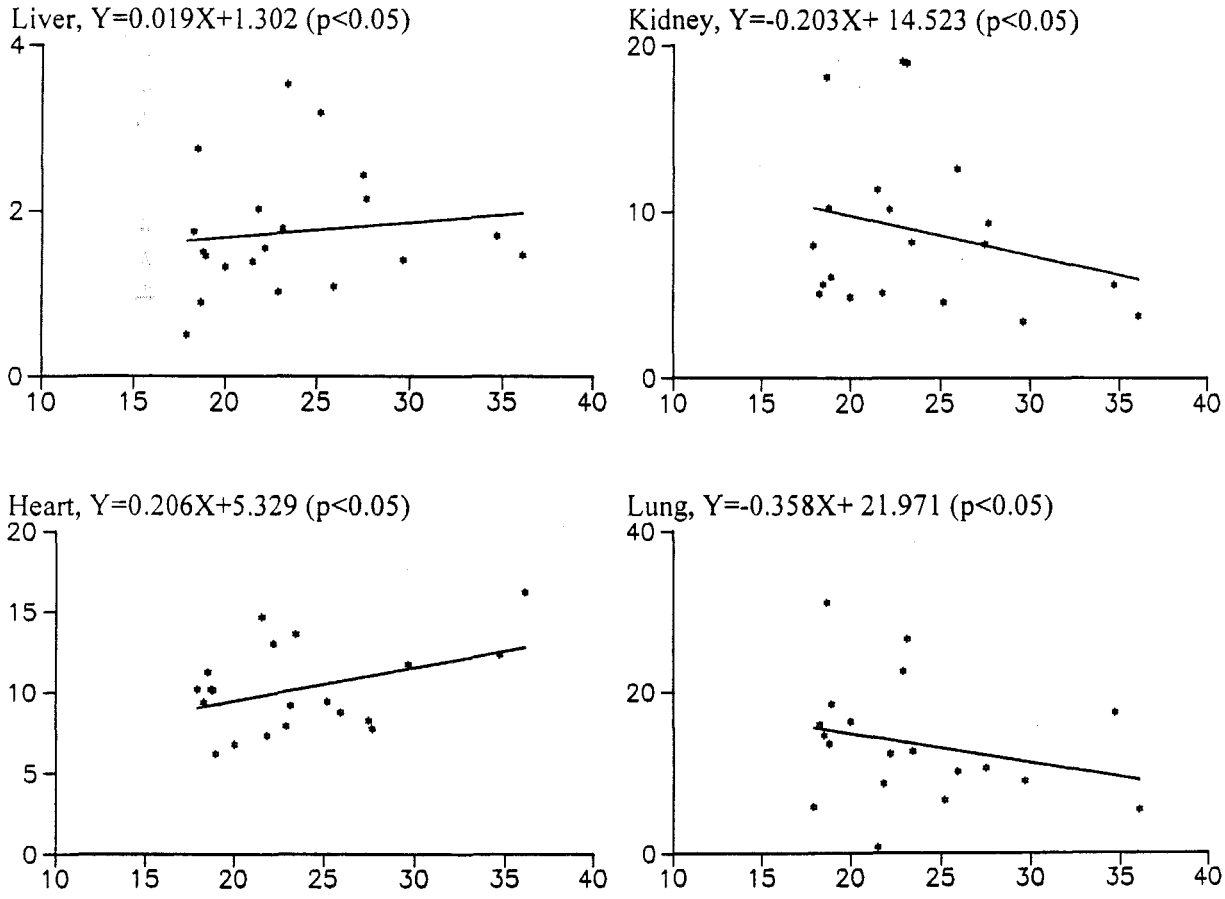

Fig. 1. Dependence between the level of blood serum gamma globulins and the SOD/catalase ratio in organs of mink with AD.
The regression equations and the level of significance are given.

The research into the relationships between the AO activity and the level of gamma globulins in the blood serum indicating the state of mink with AD has revealed that only the SOD/catalase ratio in the liver, heart, kidneys and lungs correlated with the latter (Fig. l). This shows that AD not only changes the activity of individual antioxidant enzymes in the organs of sick mink but also disorders the operation of the AO system as a whole. Considerable concentration of plasmatic cells in the organs studied and arterite in the vessels providing them with blood can lead to changes typical for functional hypoxia (*Galantsev, 1977*). Moreover, the activity of the enzymes responsible for the oxidating metabolism decreases while the activity of glycolytic enzymes increases (*Berestov, Kozhevnikova, 1981*) for the compensatory process, which may result in anemia in animals with *AD (Pekkanen et al., 1984*). Changes of the AO enzyme activity in mink with AD were followed by exchanges of LDH isoenzymic spectra in the organs involved in the pathological process (Fig2). Thus, the reduction of normally functioning hepatocytes in mink with AD increased the synthesis of "pure" isoenzyme LDH-5 by the cells of undisturbed tissue. As a result, its relative activity increased to 80% thus compensating the decreased, almost twofold, level of the hybrid forms, LDH-3 and LDH-4, at the expense of A-subunits of the above enzyme.

In connection with parenchymatic heart muscle dystrophy, considerable depletion, by one third, in the relative level of specific heart isoenzyme LDH-l has been reported as compared with that in healthy mink. This was followed by a twofold increase in the isoenzymes LDH-3 and LDH-5. If A-subunits perform half of the LDH-3 activity and LDH-5 consists entirely of the same polypeptides responsible for the anaerobic ways of glycolysis, then the latter stimulation in the disturbed tissue should serve as a compensatory mechanism for additional energy production.

In the sick mink, kidneys with increased plasmatic infiltration and a lowered number of normally functioning cells, a 15% decrease in the relative LDH-l level was also observed. This was somewhat compensated for by the growth of the relative level of LDH-2; three quarters of its subunits belong to B-type and are mainly responsible for aerobic pathways of glycolysis.

Due to the spleen tissue disturbance with AD and intensive plasma-cell infiltration, inhibition of aerobic processes can be reported. As a result, the relative content of LDH-l depleted twofold compared with that in healthy animals. The relative content of LDH-5 increased 1.5 times thus stimulating alternative ways of glycolysis, obviously for compensation.

Changes in isoenzymic LDH spectra in the organs of sick mink were reflected in changes of the relative content of LDH isoenzyme in the blood serum (Fig.2). Relative indices of four fractions, from LDH-2 to LDH-4, were found to decrease. The LDH-l level in the blood serum decreased three times compared with healthy animals. This was most likely caused by deep structural changes in the heart and spleen tissues where this fraction localized in mitochondria was found to decrease.

On the other hand, the relative content of LDH-5 increased almost twofold in the blood serum of sick mink. A growing amount of specific cytozolic isoenzyme LDH-5 in the blood serum shows deep destruction in the hepatocytic structure of cell membranes, increased permeability and enzymic infiltration into the blood. Disordered AO protection processes during AD also speak for this fact. The activity of the LPO regulation enzymes (SOD and catalase), and their ratios completely reflect the processes occuring in the mink organism during AD at the cellular level.

In its turn, the decrease and increase in the relative level of LDH isoenzymes in the organs of sick animals, especially the first and fifth enzymes responsible for alternative ways of glycolysis, show a complex regulation of biochemical processes at a molecular level under the conditions of severe pathological changes induced by the AD virus.

Thus, biochemical indices in mink organs: the activity of SOD, catalase and isoenzyme LDH spectrum in the liver, heart, spleen and, especially, the blood serum can be considered as universal tests for determining the functional state of minks with AD. At the same time the AO enzymatic activity can be used for determining the degree of lesions in mink organs with AD.

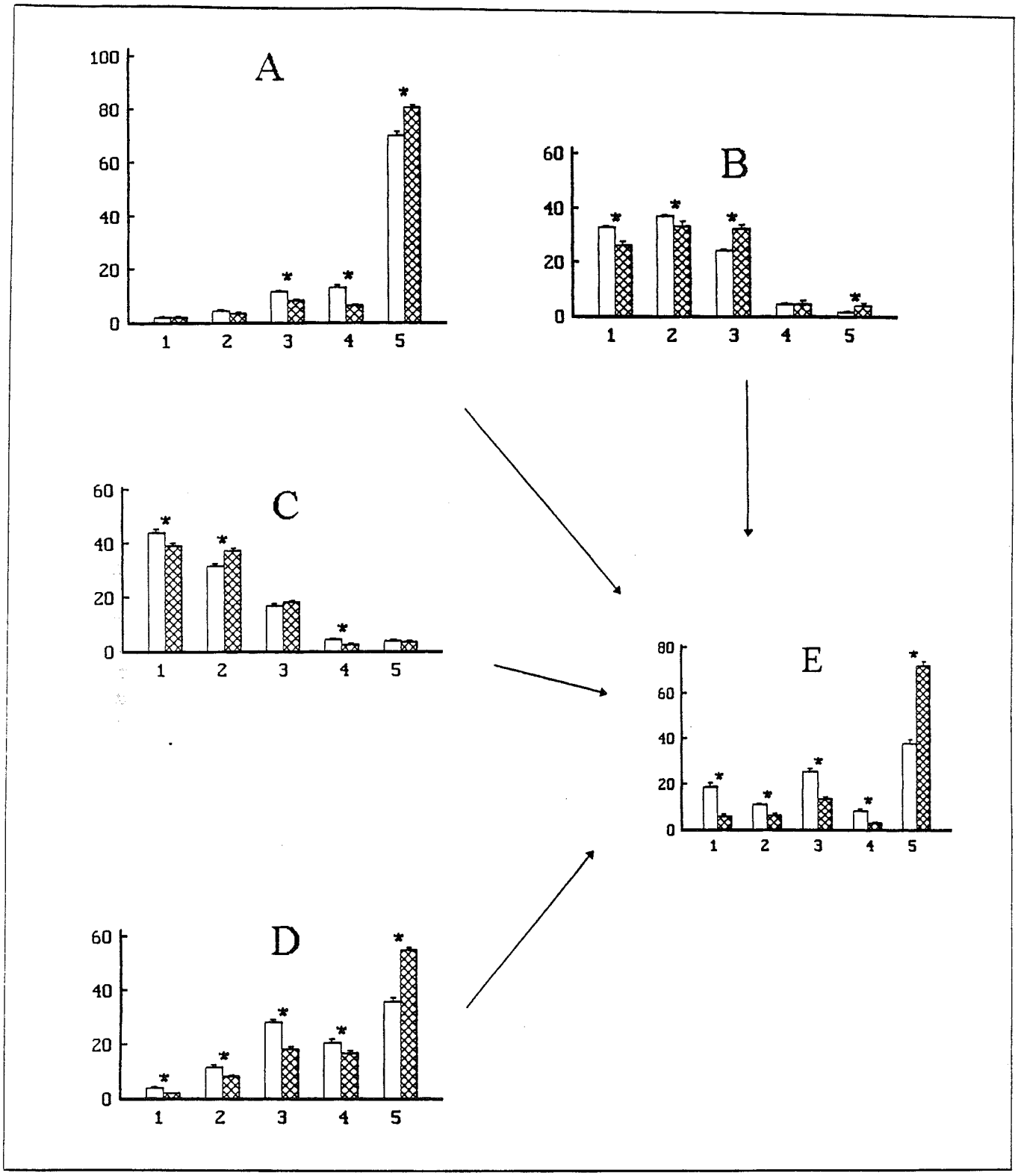

Fig. 2. Changes in the LDH isoenzyme spectra in the liver (A), heart (B), kidneys (C), spleen (D) and blood serum (E) of mink with AD.
Abscissa - LDH fraction, ordinate - content of fraction in % from the total activity. Light columns - healthy animals, shaded columns - sick animals.
* - differences between sick and healthy animals are significant (t-Student test).

