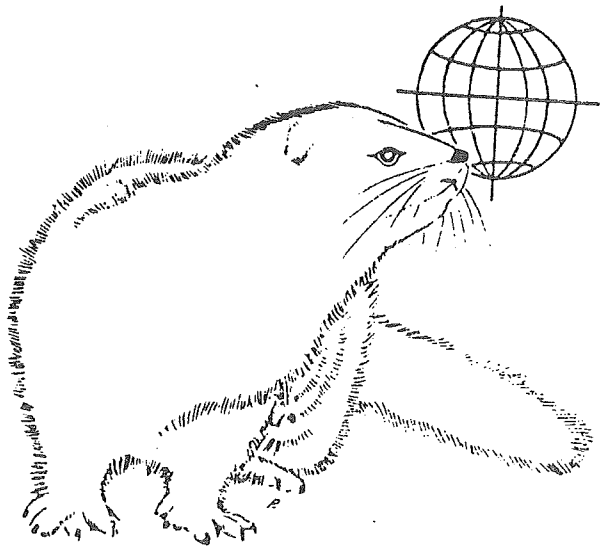

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Titles of other publications - not abstracted

Interactions of adult animals looking after puppies in blue fox families on the Medny Island. Communicative mechanism regulating mammal population structure. *E.P. Kruchenkova, M.V. Gol'tsman. Moscow (USSR), p. 55-58. In RUSS. Code 11-5-F.*

Positive and negative effects on the fur quality of chinchillas. *Anonymous. Deutsche Pelztierzuechter (Germany, F.R.), Vol. 63 (9-10), p. 135-138, 1989. In GERM. Code 2-12-O.*

Environmental pollution by minks and other kind of animals. *G. de Jonge. Deutsche Pelztierzuechter (Germany, F.R.), Vol. 63 (9-10), p. 127, 1989. In GERM. Code 10-12-14-M-F-O.*

Dimension of enclosures - Equipment of enclosures. *E. Heller. Deutsche Pelztierzuechter (Germany, F.R.), Vol. 63 (11), p. 145-146, 1989. In GERM. Code 10-12-14-M-F-O.*

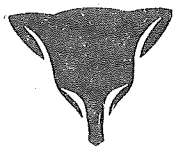
Cleaning and disinfection of farms to eliminate plasmacytosis (*Aleutian disease*). *L.T. Berndtsson. Vara Palsdjur, 61;3, p. 84, 1990. In SWED. Code 9-12-14.*

4. Genetics

Titles of other publications - not abstracted

5. Reproduction

Titles of other publications - not abstracted



6. Nutrition

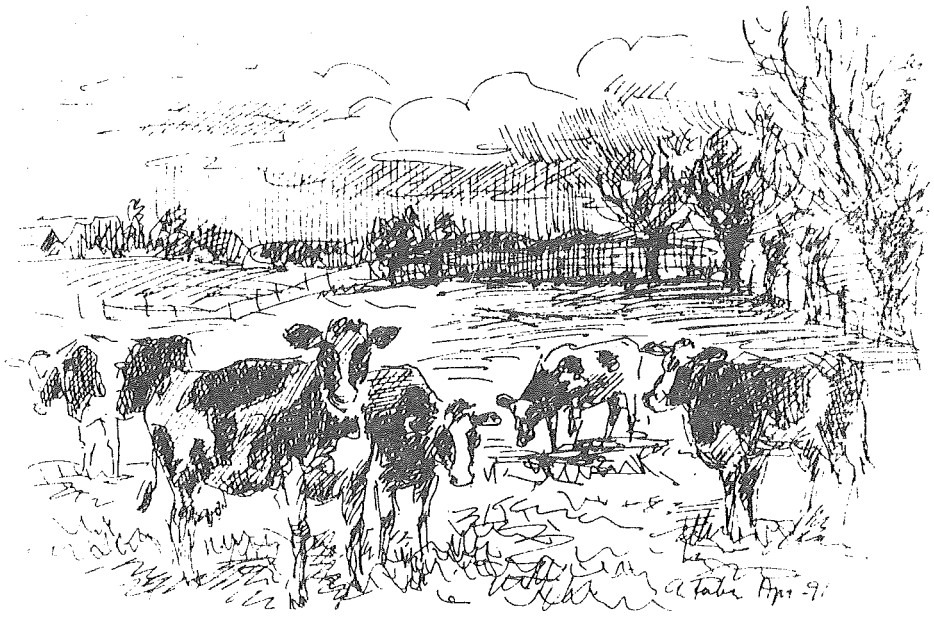
7. Veterinary

Titles of other publications - not abstracted

Investigation of the morbidity of Aleutian disease in minks of different genotypes. *Chinese Journal of Veterinary Medicine (China), Vol. 15 (2), p. 12-13, 1989. In CHIN. Code 9-M.*

Chronic fungal disease in chinchilla. *Anonymous. Deutsche Pelztierzuechter (Germany, F.R.), Vol. 63 (7-8), p. 108-109, 1989. In GERM. Code 9-O.*

8. New books



WITH COMPLIMENTS Department of Animal Breeding and Genetics

5296 NES, N.; EINARSSON, E. J.; LOHI, O.; JØRGENSEN, G. (EDITORS) **Beautiful fur animals and their colour genetics** Glostrup, Denmark ; Scientifur (1988) 271pp. ISBN 87-981959-5-6 [En, Price ~~260~~ Dkr] 320,-

This beautifully produced and illustrated book should prove an indispensable reference work for the breeders and fanciers of fur animals. The coat colour genetics of fur bearers is explained in an introductory chapter, and there are separate chapters describing the many colour types in foxes, arctic foxes, interspecific fox hybrids, raccoon dogs, mink, polecats, pine and stone martens, nutria, sables and chinchillas, with information on their mode of inheritance. Notes are also given on body weights and measurements and behaviour. A useful glossary of biological terms is provided, in addition to a list of Scandinavian marketing names. There is an index of all the species, mutants and combination types described in the book, as well as a 6-page bibliography of relevant literature. The 289 colour photographs are mostly of a very high quality.
[A. A. Fowler]