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Original Report

Bromphenvinfos (Ipowet aerosol) residues in the tissues and organs of polar foxes after the use of the preparation in doses controlling external parasites

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Summary

The investigation aimed at determining the residues of bromphenvinfos (one of the enolphosphates) after the use of its commercial form Ipowet aerosol in the doses effectively controlling external parasites in polar foxes.

Three days after the application of Ipowet aerosol the bromphenvinfos residues in the tissues and organs amounted to 0.005 – 0.0075 and in 28 days to 0.0035 – 0.005 mg/kg fresh tissue or organ thus falling within the limits of the method detectability.

Introduction

Bromphenvinfos is an enolphosphate which was synthesized in Poland.

Many toxicologic, neurotoxic, embryotoxic, metabolic and teratogenic investigations of bromphenvinfos-phosphate (Z, E)- 2 – bromo – i – (2, 4 dichlorophenyl) vinyldietyl were performed. Also, the effectiveness of this compound in controlling external parasites in farm and domestic animals was analysed (*Sciesinski, 1978; Sciesinski, 1996; Sciesinski, 1998*).

A particularly effective parasiticidal activity was noted in the case of the aerosol form of bromphenvinfos – Ipowet aerosol and methylbromphenvinfos – Polwet aerosol in controlling parasites in domestic animals (*Sciesinski, 1998*). A high effectiveness of these preparations was demonstrated against fleas (*Chaetopsylla globiceps*) and scabies (*sarcoptes scabiei v. canis*) in polar and silver foxes (*Sciesinski, 1995; Sciesinski, 1996*).

The present investigation aimed at determining the bromphenvinfos residues in the tissues and organs of polar fox after the use of Ipowet 5 aerosol in the doses effective against external parasites in polar foxes as compared to other species of animals.

Material and methods

The investigations were carried out on a cooperative farm of polar foxes. A group of 8 polar foxes (half of which were males and half females) aged 3-4 years was sprayed twice at 10 days intervals with the dose of the preparation amounting to 3.0 mg/kg b.w. as for against fleas (*Chaetopsylla globiceps*).

On the 3rd day after the last spraying 2 foxes (one male and one female) were slaughtered. The next were slaughtered at 14 and 28 days. Two foxes comprised the control group (Table 1).

Table 1. Bromphenvinfos residues in the tissues and organs of polar foxes after the application of Ipowet aerosol 0.1% acetone solution in the dose 3.0 mg/kg b.w. recommended for flea (*Chaetopsylla globiceps*) control

No.	Days after use	Bromphenvinfos residues in mg/kg tissue or organ			
		Fatty tissue	Muscular tissue	Liver	Kidneys
1	Control*	0.003	0.003	0.003	0.003
2	3	0.006	0.005	0.005	0.003
3	3	0.008	0.007	0.006	0.007
4	x	**0.007**	**0.006**	**0.0055**	**0.0075**
5	Control	0.003	0.003	0.003	0.003
6	14	0.005	0.005	0.005	0.007
7	14	0.007	0.004	0.005	0.006
8	x	**0.006**	**0.0045**	**0.005**	**0.0065**
9	Control	0.003	0.003	0.003	0.003
10	28	0.005	0.004	0.004	0.005
11	28	0.005	0.003	0.003	0.004
12	x	**0.005**	**0.0035**	**0.0035**	**0.0045**

*the method detectability limits

In order to analyse the bromphenvinfos residues in foxes, the following samples were collected: Musculus trapezius thoracis, M. gluteus superficialis, M. psoas major, M. psoas minor, subcutaneous fat from the lumber region, peritoneal and perirenal fat, liver and kidneys.

The chemical method of bromphenvinfos residue determination in the tissues and organs consists of the extract with n-hexane, introductory purification with acetonitrile and phlorisile, and the determination of bromphenvinfos isomers with the GLC method using the flame ionization alkaline detector. The method was worked out by Drygas (1976).

Results and discussion

Model investigations of bromphenvinfos residues determination in foxes were used for the comparative analysis of residues in other species of animals. Bromphenvinfos residues in the subcutaneous and muscular tissues, liver and kidneys 3 days after the application of Ipowet aerosol in polar foxes in the dose of 3.0 mg/kg b.w. as in case of flea control amount to 0.005 – 0.0075 mg/kg tissue or organ. In 28 days after the last Ipowet aerosol spraying they amount to 0.0035 – 0.005 mg/kg tissue or organ thus falling within the limits of the method detectability (0.003 mg/kg tissue or organ) (table 1).

The obtained results of the bromphenvinfos residues determinations in the tissues and organs after the application of Ipowet aerosol in foxes are similar to the values obtained after the application of that preparation in pigs (*Sciesinski, 1998*). No negative clinical symptoms were observed in the investigated animals.

Conclusions

1. Bromphenvinfos residues in the tissues and organs of polar foxes 3 days after the application of Ipowet aerosol in the dose of 3.0 mg/kg b.w., such as in case of flea (*Chaetopsylla globiceps*) control, amount to 0.005 – 0.0075 mg/kg tissue or organ.
2. In 28 days bromphenvinfos residues in foxes amount to 0.0035 —0.005 mg/kg tissue or organ fallling within the limits of the method detectability.

3. The results of bromphenvinfos residues in the tissues and organs of polar foxes after the application of Ipowet aerosol show similar values as in case of applying that preparation in pigs.

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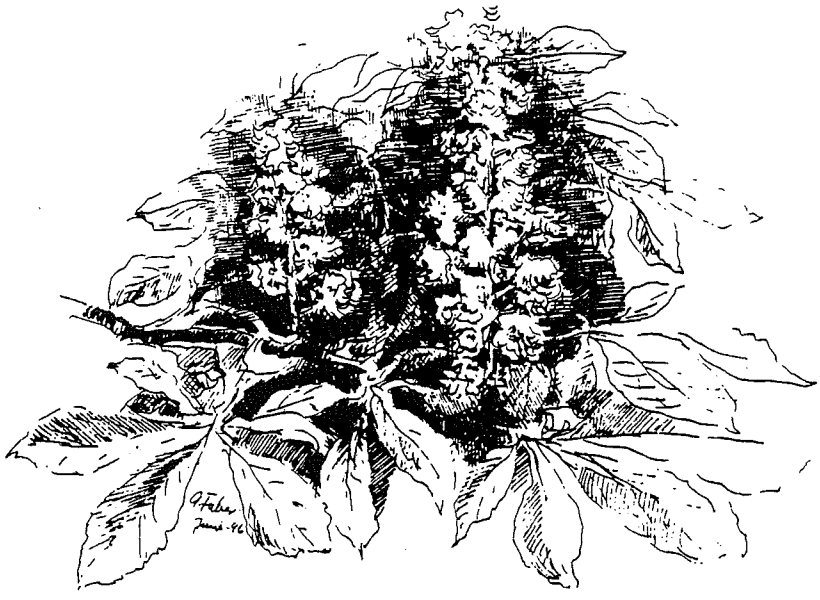

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NJF UTREDNINGAR - RAPPORTER

Production & nutrition

Management of a mink production system. Analysis of the need for adjustment at the tactical level

Steen Henrik Møller

Due to annual variation in several production results, it is difficult to assess whether the annual results should give rise to adjustments in management. Using litter size as example, a systematic method for evaluation of annual production results and the need for adjustment at the tactical level of management, has been developed. The method compares the litter size on an individual farm to the "local annual litter size" calculated from a databank built on farm data. Furthermore, the potential litter size (lsmeans) as well as the effect of *length of gestation*, *no. of matings* and *age of dam* on litter size were estimated for each farm. The *length of gestation* had a significant effect on litter size compared to *no. of matings* and *age of dam*. Combined with other farm specific factors, the mink farmer may explain the reason for the litter size obtained each year and thereby decide whether management adjustments are needed in any controllable factors. Tactical management decisions may thereby be founded on a systematic and theoretically sound basis. Whenever possible, goals for production parameters showing annual variation should be expressed in relation to the annual level of production e.g. in relation to the average. Thereby the variation in uncontrollable factors will not give rise to unnecessary adjustments in management.

Proceedings NJF Seminar no. 295. In DANH, Su. ENGL. 6 pp. 1 table, 2 figs., 3 refs. Author's summary.

Effects of different energy supply prior to the breeding season on reproductive performance and metabolism in female mink

Christian Friis Børsting, Birthe M.Damgaard, Rikke Fink

The present investigation was carried out with 75 scanblack and 75 scanbrown yearling female mink. Half of the females of each colour type was fed ad libitum (ADLIB) from mid December until mid February and the other half (RESTRICTED) was fed approx. 20% less than the ADLIB group in this period. During the last half of February both groups were fed approx. 20% below their ad libitum intake followed by ad libitum feed supply for 5 days prior to the mating season. The physical activity and the frequency of stereotypies in the restricted females were significantly higher than in the ad libitum fed females. These differences disappeared as soon as energy restriction ceased. The ADLIB females lost 11% and RESTRICTED females 21% of body weight before the end of February. RESTRICTED females had reached the same body weight as ADLIB females prior to parturition. Equal feed intake and levels of insulin T_3 and T_4 were found in the two experimental groups around mating. Litter size was not significantly influenced by the dietary treatments. These results indicate that a high flux of nutrients just before estrus and mating is the determining factor for a successful effect of the flushing strategy rather than the regimen of conditioning.

Proceedings NJF Seminar no. 295. In ENGL, Su. DANH. 8 pp. 2 figs., 5 refs. Authors' abstract.

Feeding strategies for fur animals during the growth period

Øystein Ahlstrøm

Experiments with different feeding strategies for blue foxes and mink in the growing-furring period have been carried out. There was no effects of meal frequency (one or two meals per day) on production parameters. The fat content (fat:carbohydrate ratio) in the feed did not influence body growth in mink, but in blue high dietary fat levels resulted in higher body weights and improved feed conversion rate.

Restrictive feeding in the first part of the growth period (August-October) and reduced growth owing to this, will be compensated for in the late part of the growth period if the *ad lib* feeding starts October 1. Restrictive feeding did not improve the production parameters compared with ad lib feeding, but restrictive feeding reduced the feed consumption per animal. Probably owing to reduced feed spillage and digestive

capacity in older animals. High dietary fat content is the most economical feeding during the growth period for both blue foxes and mink.

Proceedings NJF Seminar no. 295. In NORG, Su. ENGL. 7 pp. 8 tables, 2 refs. Author's summary.

Measurement of water turnover and milk yield in fur animals

Søren Wamberg

The use of the water isotope (^2H or ^3H) dilution technique for the determination of the rates of water turnover and milk yield in lactating fur-bearing animals is described. The prerequisites and the pitfalls of this technique are emphasized and some practical aspects of its application are discussed. Validation studies involving test-feeding of suckling of kittens and fox cubs proved this milk intake and the milk yield of lactating fur-bearing animals. Finally, in Table 2, some experimental and published data on the water turnover and milk production (weeks 1-4 postpartum) in four different species of carnivores are presented for comparison.

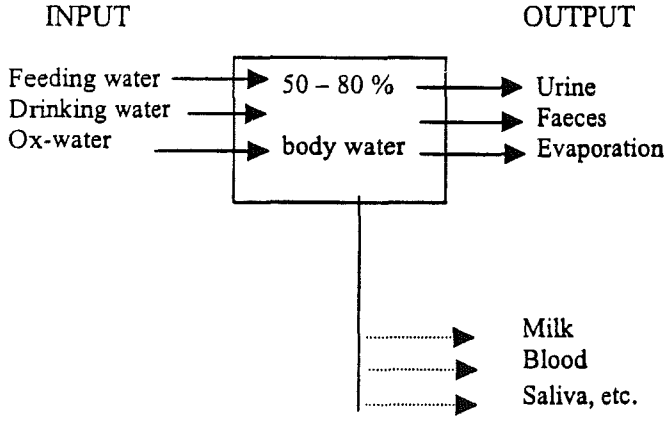


Fig. 1. Water turnover in the organism

Proceedings NJF Seminar no. 295. In DANH, Su. ENGL. 6 pp. 2 tables, 2 figs., 23 refs. Author's summary.

Metabolism of benzoic acid in fur animals

Ilpo Pölönen, Kirsi Partanen, Taina Jalava, Vesa Toivonen

Three consecutive experiments in August-September with juvenile male mink, raccoon dogs, and blue foxes were carried out. We investigated the efficiency of these species to excrete benzoylglycine, i.e. hippuric acid with incremental Na-benzoate intake. Dietary treatments were arranged 2 x 4 factorially, with two dietary glycine levels and four Na-benzoate intake levels; 0, 1, 2 and 4 mmol/kg BW. A basal diet with low glycine content was formulated to meet the minimum protein recommendation for mink, 30% from ME. This diet was supplemented with 0 or 3 g/kg of glycine-HCl, or with 0, 1050, 2050 or 4150 mg/kg of Na-benzoate. The raccoon dogs ate less, and their diet was supplemented with 4.5 glycine-HCl, and 1600, 3150, and 6350 mg/kg to maintain the targeted intake levels of benzoate and glycine. Each experiment consisted of two parts, preliminary and collection period, 3 days each. Urine and feces were collected and analysed for hippuric and benzoic acids. All animals appeared healthy and no signs of benzoate overdose were observed. Incremental dietary Na-benzoate supplementation did not affect feed palatability, water consumption, weight gain, or urine amount in any species. The effect of supplementary glycine could be seen only in the mink. Unexpectedly, it tended to decrease hippuric acid excretion ($P<.1$). Blue foxes excreted 10% of the ingested benzoate in free form in urine, regardless of intake level, mink and raccoon dogs less than half of that. In blue foxes percentage of fecal benzoate was markedly higher than with mink and raccoon dogs and increased from 2 to 15% with incremental benzoate. When benzoate intake was 1 mmol/kg BW, mink and blue foxes excreted 71 and 77% of ingested benzoates as hippuric acid, respectively. With higher intake levels the proportion of hippuric acid drastically decreased with mink, while with raccoon dogs it was only 34% with the intake level 1 mmol/kg BW. With blue foxes hippuric acid excretion did not start saturating until benzoate intake exceeded 2 mmol/kg BW. Hippuric acid pathway seems to be the principal way of benzoate elimination in the mink and the blue fox. As no signs of intoxication was observed, it is likely that in raccoon dogs part of ingested benzoates were conjugated with glucu-

ronic acid to form benzoylglucuronide instead of being accumulated in the body. It is recommended that Na-benzoate content in fur animal feeds should not exceed 1 g/kg as fed basis.

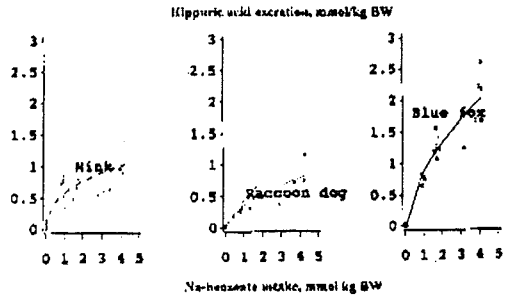


Figure 1. Hippuric acid excretion (fecal+urinary) plotted against Na-benzoate intake (ingested) in mink (R^2= 0.67), raccoon dogs (R^2=0.82) and blue foxes (R^2 =0.91).

Proceedings NJF Seminar no. 295. In ENGL. 10 pp. 3 tables, 1 fig., 15 refs. Authors' summary.

Intestinal absorption of nutrients during postnatal development of mink

Jan Elnif, Randal K. Buddington

Introduction. Mink are born at an early stage of development and provide an opportunity to study development of an altricial carnivore. During the first 4 weeks of life, mink kits are reared by their mother, and the kits are weaned at 5-7 weeks. The postnatal growth of digestive organs is relatively slow in mink kits and the effects of exogenous cortisol administration occurs relatively late compared with other species. The late development of the pancreatic enzyme activities is reflected in a low digestibility of protein in 7-9 weeks old and the intestinal hydrolytic activity in young mink develops slowly postnatally and exhibits late sensitivity to glucocorticoids. The objective of the present investigation was to study the postnatal development of the intestinal absorption of amino acids and sugars in mink kits from birth to adulthood.

Material & methods. A total of 90 mink kits were born and reared under farm conditions. Throughout the experiment the animals had free access to mothers milk, drinking water and a mink diet supplied for both mother and offspring. Mink from 8 age groups were used (new born, unsuckled (0), 24 h, 1, 2, 4, 6, and 8 weeks old and adults). The mink does not have a large intestine and as a consequence the whole intestine, a part from the very short colon, was divided into three parts of equal length. Tissues from each of the 3 sections were used for the uptake studies. The everted sleeve method was used to study amino acid (Asp, Leu, Lys, Met, Pro) and sugar (glucose, fructose) absorption as functions of intestinal region and solute concentration. The tissues were incubated for two minutes in Ringer solution with a portion of the NaCl isosmotically replaced by nutrient. Solutions were stirred at 1,200 rpm and aerated with 95% O_2 - 5% CO_2. Uptakes were performed at 37°C.

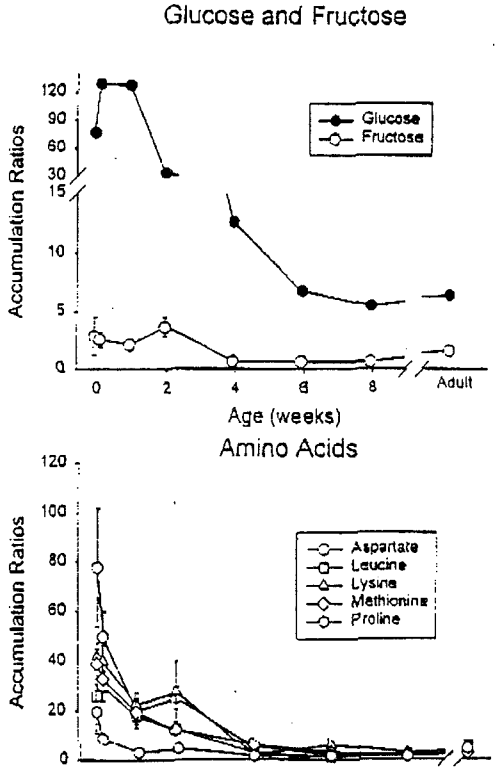


Fig. 2. The age related changes in accumulation ratios measured as the ratio between nutrient uptake rate at low concentration (tracer) divided with uptake rates at high concentrations (50 mmol/L).

Results and discussion. In the everted sleeves rates of absorption (nmol/mg-min) at 50 mmol/L were highest during the neonatal period and lowest after weaning for all solutes. The uptake rate for glucose decreased 3 fold during the first 2 weeks and were for both sugars low after weaning (<1 mmol/mg-min). The highest

rate of uptake for the amino acids was found for proline and the lowest for aspartate and there were no major changes for any of the AAs after weaning. Analysis of uptake-concentration data indicated that maximum rates of carrier mediated transport were higher for glucose than any of the amino acids, particular during the suckling period, and that the majority of amino acid uptake at 50 mmol/L at all ages was passive. Our findings reveal age-related changes in the regional distribution of different types and densities of nutrient transporters, and that the period before weaning is a critical time during which the shifts in transporter functions are most dramatic.

Proceedings NJF Seminar no. 295. In DANH, Su. ENGL. 8 pp. 2 figs., 12 refs. Authors' summary.

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

Anders Skrede

Proceedings NJF Seminar no. 295. In NORG. 8 pp. 3 tables, 8 refs. Abstract not received.