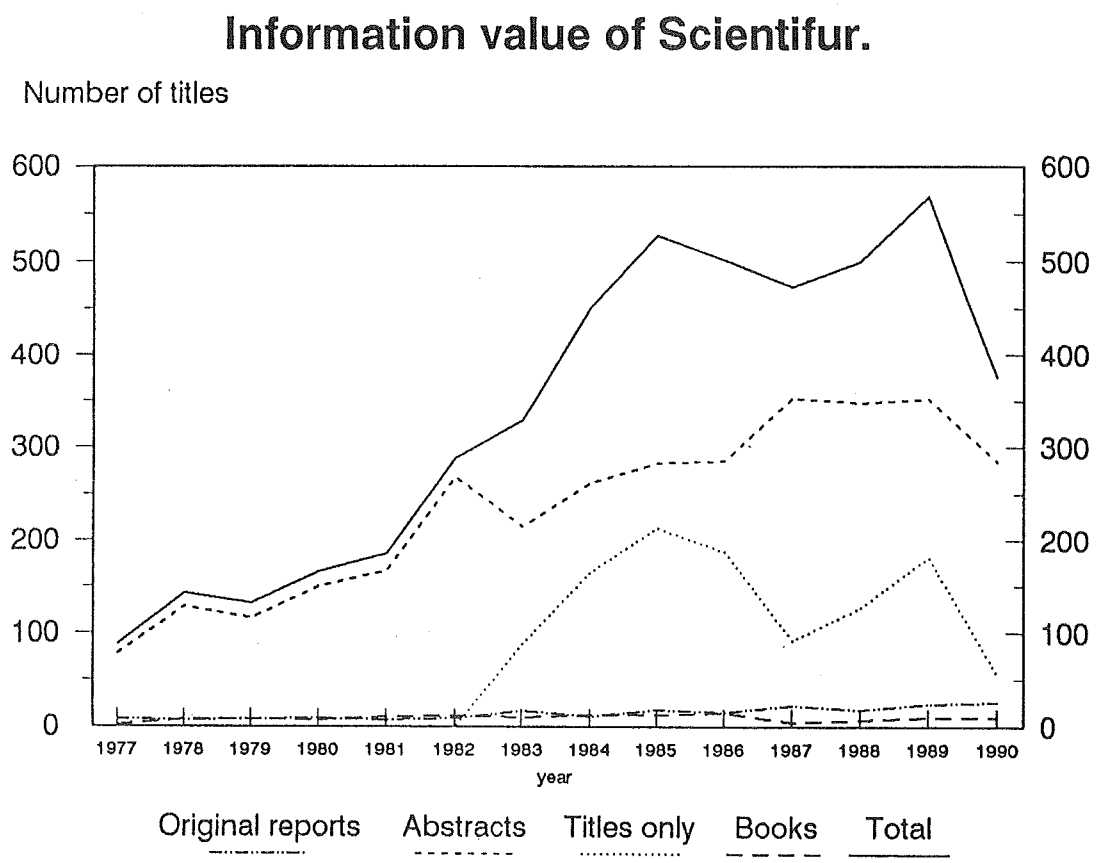
Notes

SCIENTIFUR

Vol. 15, No. 3

August 1991

Yes, you were right. Not you, but your editor was sleeping, when in the notes of Vol. 15 No. 2 he stated that he would bring a figure showing the information value of the journal. The figure did not appear then, but here it is now.



As you can see from the figure, the total number of titles has declined from 1989 to 1990. This does not mean, however, that the information value of SCIENTIFUR has followed the skin prices. The reduction is mainly due to our rejection of abstracts and titles with practical information without any documentary value. This has been necessary because the number and length of original reports has increased, and because we have to keep the weight of each issue below 250 grams for economic reasons.

In the first two issues of SCIENTIFUR Vol. 15 we have, on 173 pages, brought 9 original reports, 198 abstracts, 20 titles, and 3 book presentations, and this issue holds the record as regards number of original reports.

Home again after participation in the international scientific symposium in High Tatra, Czechoslovakia, April 22-25, and after a very interesting study trip to the Agricultural University in Krakow, to the University of

Veterinary Medicine, Kosice, and to the University of Technology and Agriculture in Bydgoszcz. I wish to thank all colleagues for all our fruitful discussions, underlining the importance of future cooperation.

Also very impressive for the Danish group was the study tour to the Institute of Cytology and Genetics, Siberian Branch of the USSR Academy of Sciences, Novosibirsk and to the V.A. Afanasyev Research Institute of Fur Animals and Rabbits, Rodniki near Moscow, to which we were invited by our dear colleague Dr. Alexander Taranin, who had also arranged the whole tour.

Again the key words were wishes for closer collaboration between institutes and regarding IFASA. We, who have been informed about and seen all the activities going on regarding fur animals in the institutes visited, are convinced that through closer contacts many resources could be used more efficiently.

As the editor of SCIENTIFUR it was a great experience for me to learn that the journal has a great responsibility for the good information all parts receive regarding international fur animal research.

After the IFASA board meeting in August we will come back to the question regarding establishment of an INTERNATIONAL FUR ANIMAL SCIENCE NETWORK as advertised in the NOTES in the last issue of SCIENTIFUR.

Also in this issue is the preliminary invitation to the INTERNATIONAL SCIENTIFIC CONGRESS IN FUR ANIMAL PRODUCTION appearing as a folder. Judging by the decisions made at the Toronto Congress regarding IFASA and the later work of the preliminary board of IFASA, together with the growing understanding of the necessity of international contacts and cooperation, it is evident that the 1992 congress will be a real milestone in fur animal research. Therefore, make your reservations and make your utmost efforts to find the possibility to participate. Participation in the congress will be your opportunity to influence the form and the extent of future international cooperation in fur animal research.

The invitation is also distributed through other channels. If you wish more copies for distribution in your area, please order these from the secretary of the congress or from SCIENTIFUR.

Another important point: There are still too few both personal and institutional members of IFASA. Some who applied for membership have not yet paid the fee for 1990, and until today many have not paid the fee for 1991. The importance of membership and payment of the fee should not be questionable to anyone in the area of fur animal production. Not only to support the work of IFASA, but also to receive SCIENTIFUR and participate in the IFASA meetings and congresses at a reduced price.

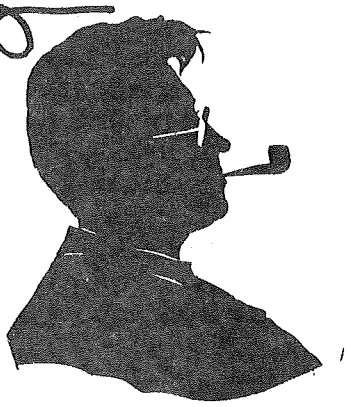
Please make the decision and pay now that you have hopefully started again full of energy and hope for the future after a good holiday.

In conclusion, thanks to Dr. D.K. Onderka for his letter to the editor quoted in this issue of SCIENTIFUR. As we havetried to explain earlier, the situation is too difficult to follow your wishes at the moment. Your letter was, however, extremely encouraging, because a colleague showed interest and gave recommendations for the future. Always when we meet colleagues outside this country, we are told of the interest in SCIENTIFUR and IFASA, but very few participate by correspondence in the discussions about how to influence the future. Participation like that could be good for the editor as well as for the board of IFASA. Therefore, think about it!

We hereby wish you a good time, and remain until November

Your Editor

Gunnar Jørgensen



Original Report

Content of some mineral elements in hair of silver foxes during ontogenesis

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Summary

Fur samples of silver foxes were analysed by means of disperse-roentgenfluorescent spectrometry from three topological parts of the body (middle part of back, middle of tail, terminal part of tail) during ontogenesis in both sexes. An uneven distribution of the mineral elements K, Ca, Mn, Fe, Cu, Zn, Br, Rb, Sr and Pb was found in the fur of males. In juvenile hair of silver foxes a higher content of some of the studied mineral elements was found compared to the period of fur ripeness in both sexes. The highest concentration of mineral elements was in the tail fur during ontogenesis of silver foxes.

Introduction

Results of microanalytical research have confirmed that besides biogenic elements also mineral elements are present to a certain amount in the functional structures of fur. Their presence in metabolic reactions provides for building and regulating processes which influence directly the manifestation of functions and organ structure.

Fur as a non-vital derivative of integument carries in the chemical composition of the hairs information about the environment which influenced the animal during the growth of hair. This property can be used to control the food ration, to optimize mineral nutrition, and to study relations between the concentration of elements and efficiency data. Fur can be used in such a way only if the concentration of elements in given somatometric localities and in ontogenetic stages of organism with defined food rations is known.

Fur is suitable for research as samples taken are painless and need no special way of storage. Most mineral elements are concentrated in higher amounts in fur, where they are firmly connected with proteinous structures, than in organs, tissues (*Eads, E., Lambdin, Ch. 1973; Katz, S. 1979*), and blood where their content is not stable (*Jenkins, G. 1979*).

A number of works aimed at solving the problems of concentration measurements of abiogenic ele-

ments in fur of farm animals rose together with the development of analytical methods in chemistry. However, they dealt only marginally with silver foxes raised in farms.

Among the first works dealing with this problem is one dealing with the determination of copper in yhe fur of wild red fox (*Ajvazian, N. 1962*) and of silver fox (*Samkov, Ju. 1972*). Bialkowski, Z., Saba, L. (1985) and Saba, L. et al. (1982) determined the concentration of potassium, calcium, manganese, iron, zinc and copper in the fur of silver foxes in the period of fur ripeness, and in blood. Authors of this work (*Saba, L. et al., 1982*) reported higher concentrations of calcium, magnesium and phosphor in the white hairs of silver foxes compared with the coloured hairs. The authors explain this fact with the existence of relations between the eumelanin level and the content of these elements in fur. Berestov, V. et al. (1984) give concentrations of Zn, Fe, Mg, Ca and Cu in fur of polar foxes and standard black minks during the ontogenesis. They found a higher content of observed elements in fur of polar foxes in comparison with fur of standard - black mink. During the spring moulting of polar foxes, higher concentrations of Zn and Fe were observed compared with winter fur. Mg and Cu content was higher in winter fur. The authors also observed significant differences in the concentration of Zn and Fe between the long hair and short hair of polar foxes. Maximum concentrations of K, Mg, Zn and Fe were found in juvenile fur of polar foxes (*Tjurnina, N. 1980*). Unequal distribution of mineral elements was found in fur of males and females in individual localities of the body. Maximum concentrations of Mn, Fe, Cu, Zn, Br, Rb and Sr were observed in silver foxes during the fur ripeness in the terminal part of tail (*Mertin, D. et al., 1990*) and of Zn, Cu, Fe, Ca in hair of tail in polar foxes (*Berestov, V. et al., 1984*).

Material and methods

The experiment took place in the Department of Fur Animals Rearing of the Research Institute of Animal Production in Nitra, CSFR. 90 males and 90 females were in the experiment.

Samples of hair were taken during the ontogenesis at the age of 30, 60 and 90 days from the dorsal part. Samples were taken from the middle part of the back, the dorsal part of the middle of the tail and the terminal part of the tail at the age of 120 and 200 days in order to determine topographic differences in the concentration of mineral elements. Fur samples were cut from the animals (approximately 2 g). Each age category and locality was represented by 5 males and 5 females. Mineral elements from the fur were determined by means of disperse-roentgenfluorescent spectrometry as follows: K, Ca, Mn, Fe, Cu, Zn, Br, Rb, Sr and Pb (*Tumanov, J., Stepanok, V., 1986*). Concentration values of observed elements were elaborated to basic variance-statistical characteristics (M ± SD). Significance of differences of arithmetric - al means were tested by t-test. Animals were kept in iron cages with grates in two-row sheds and during the experiment they were without clinical symptoms of disease. Nutritional value of feed rations is given in tabel 1.

Table 1. Contents of digestible nutritive substances in feeding doses (g. 418 $KJ^{-1}ME$).

	month							
Index	IV	V	VI	VII	VIII	IX	X	XI
Digestible protein (g)	10.7	10.3	10.3	8.6	8.6	9.1	9.2	9.3
Digestible fats (g)	3.5	3.8	3.8	4.2	4.2	3.7	3.6	3.9
Digestible sacharides (g)	5.8	5.5	5.5	5.4	5.4	6.2	6.5	6.1
$ME.plece^{-1}.day^{-1}$ (KJ)	2092	2510	2510	2929	3096	2594	2176	1966

Results and discussion

Basic statistical traits of concentrations of observed elements during ontogenesis in fur of silver foxes are given in tables 2, 3 and 4. In all age categories, in the observed topological regions of the body and in both sexes there is no quantitative representation of the studied mineral elements.

Maximum contents of most of the studied elements in juvenile hair occur in male hair. Significant differences of arithmetical mean in mineral element concentrations between sexes on the level of significance $P \leq 0.01$ are for Ca (for males 0.076 ± 0.002, and 0.058 ± 0.001% for females), Rb (3.96 ± 0.05, and 3.32 ± 0.17 $mg.kg^{-1}$) and on significance level $P \leq 0.05$ for K (0.251 ± 0.027, and 0.177 ± 0.001% $mg.kg^{-1}$) and Mn (41,40 ± 1.40, and 37.00 ± 0.76 $mg.kg^{-1}$) at the age of 30 days. Concentrations of the other mineral elements is almost on the same level for males and females except for Fe content (197.0 ± 14.8, and 249.6 ± 10.8 $mg.kg^{-1}$) which is lower in males ($P \leq 0.01$).

In females at the age of two months the concentration of K (0.240 ± 0.025 for males, 0.342 ± 0.004% for females), Ca (0.057 ± 0.003, and 0.084 ± 0.001%). Zn (356.2 ± 16.0, and 433.8 ± 12.6 $mg.kg^{-1}$), Sr (1.34 ± 0.14, and 2.58 ± 0.08 $mg.kg^{-1}$) rises significantly in comparison with males, and the content of Pb decreases (4.00 ± 0.28, and 2.52 ± 0.07 $mg.kg^{-1}$). Concentration of most of studied elements in juvenile hair of foxes increases with the age in both sexes. Increase of K, Ca, Mn, Fe, Cu, Pb ($P \leq 0.01$) and Zn ($P \leq 0.05$) contents was observed in three month old males. During the analysis of mineral element contents in fur according to sex and age we noted maximum, highly significant concentrations of the studied elements in males at the age of three months for Ca (0.085 ± 0.002%), Mn (61.16 ± 7.85 $mg.kg^{-1}$), Fe (709.0 ± 33.3 $mg.kg^{-1}$), Cu (12.16 ± 0.76 $mg.-kg^{-1}$), Zn (381.0 ± 9.8 $mg.kg^{1}$), and in females for Mn (41.62 ± 0.89 $mg.kg^{-1}$), Cu (4.39 ± 0.29 $mg.kg^{-1}$), Br (35.18 ± 0.31 $mg.kg^{-1}$), and Pb (3.82 ± 0.01 $mg.kg^{-1}$) compared with 30 and 60 day old individuals.

Table 2. The concentration of elements in juvenile hair of silver foxes.