Different planes of energy supply prior to the breeding season. Effect on blood metabolites in female mink (*Mustela vison*)

Rikke Fink, Anne-Helene Tauson, Mats Forsberg

Metabolic blood profiles were studied in a total of 30 female mink (*Mustela vison*) at different planes of energy supply prior to the breeding season in a control, a flushed and a negative energy balance group. The experiment, which was divided into six one-week periods, started on 6 February and continued until 20 March. Flushing was performed by restricted feeding in periods 2 and 3 and re-feeding in period 4 and 5. The animals were weighed weekly and blood sampled at the end of periods 1, 2 and 4, the two later occasions corresponding to one week after changes in the feed supply of the flushed group took place. Plasma was analysed for total triiodothyronine, total thyroxine, insulin and insulin-like growth factor-1. Generally, the responses to the experimental treatment clearly reflected the energy supply of the treatment groups. Within the flushed group differences in animal live weights and blood metabolites were significant between periods, while these variables remained almost constant in the control group. Differences between the control and the flushed group were however, non-significant when considered over the total experimental period, thus confirming that flushing is an acute response, inducing a rapid fluctuation in energy status, hormone and metabolite concentrations of the animal despite absence of major changes in the total nutritional status and body conditions. However, the responses in the group in negative energy balance were typical chronic modulation of the reproductive axis and associated with considerable shifts in live weight and body condition, leading the differences between treatment groups to be significantly.

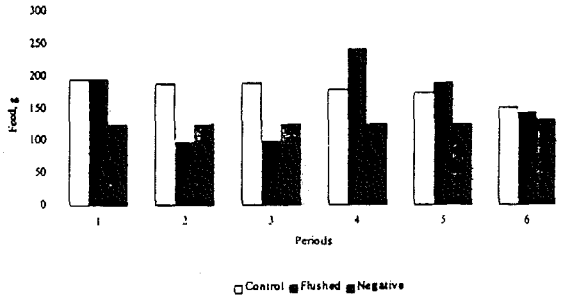


Fig. 2. Animal live weights during the 6 experimental periods for mink females given feed *ad libitum* (Control), feed restricted in periods 2 and 3 and re-fed in periods 4 and 5 (Flushed), and restricted during periods 1-6 (Negative), respectively.

Proceedings NJF Seminar no. 295. In ENGL. 8 pp. 1 table, 2 figs., 12 refs. Authors' summary.

The water use of blue fox during the winter period

L.L. Dille, M. Bakken, O.Aa Eldøy, K.R. Johannessen, S. Kaasin, R.O. Moe, S.G. Westersjø, O.D. Årdal

Proceedings NJF Seminar no. 295. In NORG. 4 pp. 4 figs. No abstract received.

Comparative nutrient digestibility in wild-living, trapped arctic fox (*Alopex lagopus*) from Svalbard and farm-raised blue fox (*Alopex lagopus*)

Øystein Ahlstrøm, Eva Fuglei, Liv Torunn Mydland

The diet of the free-living arctic fox is dominated by protein and fat of animal origin, and very little of carbohydrates. The farm-raised blue fox, which is the same species, on the other hand, is given a diet containing substantial amounts of carbohydrates. About 12-25% of the metabolisable energy in commercial fur animal diets comes from carbohydrates, mainly from grain. Therefore, one could assume that the farm-raised blue fox, which has been exposed to a carbohydrate containing diet for about 100 generations, had a higher digestive capacity for nutrients of vegetable origin than that of the free-living arctic fox. The objectives of the study were to get more knowledge of the digestive capacity of the free-living arctic fox in general and to compare the capacity with that of the farm-raised blue fox. The experiment was carried out with four wild-living, trapped arctic foxes from Svalbard, which had been kept captured for about a year, and four farm-raised blue foxes. The experimental diet was a commercial dog feed with a relatively high carbohydrate content. Compared with the farm-raised blue fox, the arctic fox had a significantly lower digestive capacity for dietary dry matter. This was mainly owing to lower carbohydrate digestibility, but also protein- and fat digestibility was lower in the arctic fox, however, not significantly. Among the amino acids, it was the typical amino acids of connective tissue and bone, proline, glycin and hydroxyproline, that were significantly better utilised by the farm-raised blue fox.

Proceedings NJF Seminar no. 295. In NORG, Su. ENGL. 6 pp. 3 tables, 3 refs. Authors' abstract.

Daily milk intake and body water turnover in suckling mink (*Mustela vison*) kits

Søren Wamberg, Anne-Helene Tauson

Daily (24 h) milk intake and body water turnover were measured in eight litters of sucking mink (*Mustela vison*) kits (6-9 kits litter^{-1}) during weeks 1-4 post partum using the tritiated water (^{3}HHO) dilution technique. The biological half-life of body water turnover in the mink kits increased linearly from 0.9 days in week 1 (3-5 days post partum) to 1.9 days in week 4 (22-24 days post partum). The daily milk intake varied markedly among the mink kits within a litter and increased significantly with increasing body mass from (mean±SEM) 10.9±0.4 g per kit during week 1 to 27.7±1.0 g per kit during week 4. Throughout the study, male kits were ~ 10% heavier and had a significantly higher milk intake than female kits.

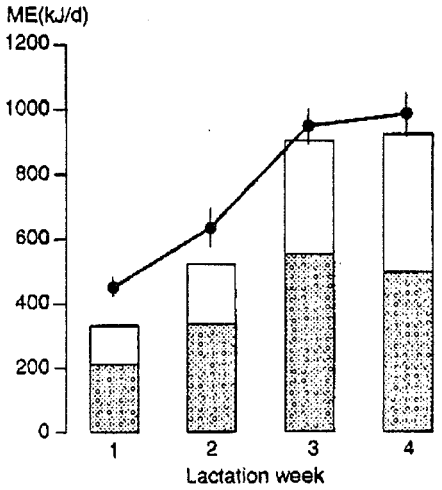


Fig. 4. Total daily output of metabolizable energy (ME)(kJ dam^{-1}) in mink milk (●) compared to the estimated (total) daily energy requirements of the kits during the first 4 weeks of lactation. Hatched columns represent the mean ME requirement for body growth (kJ day^{-1}) and open columns represent the mean ME requirement for maintenance (kJ day^{-1}). Values are means with standard errors represented by vertical bars. For details, see text. *P*: 000–000.

The results were corrected for water recycling between the dam and her kits, ranging from ~ 4 to 15% of the daily milk water intake, and the calculated daily milk yield of the 2 year old lactating mink dams increased from 87±7 g day^{-1} in week 1 to 190±15 g day^{-1} in week 4 post partum. The average body growth rate of the mink kits ranged from 2.9 g kit^{-1} per day in week 1 to 5.4 g kit^{-1} per day in week 4, and the calcualted mean intake of mink milk per unit of body weight gain was remarkably stable at 4.0 (g g^{-1}) during weeks 1-3 post partum, but increased to 5.6 (g g^{-1}) in week 4 post partum. The amount of metabolizable energy supplied to the kits by the daily milk yield of the dam increased from ≈ 450 to ≈ 990

kJ day^{-1}, which corresponded well with the calculated daily energy requirements of the kits. The tritiated water dilution technique was found feasible and reliable for repeated measurements of milk intake in suckling mink kits up to 4 weeks of age.

Abstracted in Comparative Biochemistry and Physiology, part A, pp. 931-939, 1998. 1 table, 4 figs., 43 refs. Authors' abstract.

Comparative nutrient digestibility in blue fox (*Alopex lagopus*), silver fox (*Vulpes vulpes*) and mink (*Mustela vison*)

Øystein Ahlstrøm, Anders Skrede, Sissel Frogner Tangen

Digestibility is an important factor in feed evaluation and it is also crucial for calculating energy content in feed. It is known that digestive capacity in foxes are higher compared with that of mink, but there is hardly any information available comparing digestive capacity in blue fox and silver fox. This experiment was carried for evaluate the digestive capacity in silver foxes, blue foxes and mink fed three different feeds with diverging fat:carbohydrate ratios on the basis of metabolizable energy.

In general, the fox species revealed superior digestive capacity compared with mink, especially for protein. Fat digestibility was very high independent of species and diet. Carbohydrates were determined by difference calculations which resulted in a considerable variation in the digestibility values. This inexact estimation made it difficult to reveal significant differences among the species. Protein digestibility in silver foxes was 3-4% higher than that of blue foxes. However, to evaluate the consequences of this difference on practical feed recommendations, more comparative information on digestibility of single feed ingredients in silver fox and blue fox is required.

Proceedings NJF Seminar no. 295. In NORG, Su. ENGL. 6 pp. 5 tables, 3 refs. Authors' summary.

Breeding & Genetics

Breeding systems for fur animals in Finland

Kerstin Smeds, Sanna Nikula

The first software for fur animals in Finland was developed during years 1972 - 1975. The further developed version of this centralized book-keeping system is still in use, mainly in mink farms. The system can be used for calculating breeding value estimates for litter size using selection index. The total amount of breeding animals using the centralized system in 1997 was 42,600, out of which 36,600 were mink and 6,000 foxes.

The most important software for fur animals in Finland is called Sampo. Sampo is a bilangual system (finnish/swedish), that was developed by the Finnish Fur Breeders Association. The index calculation program of Sampo was made at University of Helsinki, department of Animal Science. The dos-based Sampo was taken in common use in 1992, the windows version of Sampo was introduced to all Sampo-farms in January 1998.

Sampo can be used for calculating breeding value estimates for fertility and exterior traits. The index calculation method used in Sampo is BLUP animal model. The fertility index is based on litter size at the age of two weeks. The fur grading index is caluclated for size, darkness, underfur density, guardhair density, clarity, and general expression. The animals are graded with a scale of 1 – 5. The pelt sorting index is based on the sorting results from Finnish Fur Sales Co Ltd. The sorted traits are size, colour, clarity, and quality. Separate one-trait indexes can be weighted and combined together to form total grading and sorting indexes.

Sampo system is in use in over 300 farms, which is 15% of all fur farms in Finland. The amount of breeding animals at Sampo-farms in 1997 was over 140,000, out of which 90,300 were foxes, 46,500

mink and 3,700 finnraccoons. The exact amount of breeding animals in Sampo in 1998 is not yet clear, but over 100,000 breeding animals cards were printed at FFBA this spring in addition to over 99,000 pre-printed card bases that were delivered to farms who print the cards themselves.

Depending on species and colour, the cub result of farms using Sampo-system has been 0.1 – 0.4 cubs better than the average in Finland. The result of more effective breeding animal selection shows also in pelt quality. Sampo-farms have been placed high in the annual top-list of farms according to pelt sorting results from Finnish Fur Sales Co Ltd. In 1997, there were five Sampo-farms among the top ten blue fox farms. Sampo-farms have also been doing very well in the annual pelt shows.