Element	Group of males M ± SD			Group of females M ± SD		
($mg.kg^{-1}$)	n=5 Age 30 days	n=5 Age 60 days	n=5 Age 90 days	n=5 Age 30 days	n=5 Age 60 days	n=5 Age 90 days
K (%)	0.251 ± 0.027	0.240 ± 0.025	0.205 ± 0.010	0.177 ± 0.003	0.342 ± 0.004	0.162 ± 0.001
Ca (%)	0.076 ± 0.002	0.057 ± 0.003	0.085 ± 0.002	0.058 ± 0.001	0.084 ± 0.001	0.057 ± 0.001
Mn	41.40 ± 1.40	37.92 ± 4.55	61.16 ± 7.85	37.00 ± 0.76	40.20 ± 0.20	41.62 ± 0.89
Fe	197.0 ± 14.8	703.0 ± 54.2	709.0 ± 33.3	249.6 ± 10.8	733.2 ± 30.6	444.0 ± 9.1
Cu	4.50 ± 0.37	7.04 ± 1.53	12.16 ± 0.76	4.05 ± 0.35	4.00 ± 0.33	4.39 ± 0.29
Zn	151.2 ± 5.1	356.2 ± 16.0	381.0 ± 9.8	145.2 ± 4.2	433.8 ± 12.6	339.8 ± 8.2
Br	33.24 ± 0.58	29.58 ± 0.59	32.42 ± 0.88	34.58 ± 0.46	31.60 ± 0.06	35.18 ± 0.31
Rb	3.96 ± 0.05	3.59 ± 0.07	2.08 ± 0.12	3.32 ± 0.17	3.72 ± 0.05	3.82 ± 0.01
Sr	2.25 ± 0.21	1.34 ± 0.14	2.29 ± 0.08	2.25 ± 0.05	2.58 ± 0.08	2.20 ± 0.04
Pb	2.55 ± 0.45	4.00 ± 0.28	4.24 ± 0.26	2.65 ± 0.14	2.52 ± 0.07	2.28 ± 0.02

Table 3. The concentration of elements in hair of silver foxes in moulting season (age 120 days).

Element	Group of males (n=5) M ± SD			Group of females (n=5) M ± SD		
(mg.kg^{-1})	MPB	MT	TPT	MPB	MT	TPT
K (%)	0.163 ± 0.003	0.306 ± 0.011	0.361 ± 0.138	0.183 ± 0.011	0.184 ± 0.006	0.162 ± 0.016
Ca (%)	0.043 ± 0.004	0.070 ± 0.005	0.067 ± 0.005	0.054 ± 0.006	0.058 ± 0.006	0.061 ± 0.007
Mn	30.82 ± 4.67	45.48 ± 6.91	59.74 ± 4.74	40.16 ± 1.63	36.08 ± 5.27	39.36 ± 1.36
Fe	134.2 ± 9.5	273.0 ± 8.6	676.6 ± 27.7	113.2 ± 9.8	238.2 ± 21.1	745.8 ± 21.7
Cu	3.20 ± 0.38	7.13 ± 0.46	8.12 ± 1.27	5.26 ± 0.87	4.52 ± 0.39	7.66 ± 0.96
Zn	161.2 ± 12.7	284.0 ± 18.5	241.6 ± 10.7	183.8 ± 9.9	198.8 ± 5.2	204.6 ± 14.4
Br	21.08 ± 1.38	23.44 ± 0.93	26.71 ± 1.27	19.56 ± 1.13	22.92 ± 0.94	24.16 ± 1.51
Rb	2.09 ± 0.08	1.44 ± 0.28	3.08 ± 0.12	2.23 ± 0.13	2.16 ± 0.20	1.66 ± 0.22
Sr	2.16 ± 0.08	2.44 ± 0.29	2.32 ± 0.10	2.80 ± 0.17	2.38 ± 0.08	1.66 ± 0.25
Pb	2.62 ± 0.19	2.57 ± 0.10	3.06 ± 0.28	2.28 ± 0.02	2.47 ± 0.10	1.97 ± 0.30

Table 4. The concentration of elements in hair of silver foxes in fur ripeness period (age 200 days).

Element	Group of males (n=5) M ± SD			Group of females (n=5) M ± SD		
(mg.kg^{-1})	MPB	MT	TPT	MPB	MT	TPT
K (%)	0.165 ± 0.009	0.174 ± 0.004	0.166 ± 0.016	0.181 ± 0.001	0.161 ± 0.015	0.156 ± 0.014
Ca (%)	0.050 ± 0.009	0.041 ± 0.007	0.060 ± 0.008	0.045 ± 0.006	0.056 ± 0.007	0.056 ± 0.003
Mn	49.48 ± 3.36	32.46 ± 1.69	39.12 ± 1.12	37.92 ± 1.42	36.10 ± 5.44	48.88 ± 5.87
Fe	100.5 ± 7.8	296.6 ± 26.2	526.6 ± 49.3	85.80 ± 14.50	308.0 ± 23.1	616.8 ± 48.9
Cu	10.54 ± 0.58	6.480 ± 0.650	8.640 ± 0.900	5.850 ± 0.960	6.960 ± 1.290	10.38 ± 0.22
Zn	166.2 ± 6.4	233.2 ± 30.2	247.8 ± 16.3	178.4 ± 5.7	228.8 ± 12.1	297.6 ± 11.6
Br	20.24 ± 0.10	22.82 ± 1.68	24.60 ± 1.01	22.32 ± 0.56	20.88 ± 1.44	24.72 ± 1.75
Rb	2.480 ± 0.160	2.980 ± 0.550	3.350 ± 0.350	2.680 ± 0.330	2.390 ± 0.450	3.400 ± 0.480
Sr	2.190 ± 0.180	1.610 ± 0.290	2.050 ± 0.210	2.130 ± 0.060	1.760 ± 0.330	2.370 ± 0.040
Pb	2.440 ± 0.090	3.090 ± 0.140	2.400 ± 0.060	2.570 ± 0.170	2.650 ± 0.170	2.430 ± 0.080

MPB - the middle part of back, MT - the middle of tail, TPT - the terminal part of tail.

The original juvenile pelt begins to change to the summer pelt at the age of 1 month and the change ends at the age of 2-3 months. Intensive moulting of summer fur takes place at the age of four months and together with the change low winter fur begins to grow. The moulting process in young foxes lasts longer compared with adult individuals. Intensity of summer fur change depends on sex, age, physiological state, nutrition and climatic conditions. Therefore, the course of fur change can be an indicator which signals the presence of negative factors in the young foxes' rearing.

A characteristic indicator of the physiological state of young foxes during ontogenesis, is the content of mineral elements in fur. According to the content of some elements in hairs during the moulting season, we can evaluate the suitability of the nutrition of young foxes during the growth of fur and optimize the ration of mineral elements during the next period according to these results. The concentration of observed elements between sexes and locality - middle part of back in males and females - is approximately on the same level (table 3) as reported by Mertin et al. (1990) in silver foxes during the fur ripeness. A significantly higher content of Sr ($P \leq 0.01$) in the given locality occurs only in females. The maximum content of most studied mineral elements is in the hair of males in the dorsal part of the middle part of the tail and in the terminal part of the tail.

Significantly higher differences in concentration of arithmetical means on the level of significance $P \leq 0.01$ are for K (0.306 ± 0.011 for males, 0.184 ± 0.006% for females), Cu (7.13 ± 0.46, and 4.52 ± 0.39 $mg.kg^{-1}$), Zn (284.0 ± 18.5, and 198.8 ± 9.9 $mg.kg^{-1}$) in fur of dorsal part of tail, and Mn 59.74 ± 4.74, and 39.3 ± 1.36 $mg.kg^{-1}$), Rb (3.08 ± 0.12, and 1.66 ± 0.22 $mg.kg^{-1}$) in fur of terminal part of tail, and on the level of significance $P \leq 0.05$ for Sr (2.32 ± 0.10, and 1.66 ± 0.25 $mg.kg^{1}$), and Pb (3.06 ± 0.28, and 1.97 ± 0.30 $mg.kg^{-1}$) in fur of the terminal part of the tail.

During the evaluation of the results of mineral element concentrations in fur of males and females in various localities of sampling, uneven distribution of these elements was discovered. Maximum concentrations of the studied mineral elements are in the fur of the tail in males. In this locality, there are highly significant arithmetical means of K, Mn, Fe, Cu, Br and Rb contents in the fur of the terminal part of the tail and of Ca, Zn, in the dorsal part of the middle part of the tail. Distribution of mineral elements is more equable in females compared with males. In most cases the concentration of the studied elements is on the same level, although there is a tendency towards the increase of Ca, Zn, Br, Pb in the locality of the tail. However, it is statistically insignificant. There are maximum concentrations of Fe and Cu ($P \leq 0.01$), minimum content of Sr ($P \leq 0.01$) in the mentioned locality.

During the period of fur ripeness we found an insignificant influence of sex, and significant or highly significant influence of locality of sampling upon the concentration of most of the observed elements, and significance of differences between concentrations in the terminal part of the tail and other localities.

K and Ca (0.156 - 0.174, and 0.050 - 0.602%) had the highest concentrations. The lowest concentrations were Cu, Rb, Pb and minimum differences among the localities of sampling were with Br. This source of variability was significant with Mn, Fe, Cu, Zn, Br, Sr and Pb in the evaluation of influence of sampling locality on the element concentrations.

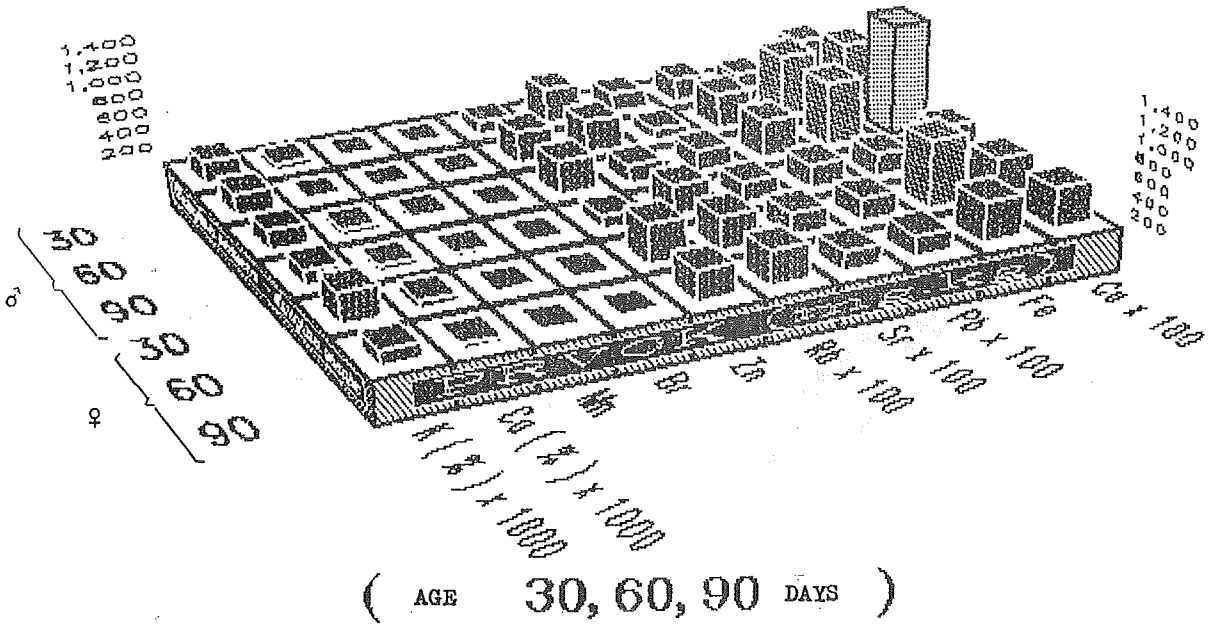

Figure 1. The concentration of elements in juvenile hair of silver foxes.

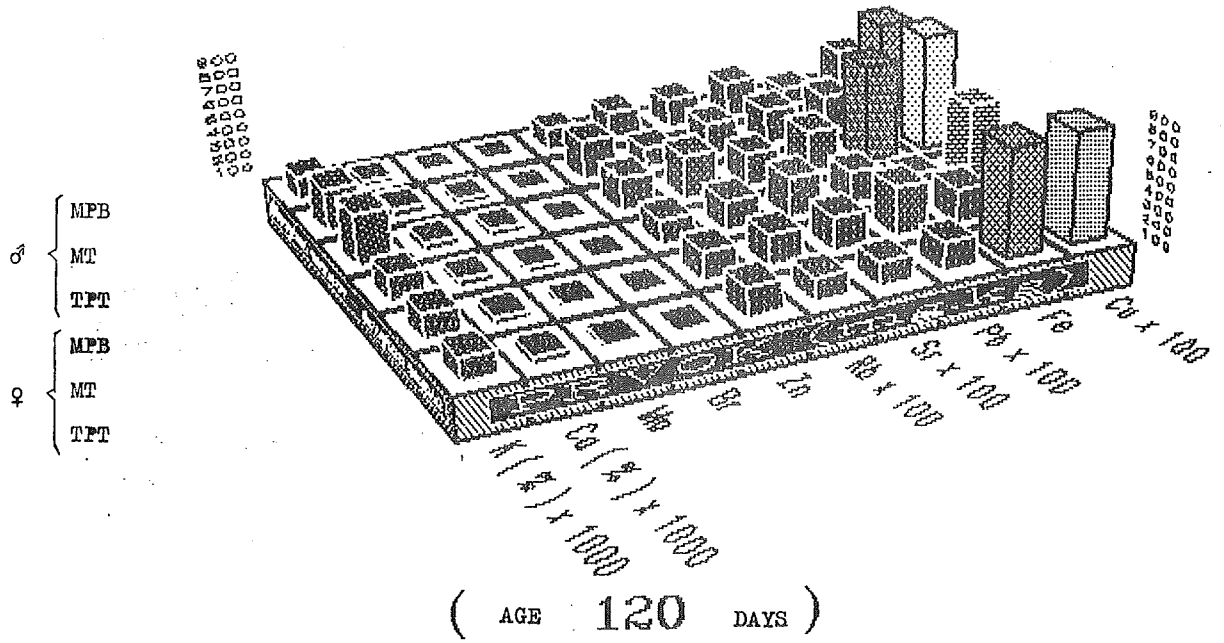

Figure 2. The concentration of elements in hair of silver foxes in moulting season.