Proceedings NJF Seminar no. 295. In SWED, Su. ENGL. 8 pp. 2 figs., 13 refs. Authors' abstract.

Computerised breeding systems for fur animals in Norway

Kai-Rune Johannessen, Helen Kristiansen

Pelsdyrkontrollen (PK) was established in 1986 as a computerised breeding system for fur animals in Norway, based on centralised farm-data calculations. PK has been developed and is run by The Norwegian Fur Breeders' Association. The data coming from the farms includes mating and breeding results, fur quality and animal body size. Breeding values for female fertility (based on number of whelps at 3 week), fur quality and body size are calculated and cage-cards with animal-ID, breeding indices and pedigree are sent out to the farmers as well as different kinds of statistical listings. The data from the farm can be sent to PK in writing, by PK's PC-program PKAVL (diskettes/e-mail) or by hand held terminals with specially designed programs, which can be linked directly to the telephone. At the moment there are approximately 300 breeders using PK as an aid in their breeding work. This is near 25% of the active farms in Norway. For foxes the fox mating circles are important as a basis for the breeding stock in PK. Pelsdyrkontrollen is at the beginning of major changes to meet the challenges to develop a modern breeding system, attractive and well designed for Norwegian fur farmers in the future. Connections to skin data from the auction houses, renewal of the breeding indices, bringing new traits into the breeding plans and the use of Internet are important factors in this work.

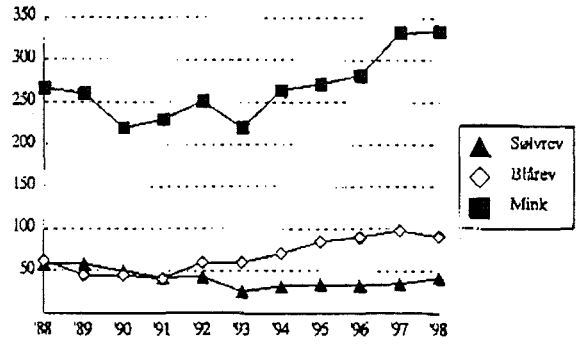


Fig. 2. Udviklingen i gjennomsnittlig antall avlstisper pr. farm, 1988-1998

Proceedings NJF Seminar no. 295. In NORG, Su. ENGL. 2 tables, 7 figs. Authors' summary.

Molecular genetic mapping of central colour genes in fox (*Vulpes vulpes*)

Dag Inge Våge

Two mutations that cause black coat colour have recently been characterised by molecular tools. The mutations are localised in two different genes called *agouti* and *extension*. While the *extension* gene encodes the melanocyte stimulating hormone receptor (MSH-R), an antagonist with the ability to block the MSH-R is encoded by the *agouti* gene. The Standard Silver fox phenotypes is a result of a deletion in the *agouti* gene, while the Alaska Silver fox phenotype is caused by an *extension* gene mutation that makes the receptor constitutively active. By combining alleles from the *agouti* and *extension* loci, five different Silver fox genotypes with almost identical phenotype are produced. With the new possibility of genotyping these mutations by DNA-based methods, the role of the Alaska-mutation in developing "brown hairs" in the Silver coat may be investigated. Preliminary results indicate that this defect can not be caused by the alaska-mutation alone. However, animals that are ho-

mozygous for the alaska-mutation and also carry one or two functional *agouti* alleles could possibly develop this defect. This will be investigated by producing the actual genotypes in the coming breeding season.

Proceedings NJF Seminar no. 295. In NORG, Su. ENGL. 4 pp. 1 table, 6 refs. Author's summary.

Estimation of genetic parameters in mink - body weight, pelt quality and litter size, - results based on field data

Bente Krogh Hansen, Peer Berg

Modern breeding systems have been used in mink production for several years. A new version of the Danish breeding programme DanMink for use with PC is planned. Prediction of breeding values will in the new version be based on an Animal Model. Animal Model is a group of statistical models used in biometrical genetics. The part shared by these models is that individual animals' breeding value is included in the model, and through the use of the numerator relationship matrix information on all relatives and mates is taken into account. Apart from this characteristic an Animal Model may include various fixed effects, such as year and sex, to simultaneously correct for these, and various random effects, such as common environment shared by full sibs, to account for non-genetic sources of correlations between animals. Thus it is necessary to adapt the Animal Model to its specific use. To develop an Animal Model for Danish mink breeding, it was decided to initiate a project to validate the assumptions and predictions of an Animal Model. The aim of this project is to test the assumptions of an Animal Model for predictions of breeding values in mink and to fine tune an Animal Model to mink breeding. This paper is a part of the above project and the aim of it is to estimate genetic parameters for body weight, pelt quality and reproduction based on field records. This is the first step in validating an Animal Model for mink. The analyses were based on black and brown mink colour types from 10 farms. All farms included have data from more than two generations. Only animals from pure lines are included. Those restrictions reduced the original number of records with 20 pct. Altogether records from 57984 litters, including 334769 kits (92296 male and 97389 female kits) remained for the analyses. Traits analysed were body weight, pelt quality graded in November and litter size at two weeks. The female body weights are adjusted to male weights, by multiplying by the ratio of the mean body weight of males to the corresponding mean of the females. Variance components were estimated in univariate Animal Models by an Average Information REML algorithm (Jensen et al. 1998) using the DMU programme package (Jensen & Madsen, 1994). Heritability of the direct additive effect (h_a^2) on body weight was intermediate between 0.36 and 0.51. Still in November 10 pct of the variation in body weight was due to the common litter environment (and non additive genetic effects). Thus the specific environment (c_s^2) had effect on body weight. The achieved heritability estimates (h_a^2) for pelt quality varied between farms ranging from 0.16 to 0.34 (Table 3). Only on three farms the achieved estimates are below 0.20. Also the specific environment (c_s^2) has effect on pelt quality. Still in November 5 pct of the variation in pelt quality was due to the common litter environment. Heritability of the direct additive effect (h_a^2) on litter size was between 0.05 and 0.15. The common environmental (c_e^2) effects between repeated litters of the same dam in the analysis of litter size was between 0.04 and 0.15. The repeatability, which is the sum of the direct additive effect and the common environmental effect, varied between 0.10 and 0.24.

Based on the analyses performed it can be concluded that field data can be used to estimate genetic parameters. Common environmental effects are important for all the traits studied. Including common environmental effects is necessary to obtain unbiased predicted breeding values.

Proceedings NJF Seminar no. 295. 5 pp. 4 tables, 8 refs. Authors' abstract.

Selection for confidence increases trust towards humans in blue foxes

Hilkka Kenttämies

A selection experiment for more confident blue foxes has been running since the year 1995 using the mate-

rial of the native farm. Animals in the base population were divided into two equal groups, and the experiment has continued within closed lines using yearlings as parents of the following generation. Confident behaviour was defined by using a feeding test. Breeding values for the traits were estimated by BLUP and animal model. Heritabilities were estimated by univariate REML and animal model. Animals in the selection line were selected due to breeding value for confidence and those in the control line due to a combined BV for production traits. Moderate heritability estimates (0.25± 0.01 for the first test result and 0.30± 0.004 for mean of four consecutive tests) were obtained in material from the first three years (N=2528). Response to selection for confident behaviour appeared already in the second selection generation in comparison with the unselected (0) generation or control. Results obtained from the third selection generation increase accuracy of the present study. In future, it is worth considering to include temperament together with production traits in total BV in order to improve confidence and welfare of farm-bred blue foxes.

Proceedings NJF Seminar no. 295. 8 pp. 4 tables, 19 refs. Author's summary.

Selection for trusting blue foxes – reproduction results and stability of temperament

Steffen W. Hansen

The objective of the project is to improve the adaptability of the blue foxes to the production system through selection for behaviour, to examine if this selection for a tame temperament improves the reproduction result, and furthermore to examine the stability of the foxes' temperament over time. The selection criterion used was the animal's reaction to the "Titbit-test".

In November 1996, the cubs on 4 farms were tested by means of the titbit-test. In February 1997, the breeding animals (P-generation) were tested and divided into 2 lines: a selection line consisting of the most trusting females and a production line consisting of the remaining females. In November 1997, the cubs of the two lines were tested and the most trusting female cubs of the selection line were selected to be breeding females in the selection line (F1 generation). In the production line, the breeding females were selected regardless of temperament. In February 1998, all the breeding animals (P and F1 generation) on the farm were tested again. The reproduction result in 1997 is calculated for the selection line and the production line, respectively.

The reproduction result in 1997 showed that blue foxes selected for a trusting temperament gave birth to and weaned more cubs than blue foxes not selected for temperament.

A great variation in the foxes' temperament was found between farms. This variation seems to reflect the reproduction result of the farms – farms with the most trusting females thus having the best reproduction result.

The examination of stability of temperament showed that 70% of the trusting cubs also reacted trustingly as first-year breeding females when the selection criterion was that they should have reacted trustingly in at least one observation per test. For fully-grown females tested after a year, 50% maintained a trusting temperament.

If the selection criterion for trust is changed so that the foxes should have reacted trustingly in at least 50% of the observations per test, the stability is reduced. Only 50% of the trusting cubs reacted trustingly as first-year females, and for fully-grown females, the stability drops 32% after one year.

This result gives occasion to consider the selection criterion for trust. Up to now, the "necessary" number of animals has been selected among those reacting trustingly most often. If this method is to be maintained, the results indicate that the number of observations per test should be increased to ensure a greater stability of temperament Alternatively, all foxes having reacted trustingly just once should be included in the selection line, i.e. foxes that always react fearfully should not be included in the experiments.

Proceedings NJF Seminar no. 295. In DANH, Su. ENGL. 10 pp. 8 tables, 2 figs. Author's summary.

Selection trials for trusting silver foxes in Denmark

Leif Lau Jeppesen, Vivi Pedersen

Proceedings NJF Seminar no. 295. In DANH. 5 pp. 2 tables. No abstract received.

Homology between genes for brown coat colour in silver fox (*Vulpes vulpes*) and blue fox (*Alopex lagopus*)

Liisa Jalkanen, Outi Lohi, Risto Savolainen

Large variation of coat colour is typical for many fur bearing species. A possible homology between genes causing certain coat colour in different species has for a long time been a subject of research interest. In situations, where inter species hybrids are viable, such homology has been demonstrated in practice like in question of the two farm bred fox species silver fox (*Vulpes vulpes*) and blue fox (*Alopex lagopus*). A known example of this is the blue inter species hybrid sapphire frost, which is a product of crossing between eastern pearl silver fox and sapphire blue fox (*Nes et al., 1988*).