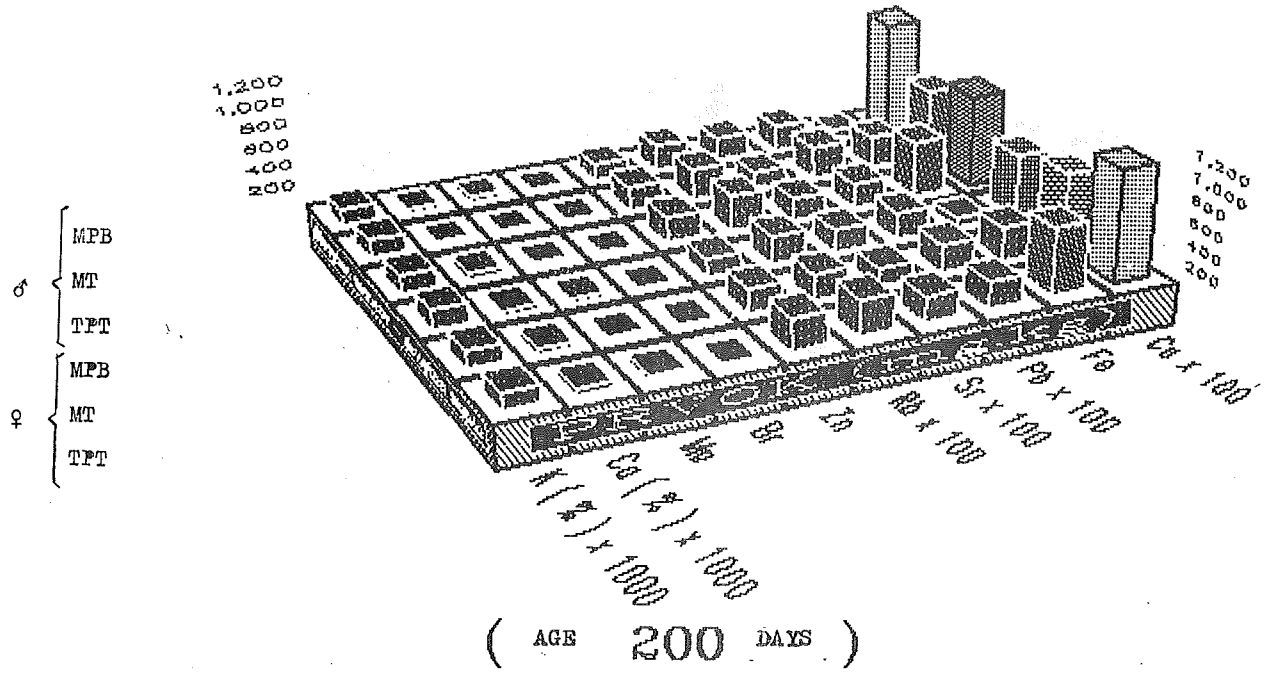

Figure 3. The concentration of elements in hair of silver foxes in fur ripeness period.

On the basis of our results we can state that in the juvenile hair of foxes there is a higher content of some studied mineral elements and it is manifested particularly in males. In one month old males the concentration of K, Ca, Br, Rb and in females the concentration of Br is significantly higher, in two months old males it is the concentration of K, Zn, Br, Rb, Pb in females the concentration of K, Zn, Br, Rb and in three months old males the concentration of K, Ca, Mn, Fe, Cu, Zn, Br, Pb in females the concentration of K, Br, Rb is significantly higher compared with individuals in the period of fur ripeness. Similar facts were also found in the fur of polar foxes with K, Mg, Zn and Fe (*Tjurnina, 1980; Berestov, V. et al., 1984*). During the moulting season markedly higher amounts of K, Ca, Mn, Fe, Br and Sr are concentrated in the fur of silver foxes compared with the content of these elements during the period of fur ripeness. It is proven by results obtained in polar foxes for Zn and Fe (*Berestov, V. et al.*) and in silver foxes for K, Ca, Mn, Fe, Br, Sr (*Mertin, D. et al., 1990*). Maximum concentrations of the studied mineral elements are in the terminal part of tail, i.e. in the white hairs, and it was confirmed by Saba, L. et al. (1982) for Ca, Mg and P, and they substantiate the existence of relations between the level of eumelanine and the content of these elements in fur. Maximum concentrations of mineral elements in the fur of the tail confirmed by Tjurnina (1982) in polar foxes and mink.

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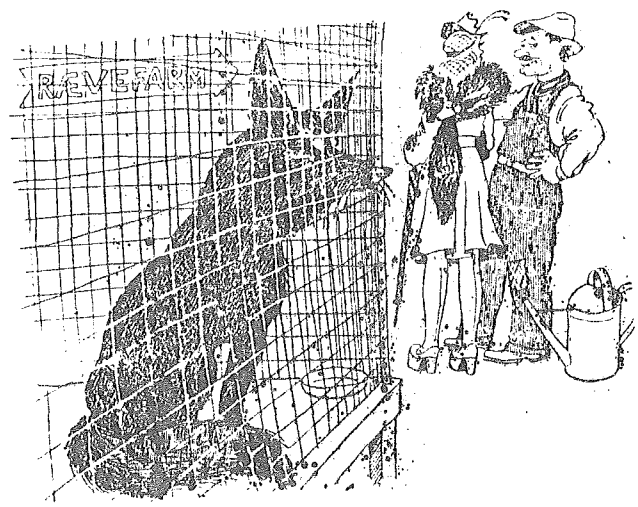

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Original Report

Spatial and circadian activity profiles of farmbred blue foxes housed in different-sized ground floor enclosures

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Summary

The present paper deals with the activity profiles of farmbred blue foxes (*Alopex lagopus*), and provides a detailed mapping of their spatial and circadian utilization of different-sized enclosures equipped with rest shelves, nest boxes and burrows. The results showed that use of nest boxes was very little in general. The same is true for the roofs of the boxes as well as the burrows. The utilization of both wooden and wire-mesh shelves was about the same order of magnitude, amounting to about 15% daily. Normally the animals used the extra equipment studied occasionally, either for sitting or resting for a while. No significant correlation between the use of such equipment and social status of the animals was found. Nor did the season or ambient conditions markedly affect usage. All of these findings support the conclusion that the animals do not perceive them as shelters against the weather. Spatial use of the enclosure areas was unevenly distributed and thus the animals, for one reason or another, seemed to prefer certain sites. The behavioural profiles of the animals studied in large enclosures did not seem to differ significantly from those observed in conventional farm cages.

Introduction

The blue fox (*Alopex lagopus*) is a medium-sized canid commercially raised for its attractive fur coat throughout the northern hemisphere, including Scandinavia. Since becoming a major furproducing animal in the late 1960's, scientific interest on its breeding, energy economy and ethology has also markedly increased (*c.f. Konnerup-Madsen, 1982; Valtonen & Moss, 1983; Moss & Ostberg, 1985; Korhonen et al., 1985; Braastad, 1986; Sønderup, 1986; Hoffmeyer, 1986; Frafjord, 1986; Harri et al., 1987; Pedersen, 1988, 1989*). Particularly criticism in the campaign against the raising of foxes in small cages has led to the establishment of experiments, in which the housing of farmed canids in larger cages has also been tested (*c.f. Korhonen & Harri, 1988; Korhonen et al., 1991*). Those experiments were first started under conventional shadehouse conditions, in which the usefulness of larger cages was easier to compare, but later also continued in large ground floor enclosures outside the shadehouses.

Not only is the cage size important, but also the possibility of lying on sleeping plates or on rest

shelves seems to interest blue foxes (*c.f. Harri et al., 1988, 1990*). Thus, the utility of such extra equipment inside conventional farm cages has been tested. The results are promising, although some controversial data also exist to some extent. The main conclusion, however, is that blue fox often prefers places above the ground floor level. Similar observations are available from wild blue and arctic foxes in nature (*Chesemore, 1986; Kaikusalo, 1971*).

Some time after the start of the housing experiments with arctic blue foxes in large enclosures, we also noticed the tendency of foxes raised in small groups or packs to use roofs of nest boxes as sites for sleeping and lying. There also tended to be social competition for these higher places while sometimes the dominant animals would ward off the subordinate ones. The foxes also dug a few burrows or ground holes which some of the animals seemed to use for resting. These observations were therefore the main impetus for the series of experiments we decided to conduct. The present paper thus provides a detailed mapping on the use of nest boxes, burrows and shelves as lying sites for the arctic blue foxes housed in large enclosures. In addition, we have focused our interest on ethological problems. We have tried to determine when and why the animals use the extra equipments offered and whether or not the possible use of such equipment influences the behavioural profile of an animal.

Materials and methods

General procedures
The experiments were performed during 1990-91 (1) at the Research Fur Farm of Kuopio University, in Juankoski, and (2) at the Muddusjärvi Research Farm, in Kaamanen. The former farm is located in eastern Finland, and latter one in the northeast part of Finnish Lapland. Environmental conditions in Kuopio were subarctic but in Kaamanen closer to the arctic climate (Muddusjärvi is situated about 350 km north of the Arctic circle).

The experimental animals were all farmborn blue foxes aged about 1 year. They were fed a ready-mixed fox feed manufactured by the local central feed kitchens. Housing and handling were according to conventional farming procedures. Water was freely available.

Experimental design
The experimental groups were housed in outdoor enclosures measuring (1) 4 m wide x 6 m long x 2 m high, (2) 8 m wide x 11 m long x 2 m high, and (3) 8 m wide x 17 m long x 2 m high. Each enclosure had a ground floor with wire-mesh walls. The enclosures were placed in experimental fields at a distance of about 10 m from farming shade-houses. The sizes of wooden nest boxes (in exps. 2,3) were 40 cm wide x 70 cm long x 40 cm high. The diameter of the round box (in exp. 1) was about 40 cm. It was made of stonebar. Enclosure number 1 additionally included two wooden rest shelves (55 cm wide x 35 cm long x 2 cm thick) and two wire-mesh shelves (55 cm wide x 32 cm long). These shelves were placed 30 cm above ground level. They were all covered by one large roof that measured 105 cm wide x 145 cm long x 125 cm high. The experimental cages are described in detail in figs. 1, 2 and 3.

The numbers and sexes of the animals in enclosures 1, 2 and 3 were as follows: 2 (both males), 6 (3 males, 3 females) and 4 (2 males, 2 females), respectively. They were housed in the enclosure from age 3 to 9 months.

Data collection
A detailed mapping of the animals' daily behavioural profiles was obtained by direct visual observations lasting 24 consecutive hours and made by two different individuals simultaneously. Each behaviour was recorded on paper by certain codes, and later analyzed at the Fur Farming Research Station. The observations were made from a car situated about 5 m from the wire-mesh wall. The animals easily got used to the car and thus it did not cause any marked disturbances.

Estimation of social hierarchies
The social rank status of the animals was estimated mainly by two means: (1) during feeding times when competition for feed occured. The order in which individuals fed at the dish, as well as the number and outcome of challenges made by other foxes, were recorded. The behaviour of both the challengers and the defenders, was recorded. (2) during consecutive 24 hour observations when the hierarchical positions of the animals could be elucidated from their visual status signals, scent-markings and other related behaviour. The fact that the males were normally dominant over females made it possible to divide the groups according to sex.

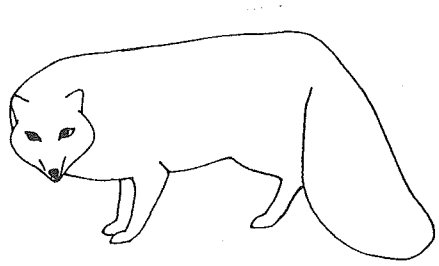
Results

Experiment 1

In experiment 1, the male fox utilized significantly more time for locomotion than the female fox. Thus the time used for rest, including activities such as sleeping and lying awake, was more pronounced in the female fox. The amounts of time spent on other activities by both individuals were about the same order of magnitude. Table 1 further summarizes the most common daily activities of blue foxes studied in different-sized cage conditions. The foxes in exp. 1 were most active and, correspondingly, in exp. 2 most inactive. The time used for sleeping was about the same order of magnitude in all conditions, except in exp. 1.

Table 1. Comparison of the most common behavioural activities (in minutes per daily 24 hours) between different-sized cages. Farm cage: 120 cm long x 105 cm wide x 60 cm high (*Korhonen, 1988*). Exp. 1: 6 m long x 4 m wide x 2 m high. Exp. 2: 11 m long x 8 m wide x 2 m high. Exp. 3: 17 m long x 8 m wide x 2 m high. The floor of the farm cage was made of net whereas the experimental enclosures consisted of earth floors.

	Farm cage	Exp.1	Exp. 2	Exp. 3
Locomotor activity	198	367	134	243
Sleeping	711	432	728	738
Lying awake	347	258	298	136
Sitting	100	240	168	79
Standing	58	121	38	131
Eating	10	11	9	4
Other	16	11	65	109



The spatial use of the enclosure area was concentrated on certain sites, i.e. the foxes mainly preferred parts C and D (table 2, fig. 1). Part B was not used at all for sleeping outside the nest and, to a very minimal extent, for lying awake. The use of various enclosure areas was rather similar in both animals.

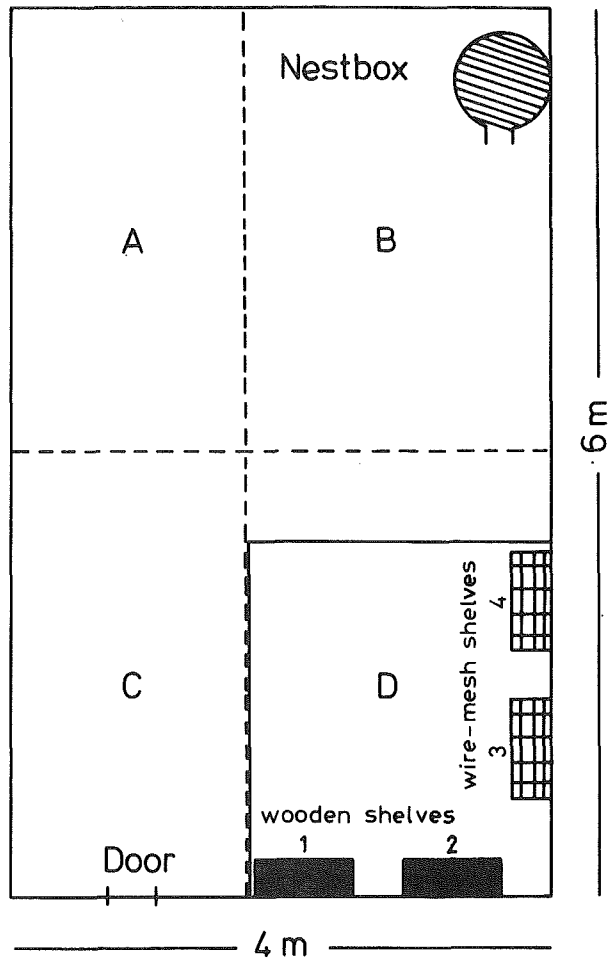


Fig. 1. Schematic presentation of the test arrangements in Experiment 1. The enclosure area was divided into four subareas which are marked here A, B, C and D. The enclosure was occupied by male and female blue fox. For further description of the arrangements see the text.