Efforts to cross brown silver fox types burgundy or colicott with brown arctic pearl blue fox have not produced clearly brown colour and have thus not shown homology between these genes. On the Juankoski research farm of the University of Kuopio in Finland two arctic pearl blue fox vixens were in 1998 inseminated with sperm of Polish pastel silver fox. All offspring in the two litters with 6 and 14 cubs, respectively, have pale brown coat colour, blue eyes and white tip of the tale. Thus a homology exists between the gene for arctic pearl in blue fox (*Alopex lagopus*) and the gene for Polish pastel in silver fox (*Vulpes vulpes*). Pearl frost is suggested as name for this new inter species hybrid.

Proceedings NJF Seminar no. 295. In DANH, Su. ENGL. 4 pp. 4 refs. Authors' abstract.

Etology & Welfare

Effect of enlarged cage space and earth stimulus on locomotor and digging activity in blue foxes

Hannu Korhonen, Lauri Jauhiainen, Paavo Niemelä

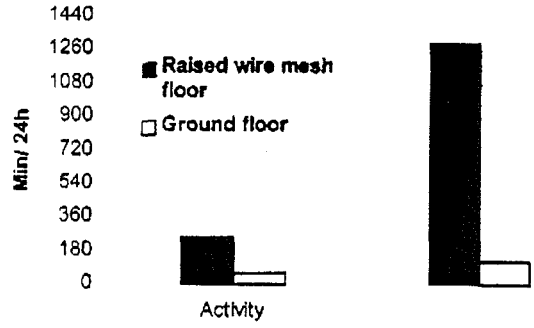


Fig. 4. Comparison of activity and total time spent between wire-mesh floor (at a higher level in shed cage) and earthen floor (on the ground) (option D in Exp. 1). Data are the means for eight male blue foxes.

Two separate behavioural experiments were carried out to clarify the effect of gradually increasing cage space and access to an earthen floor at ground level on activity, floor preference and digging motivation in farm blue foxes (*Alopex lagopus*) (Exp. 1: May-June, N = 8 adult males; Exp. 2:July-Sept, N = 8 adult males). The experimental set-up employed a construction in which the solitary animal spent the first 2 weeks in a small shed cage (80 cm long x 105 cm wide x 70 cm high). Thereafter, cage length was enlarged from 80 to 120 cm for a further 2 weeks and then to 240 cm. Finally, the fox also had free access to an earthen floor at ground level (80 cm long x 105 cm wide x 70 cm high). In Exp.2, after the foxes had spent 2 weeks on the earthen floor, the floor material was replaced by wire-mesh. Behavioural activity of the animals was measured by continuous 24-h video recordings. Statistical analyses were based on the mixed-model approach to the repeated measurements.

The results showed that the amount of the foxes' locomotor activity did not change despite enlarged cage space and access to the earthen floor. Nor did the duration of activity bouts change with increasing cage size. Mean length of activity bout was in each cage option rather short. When both the shed cage and earthen floors were simultaneously available, the foxes preferred the former option. Present earthen floor structure did not highly motivate foxes to dig. Before it is possible to make final conclusions on space needs of farm foxes, additional studies in larger space than a traditional shed can hold are necessary.

Proceedings NJF Seminar no. 297. 8 pp. 5 figs., 2 refs. Authors' abstract.

Stereotypies in young farmed foxes

Ingela Wikman, Jaakko Mononen, Teppo Rekilä, Mikko Harri

Stereotyped behaviour occurs frequently in captive farm and zoo animals. Stereotypies have not been studied earlier in farmed foxes. In the present study, possible stereotyped behaviours were identified and classified for juvenile silver foxes (*Vulpes vulpes*) and blue foxes (*Alopex lagopus*) caged in traditional wire mesh cages. The behaviour of 12 blue and 12 silver foxes of both sexes was videorecorded for two 24 h periods at the ages of 3-5 months. Their behaviour was analysed with continuous recording. A behavioural pattern was regarded to be a stereotype if the pattern had invariate sequence of movements and an animal repeated the pattern more than 15 s. Four main categories of possible stereotypies were found: SI. repeated pacing including pacing and jumping along a cage wall or around in the cage with or without a twirl of the head, S2. repeated pacing and jumping along a cage wall with a neighbouring fox, S3. scratching, licking and biting the cage and S4. repeated chasing and biting of own tail. Blue foxes performed these four types of behaviours 2.7 ±7.5 (median= 0), 0.6±1.5 (0), 21.6±12.1 (19.5) and 0.8±1.2 (0) min/24 h, respectively. The figures for silver foxes were 4.5±6.6 (0.7), 2.9±2.4 (2.1), 18.6±8.7 (17.8) and 2.2±3.1 (0.9) min/24 h, respectively. Silver foxes performed more S2 than blue foxes ($P<0.001$, Mann-Whitney U-test). No other differences were observed either between species or between sexes within each species ($P>0.05$, Mann-Whitney U-test). In both species, S3 occurred more often during evening (1600-2400 hours) than during night and working hours ($P<0.05$, Friedman Two-way ANOVA). SI was observed more often during working hours than during other times of day in blue foxes ($P<0.05$). S3 and maybe S2 do not necessarily fulfil all the criteria of a true stereotype: they may have an obvious function. We conclude that true stereotypies are rare in juvenile farmed foxes.

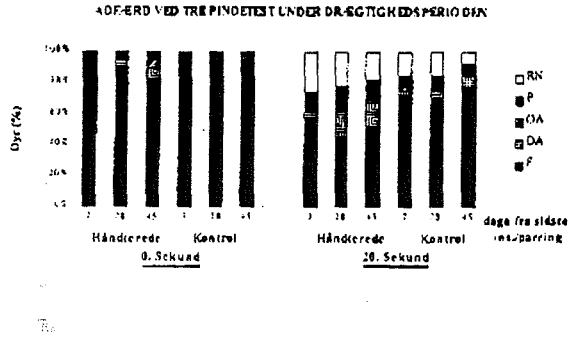
Proceedings NJF Seminar no. 297.6 pp. In SWED, Su. ENGL. 3 tables, 10 refs. Authors' abstract.

Handling and reproduction in blue foxes

Tania M.S. Dalgaard

The results presented here are extracts from my thesis for the Master's of Science degree. The aim of the project was to investigate the long term effect of early handling and access to all year nest boxes on the behaviour and reproduction in primipara blue fox (*Alopex lagopus*) vixens. In addition, attempts were made to estimate the welfare of the animals in the experimental situation. The project was carried out during the first reproductive year of the vixens and lasted for six month. Due to the extend of the project, the presented results only include the part of early handling. The subject of the investigation was 87 vixens who all as cubs had been used in a different experiment (*Bertelsen, 1996*). In this, from the age of seven to ten weeks, half of the cubs had been handled in an assumed positive way two minutes a day, five days a week. The remaining half acted as control. The extract presented here includes results from heat checks, weighing of the vixens at the first insemination or mating and litter sizes. The reproductive success of the foxes was measured as the number of born and weaned cubs per mated vixen and as cub losses from birth to weaning, Additional results presented include those from three stick-tests performed at 7, 28 and 45 days after the last insemination or mating. The handled vixens were earlier in heat, gave birth to (n.s.) and weaned more cubs per vixen than did the control

group. With regard to weight no significant differences were found between the two groups at the first insemination/mating or between producing and nonproducing females. In the behavioural tests where significant differences were found between the two groups, there were less fearful individuals in the handled group than in the control group. In conclusion, it can be said that the results indicate a long term effect of early handling. The vixens seems less fearful of humans and have increased reproductivity. The results also seem to indicate an improved welfare for handled vixen compared to vixens in traditional settings.



Proceedings NJF Seminar no. 297. 10 pp. In DANH, Su. ENGL. 4 tables, 1 fig. 9 refs. Author's summary.

Effects of handling stress during heat and pregnancy on reproduction and behaviour in blue fox (*Alopex lagopus*)

Anne Lene Hovland, Bjarne 0. Braastad, Morten Bakken

Proceedings NJF Seminar no. 297. In NORG.7 pp. 4 tables, 20 refs. No abstract received.

Handling of foxes. Damage with use of different types of neck tongs

M. Bakken, 0. Eldoy, K.R. Johannessen, S. Kaasin, L. Lönne, R. Moe, S. Westersjö, O.D. Ardal

Proceedings NJF Seminar no. 297. In NORG. 7 pp. 2 tables, 2 figs., 27 refs. No abstract received.

Demand for food in blue foxes (*Alopex lagopus*)

Sari Kasanen, Maarit Iso-Oja, Jaakko Mononen, Mikko Harri

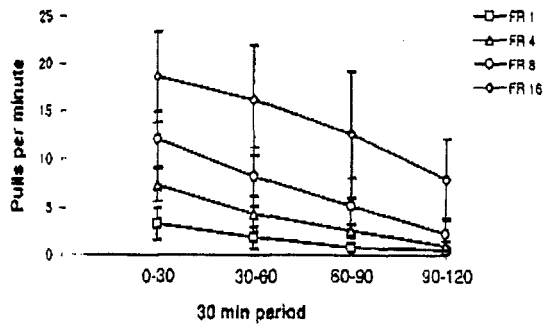


Fig. 2. The rate of pulling the wire loop by blue foxes (n=4) in two-hour experiments with various Fixed Ratios (= the number of wire loop pulls per food reward, FR). The mean for each animal for each 30-min period and FR were calculated. These means were used as variables when calculating the means and SDs presented in the figure. The differences between the FRs for all 30-min periods and the differences between the 30-min periods for all FRs were significant ($p<0.05$ for all eight comparisons, Fried man two-way analysis of variance)

Welfare of farmed animals is best ensured by letting them satisfy their strongest needs. The relative strength (or elasticity) of various needs of animals can be assessed with the aid of operant conditioning. In the present study we used operant conditioning for assessing the demand for food in blue foxes (*Alopex lagopus*). Four adult blue fox females were tested in an experimental cage where a fox could get food by pulling a plastic covered wire loop. The foxes had to pull against 3 N force. After required number of pulls the fox got a food reward of 2 g. Fixed Ratios (FR, number of pulls demanded for 2 g food reward) 1, 4, 8 and 16 were used, sessions with each FR were repeated five times. One test session lasted for two hours and the amount of food the fox consumed during that time was measured. The logarithms of the mean amount of food eaten by a fox during four last sessions with each FR was plotted against the logarithms of FRs. A linear curve was fitted according to these four points, and the slope of the curve was

determined. The slope for the demand curve for food was 0.02 ± 0.04 (absolute value, mean ± SD), indicating inelastic need for food in blue foxes, as expected.

Proceedings NJF Seminar no. 297. 7 pp. 2 figs., 3 refs. Authors' summary.

Health related indicators of animal welfare in foxes

Randi Oppermann Moe

A necessary basis for the work aiming at increasing animal welfare in farmed foxes is to identify species specific valid indicators of animal welfare. One possible approach may be to investigate impaired immune function and, thus, increased susceptibility to disease, as an indicator of welfare. The presentation focussed on reviewing recent years research in the field of psychoneuroimmunology. Possible approaches that need to be validated for foxes are to investigate the ability of lymphocytes to proliferate in vitro, study antibody formation following immunisation, and phagocyte activity following stress. This work has been initiated and will be followed up in a new project.

Proceedings NJF Seminar no. 297. In NORG. 3 pp. 13 refs. Author's abstract.

Foxes' fear of humans can be evaluated using the feeding test

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

The Feeding test is based on the hypothesis of hyponeophagia, i.e. that fearful animals do not start eating in a strange situation. Relationships between the results of the Feeding test and other behavioural and physiological measures, supposed to indicate fearfulness, supported the hypothesis that the Feeding test measures fear of foxes. In addition, the Feeding test seems to be applicable for practical situations, as it is repeatable, free of random errors and easy and quick to perform.

Proceedings NJF Seminar no. 297. 5 pp. 1 fig., 11 refs. Authors' summary.

Effect of open/closed nest box on behaviour of blue foxes and growth of cubs

Steffen W. Hansen

Purpose. To investigate whether the opening of the nest box affects female blue foxes' and their cubs' use of the nest box, and whether a possible decrease in the use of the nest box and thus an increased exposure to the environment has a positive effect on the growth of the cubs and their subsequent temperament towards humans.

Method. Immediately after mating, 45 females had access to a closed top box, and 34 females to an open top box. The closed top boxes were permanently closed during period of gestation and suckling, whereas the open top boxes were closed in the period from 14 days before to 14 days after the time of birth. The foxes' use of nest box was registered by scanning observations before and after feeding at 9.00 hours. The cubs were weighed when the female was removed from the cubs (day 60), and when the cubs were placed in pairs at approx. 74 days of age. The temperament of 217 cubs was tested by means of the Titbit-test in October/ November when the cubs were housed in pairs without access to a nest box.

Result. After birth, females with an open nest box spent more time in the cage compared to females with a permanently closed nest box ($p < 0.01$, Wilcoxon 2-sample test). A higher percentage of cubs per litter were in the cage when the nest box was open than when it was closed ($p < 0.01$, Wilcoxon 2-sample test). Cubs with an open nest box had a higher growth from the age of 60 to 74 days compared to cubs with a permanently closed nest box, but the difference was not statistically significant ($p = 0.20$ GLM procedure). Cubs housed in open nest boxes were more trusting towards humans than cubs housed in closed nest boxes ($p < 0.05$, ttest procedure).

Conclusion. As opposed to a closed nest box, the opening of the nest box induces the female and the cubs to spend more time in the cage compared to housing in permanently closed nest boxes, an increased early exposure to human contact and farm feed subsequently make the cubs react more trustingly

towards humans. It was not statistically possible to prove an effect on the growth of the cubs.

Proceedings NJF Seminar no. 297. 3 pp. Poster. In DANH, Su. ENGL. Author's summary.

Comparison of two breeding systems for timing of whelpings in farmed silver foxes

J. Mononen, M. Harri, K. Rouvinen, T. Rekilä

Essentially two different mating systems are practiced in silver fox farming: in the "Truro system" vixens are kept in their breeding cages, separated from each other, before and after the breeding time. In the "Kuopio system" vixens are placed in adjacent cages close to one another before the breeding time and after mating they are transferred to new cages in the mating order. In addition to practical reasons, the vixens are assumed to develop earlier and more synchronised heat in the "Kuopio system". Comparison of these two system revealed, however, that in the "Truro system" multiparous vixens had more synchrorised heat with the majority of matings at the beginning of the season. In prirniparous vixens no difference was observed.

Proceedings NJF Seminar no. 297. 7 pp. Poster. 2 tables, 1 fig., 10 refs. Authors' summary.

Temporal suitability of an enlarged cage system for silver fox families

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

The present farming system may limit the animals' opportunity to exercise more and behave socially because the space *per se* is a limiting factor. Therefore, in the present study, locomotor activity of silver fox families and some aspects of social behaviour of the family members in row cage systems with a floor area of 7.2 m^2 was monitored from weaning to maturity of the offspring. In conclusion, the present results show that the presented family housing of silver foxes might be considered as an alternative housing method to the existing farming method until the late autumn. Thereafter, aggressions between the family members and the use of available space increase so that the social system presented here may no longer be beneficial to be maintained

Proceedings NJF Seminar no. 297. 8 pp. Poster. 3 figs., 17 refs. Authors' summary.

Infanticide and periparturient behaviour in reproducing farmed blue foxes

T. Pyykönen, J. Mononon, T. Rekilä, M. Harri

Blue fox vixens (10 primiparous, seven multiparous) were video-recorded inside the breeding box around parturition to get information about their reproductive behaviour. The data was analysed in six phases: five days (-5 d) and one day (-1 d) prepartum, parturition, and the next three days (+1d, +2d, +3d) postpartum. Births were distributed quite uniformly around the clock. The true litter size at birth was 11.2±2.7 cubs for ten primiparous vixens and 10.4±3.5 cubs for seven multiparous vixens. The parturition period lasted 237±83 min varying from 2 to more than 6 hours while the interval between subsequent deliveries was 24±14 min. The closer to parturition the more the vixens spent time in the nest box. Both resting and active behaviour inside the box increased. Nest boxes were not bedded with fur tangles. About 43% of the parturition time was spent cleaning, grooming and inspecting the cubs. After parturition vixens rested or slept most of the time (80%). Total cub-care showed no relationship to litter size, indicating that an individual cub receives more care in smaller litters. Infanticide was not observed and all vixens that delivered a litter of living cubs weaned also healthy litter. This study confirms earlier *results (Ilukha et al. 1997)* that infanticide plays a minimal role as a cause of postnatal cub mortality in blue foxes. It also shows that experimental results and conclusions, from one species should not be extrapolated to another species without investigation.

Proceedings NJF Seminar no. 297. 8 pp. Poster. 3 tables, 8 refs. Authors' summary.

Hematological and clinical-chemical parameters in mink with different temperament

Birthe M. Damgaard, Steffen W. Hansen

Scanblack mink have been selected for behavioural traits through ten generations, the selection criteria being their behavioural response to human contact. The mink were classified in three lines for explorative, fearful and aggressive temperament. In the present investigation, blood samples were collected in the parent generation (P) and in the first four generations (F1 - F4), and in generation ten (F1O). Blood samples were analysed for number of erythrocytes, hemoglobin value, number of leucocytes, differential count of leucocytes and number of thrombocytes. Furthermore, plasma samples were analysed for activity of ALAT and ASAT and for concentration of urea and total protein. No genetic correlation between temperament and hematological and clinical-chemical variables has been demonstrated after selection through four generations. All blood variables varied with age. The number of leucocytes in pregnant females increased markedly in midgestation. The number of erythrocytes and clinical-chemical variables seemed to be very sensitive to whereas the number of leucocytes and the relative frequency of individual groups of leucocytes seemed to be fairly insensitive to natural biological changes.

Proceedings NJF Seminar no. 297. Poster. In DANH, Su. ENGL. 8 pp. 2 tables, 1 fig., 10 refs. Authors' summary.

Transportation in foxes

Randi Oppermann Moe, Morten Bakken

The study was initiated to investigate whether immune status in farmed silver foxes may be affected by transportation. 16 ten-month old silver fox vixens were exposed to a two days session of transportation (4 h and 2 h), handling and being left in transportation cages over night. Blood samples were obtained the day before, immediately following the last day of transportation, and one and two weeks following transportation. Parameters studied included numbers of lymphocytes and neutrophil/lymphocyte ratio and plasma cortisol. Numbers of lymphocytes were reduced, and the neutrophil/lymphocyte increased immediately following transportation and up to two weeks later. Plasma cortisol levels increased but not significantly. In conclusion, the transportation had long term effects on immune status in silver foxes.

Proceeding NJF Seminar no. 297. 2pp. Poster. In NORG, 6 refs. Authors' abstract.

The effect of the present of a shelf on the activity during growth and lactation in female mink

Lise Overgaard

The aim of this study was to investigate whether a greater complexity of the physical environment in the shape of a netshelf would affect the activity of female mink, and if the use of the shelf depended on its position. The positive correlation between the increased activity and the occurrence of abnormal behaviour was also examined.

Sixty pairs of mink were placed in cages equipped with a shelf 20 cm under the roof during growth, 60 pairs in cages equipped with a shelf 10 cm under the roof and 60 pair in conventional cages. The shelves were placed in the back of the cage. Respectively 17, 18 and 20 female mink from these groups continued in the investigation during the lactation period. The behaviour of the mink was observed by scan sampling from the beginning of September to the beginning of November and again from birth to the weaning of the kits at 7 weeks of age. The results showed that an increased complexity in the shape of a shelf assisted to both an increased activity in female mink, and a greater use of the cage. During lactation both groups with a shelf were significant more active than the mink without a shelf, but during the growth season the mink with the high placed shelf were significant more active. The shelves were used in 15 - 25% of the time spent in the cage, and in more than half of the observation the behaviour was active. During lactation the mink with a high shelf were observed more frequently using the shelf than the group with the low shelf. In spite of the greater activity, both groups with shelves had a smaller occurrence of stereotype behaviour during growth. This may be caused by a

delayed development of abnormal behaviour due to the novelty of the shelf. During lactation a positive correlation between activity and abnormal behaviour were found.

Prceedings NJF Seminar no. 297. Poster. In ENGL, Su. DANH. Only abstract received. Author's abstract.

Miscellaneous

Preliminary results of in vitro culture of in vivo produced polecat (*Mustela putorius*) embryos

H. Lindeberg, S. Amstislavsky, M. Järvinen, M. Valtonen

As a part of an ex-situ conservation program in vitro culture of in vivo produced polecat embryos was investigated. Estrus cycle of 10 polecat females was followed and females were mated twice on consecutive days with 9 different males. Females were sacrificed 2-12 days after last mating and uteri collected for recovery of embryos. Flushings resulted in a total number of 100 embryos that represented developmental stages ranging from 1-cell stage to large expanded blastocysts. After in vitro culture, 51 cultured 1-cell - compact morulae stage embryos yielded 41 new blastocysts with a blastocyst production rate of 80%. This promising result is encouraging in terms of effectively utilize in vitro culture in further reproductive studies in the polecat and for embryo transportation for commercial purposes.

Proceedings NJF Seminar no. 297. 7 pp. Poster. In ENGL, Su. NORG. 2 tables, 2 figs., 8 refs. Authors' abstract.

Surgical embryo transfer in the blue fox (*Alopex lagopus*)

H. Lindeberg, S. Amstislavsky, J. Aalto, J. L. Jalkanen

Embryo transfer in the blue fox was investigated as part of an ex-situ project concentrating in developing assisted reproductive techniques in order to save the threatened Scandinavian arctic white fox. Natural estrus of 45 females was followed with measuring vaginal electrical resistance values on basis of which suitable transfer pairs were selected. Thirteen donor females were sacrificed, uteri were flushed and a total number of 160 embryos were recovered, out of which 110 were transferred. Nine surgical embryo transfers were carried out resulting in birth of 17 pups and delivery but loss of 2 additional pups. Altogether 4 females whelped. Post-mortem examination of uteri of those recipient females which did not deliver any pups revealed 14 implantation sites in their uteri. This study reports the first embryo transfer pups in the blue fox derived from in vivo produced embryos surgically transferred into nonmated recipients.

Proceedings NJF Seminar no. 297. 6 pp. In ENGL, Su. SWED. 1 table, 9 refs: Authors' abstract.

A comparison between microscopic and automated differential counts in farmed foxes

Randi Oppermann Moe, Hege Brun-Hansen, Morten Bakken, Tormod Adnoy, Hanne Morberg

The aim of the study was to compare results obtained using the conventional microscopic differential count (M-diff) with those obtained using an automated method (A-diff) employing the Technicon H*1 Hematology Systems with canine-specific software in clinically healthy silver and blue foxes. A-diff and M-diff were determined on the same blood samples from 32 silver and 37 blue fox blood samples. Furthermore, samples from other 14 silver and 14 blue foxes were split and analysed automatically in duplicates. Means and ranges obtained with the two methods were similar. Furthermore, the Pearson correlation coefficients indicate that there was good agreement between A-diff and M-diff results within both fox species, particularly with regard to lymphocytes and neutrophils. A generally lower, but still highly significant, correlation between M-diff and A-diff was found for monocytes and eosinophils. There was a high precision for all leukocytes within the A-diff. For neutrophils and lymphocytes, the regression slope was close to the optimal value of 1.0 in both species. The slope for eosinophils in blue foxes (0.48) is indicative of a proportional error. The intercept value (range from –1.61 to 3.44) is indicative of constant bias which must

be taken into account before interpreting results based on different methods of analysis. In summary, the study demonstrated that by using the Technicon H*1 Hematology Analyzer together with canine software it is possible to obtain reasonably accurate and precise differential leukocyte counts in clinically healthy silver and blue foxes.

Proceedings NJF Seminar no. 297. 2 pp. Poster. Authors' abstract.

Fur development in growing mink influenced by different dietary protein levels

Palle V. Rasmussen, Christian F. Børsting

The effect of different dietary protein levels on fur development in growing mink was studied histologically from birth until pelting in five groups of pastel mink.

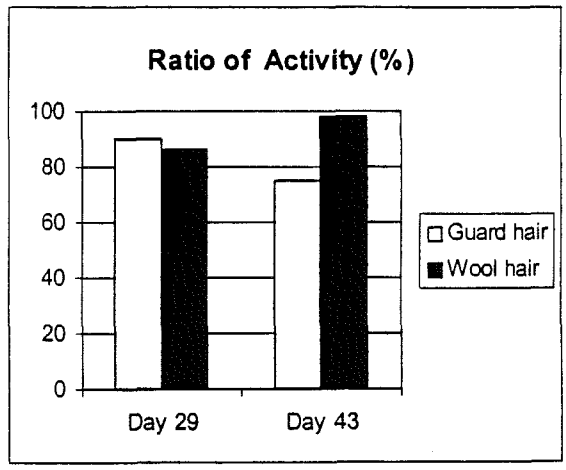
Two groups of pastel female mink were fed either 60 % (HIGH PROT) or 40 % (LOW PROT) of ME from protein during pregnancy and lactation. In the beginning of July shortly after weaning, 50 male and 50 female kits from the LOW PROT females were put on a new LOW PROT diet (20 % protein, group 5). Male kits of 50 litters from HIGH PROT females were randomly distributed to 4 experimental groups (1, 2, 3 and 4). Kits of group 4 were shifted to the LOW PROT diet (20 %) at the beginning of July, whereas the other 3 groups were shifted to a new HIGH PROT diet (34 %) at this stage. Group 3 was transferred to LOW PROT on 14 August and group 2 on 28 September, whereas group 1 remained on the HIGH PROT diet until pelting. Each male kit was housed together with a female kit.

Skin biopsies taken from kits killed day 0, day 15, day 29 and day 43 in group 1 and 5 were examined in order to describe early hair growth. Skin biopsies from each of 15 males (anaesthetized) in each group were taken every third week and examined in order to describe hair growth from weaning until pelting.

Histological and microscopical methods were used in order to determine the ratio of activity, ROA, defined as the number of hairs in growing stage in per cent of the total number of hairs. The fibre length and thickness were determined morphometrically and relationships between morphological variables and fur properties of dried pelts judged by different sensorial methods were examined.

It is concluded that by means of detailed histological methods it is possible to describe the histogenesis of hair in mink. The determination of ROA of both guard hairs and wool hairs brings even minor changes in early hair growth to light.

There is a positive relationship between ROA in October (wool hairs from males) and fur volume in pelts. However, the growth period and speed of individual hairs may influence the fur volume.



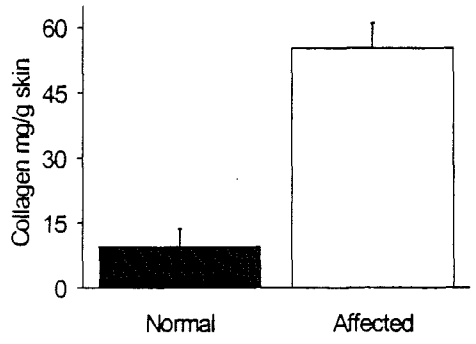
Proceedings NJF Seminar no. 297. 10 pp. Poster. 3 tables, 4 figs., 8 refs. Authors' summary.

The content of elastin and collagen in skin from silver foxes (*Vulpes vulpes*) displaying the "curly hair' defect

Bent Riis

The present study tested a number of pelt parameters from silver foxes carrying the genetic defect "curly hair" and from normal control animals. The parameters were: hair weight, content of insoluble elastin and content of acidic and NaCl soluble collagens. The

weight of hair was not found to differ between the two groups. It was shown that the structural proteins within the skin are affected by the "curly hair" defect. This genetic defect affects both hair and skin components in silver foxes.



Amount of NaCl-soluble collagen.

Proceedings NJF Seminar no. 297. 8 pp. Poster. 4 figs., 8 refs. Author's summary.

Supercritical Fluid Techniques as Tools in Biochemical Mink Research including studies of Mink Milk and Feed

C. Biergegaard, S. Buskov, K. Mortensen, H. Sørensen, J.C. Sørensen, S. Sørensen

Proteins, carbohydrates, lipids and essential low molecular weight (LMW) compounds are important constituents of fur animal feed. The polymeric proteins, carbohydrates and lipids need to be hydrolysed in the gastrointestinal tract before the monomeric (LMW) compounds can be absorbed to the blood and used by the animals. Partial hydrolysis of mink feed has, however, often occurred before the feed is used. This may result in too high concentrations of antinutritional or toxic compounds in the feed due to transformations of lipids into rancidity products, and of amino acids into biogenic amines or products thereof. Xenobiotica of different origin can also be the reasons for such effects.

Studies of the above mentioned compounds have comprised the various reasons to variations in feed quality, studies of mink milk, and of the digestive processes and metabolism in mink, unveiling of the reasons to feed and hereditary caused diseases. These studies as well as investigations of the composition of mink skin/fur give an urgent and pronounced need for efficient methods of analyses. This is also the case for lipophilic compounds and amphiphilic compounds occurring as membrane constituents. Especially the latter types of compounds have previously caused serious analytical problems owing to their special properties, which are like surfactant properties. However, with the new possibilities of using supercritical techniques in combination with HPCE-MECC it seems to be possible with adaptation of appropriate methods to this previously "grey analytical area".

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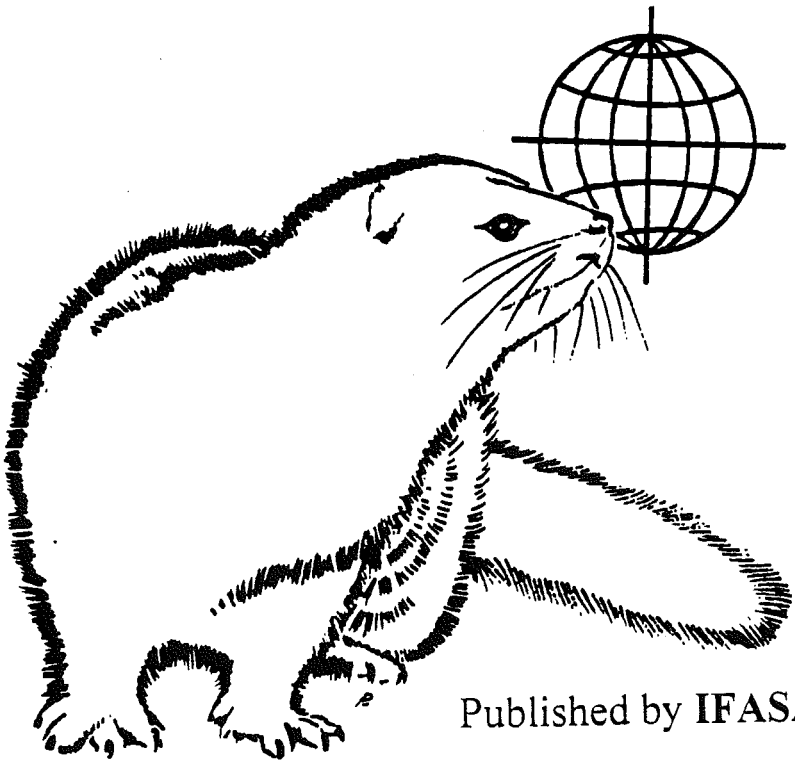

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