Table 2. Spatial use of the enclosure area in Experiment 1. The most common of behavioural activities are given in percentages of daily 24 hours. The data was gathered during mid-winter. See also the text and fig. 1.

	MALE				FEMALE			
	A	B	C	D	A	B	C	D
Sleeping	18.5	0	61.7	20.3	11.3	0	38.1	50.6
Sitting	12.1	4.2	31.0	52.7	11.4	13.1	9.7	65.8
Standing	14.9	13.8	43.1	28.2	15.5	23.6	49.3	11.4
Walking	20.4	19.7	34.1	25.8	17.6	29.4	22.9	30.1
Lying awake	14.6	0	39.0	46.4	2.6	7.7	23.2	66.5
Mean	16.1	7.5	41.8	34.6	11.6	14.7	20.5	45.2

Both wooden shelves and wire-mesh shelves were used for very similar amounts of time, i.e. from 181 to 233 minutes during the 24-period (table 3). No significant differences were observed between the sexes as concerns use of the shelves. The animals, on the other hand, did not prefer to use the roof of the nest box for any type of activities. They visited the roof only occasionally. The total time period it was used was about 10 minutes during the observation period. The male fox did not visit the nest box at all during the consecutive 24-hour period, but the female stayed inside it slightly over 380 minutes. We are not quite sure about her doings there, but it is tempting to conclude that she was probably mainly sleeping or otherwise resting.

In table 4 the use of each shelf is separately presented. We can see that wooden shelf number 2 was the least used whereas wooden shelf number 1 and wire-mesh shelf number 4 were rather similarly utilized. Sitting was the most common activity observed on the shelves in general. The foxes especially seemed to prefer wooden shelf number 1 as concerns sitting behaviour. The wooden shelf number 2 was not at all used for sleeping. The roof of the nest box was utilized only for sitting or standing.

Table 3. The use of resting platforms and nest box in Experiment 1. The data are given in percentages of daily 24 hours.

	MALE	FEMALE
On wooden shelves	12.6	14.2
On wire-mesh shelves	15.8	16.2
On roof of nest box	0.8	0.6
Inside nest box	0	26.5

Table 4. A more detailed mapping of the use of resting platforms (1 and 2=wooden shelves, 3 and 4=wire-mesh shelves, 5=roof of nest box; see also fig. 1). The data are given in minutes per 24 hours.

	MALE					FEMALE				
	1	2	3	4	5	1	2	3	4	5
Sleeping	4	0	13	68	0	43	0	48	43	0
Sitting	115	16	35	39	7	47	9	6	51	9
Standing	10	8	3	3	4	12	15	7	7	0
Lying awake	27	1	41	25	0	50	29	18	53	0
Total	156	25	92	135	11	152	53	79	154	9

Experiment 2

Here again, the enclosure area was very unevenly utilized (fig. 2). Thus, the average use of parts A, B, C, D and E amounted to 48.9, 11.1, 9.1, 11.7 and to 19.2 %, respectively. Table 5 provides a more detailed mapping of the spatial activities within the enclosure. The five most common of the recorded behaviours are presented for each of the marked areas. As can be seen, the animals prefered part A especially for sleeping, lying and sitting. Time spent on walking was about the same in each of the enclosure sites. Part E was not used for sleeping at all and very little for lying. Individual differences in each of the recorded behavioural activities were evident. The social status of the animal was not markedly pronounced in the results presented; thus, any correlation between hierarchical position and utilization of the enclosure area cannot be emphasized here. The same conclusion holds true as to sex; no statistically significant differences could be found between sex and spatial area utilization.

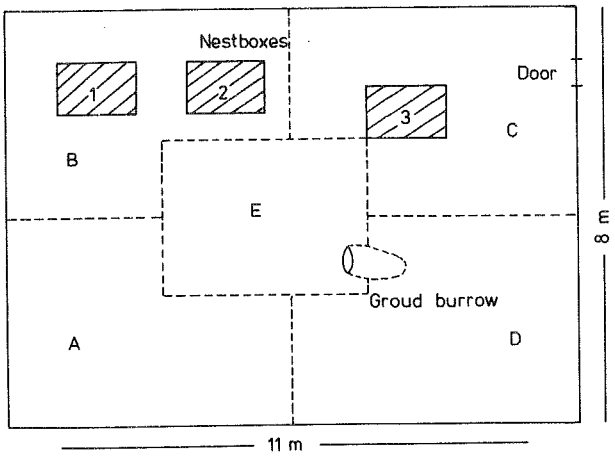


Fig. 2. Schematic picture of the experimental arrangements in Experiment 2. The enclosure area was here divided into five different subareas. The ground burrow was made by the blue foxes (2 males, 2 females) studied. The text includes a more detailed description of the arrangements.

Table 5. A detailed summary of the use of enclosure area in Experiment 2. The most common of behavioural patterns are presented in minutes per 24 hours. Social status of the foxes are given as follows: DO=dominant, SD=subdominant. The data include the early winter period. See further the text and fig. 2.

USED AREA	MALE-SD	MALE-DO	FEMALE-SD	FEMALE-DO	Mean
A: Sitting	132	64	66	17	70
Standing	14	18	8	7	12
Walking	50	54	33	37	44
Sleeping	553	483	476	234	437
Lying awake	153	105	143	22	106
B: Sitting	23	75	16	27	35
Standing	-	10	-	3	3
Walking	36	53	29	21	35
Sleeping	13	50	12	87	41
Lying awake	79	197	24	42	86
C: Sitting	25	24	39	35	31
Standing	8	5	3	7	6
Walking	18	25	22	22	22
Sleeping	23	-	53	259	84
Lying awake	27	15	115	54	53
D: Sitting	15	25	18	63	30
Standing	18	9	7	23	14
Walking	20	34	33	45	33
Sleeping	-	-	84	72	39
Lying awake	3	-	48	54	26
E: Sitting	3	4	4	27	10
Standing	7	9	2	7	6
Walking	17	26	6	29	25
Sleeping	-	-	-	-	-
Lying awake	-	1	-	4	1

The time spent inside the nest box was zero for each of the foxes studied (table 6). The total use of the ground burrow was also slight; MALE-DO, MALE-SD AND FEMALE-DO did not at all visit inside the burrow, only FEMALE-SD did, and that was to sleep there for about 2.5 hours.

The roofs of the nest boxes were more commonly favored, and normally either for sleeping or lying awake. The roof of nest box no:1 was used the least, whereas the roofs of the other two boxes were preferred for about the same magnitude of time. MALE-SD and FEMALE-DO utilized the roofs most often.

Table 6. The use of nest boxes, their roofs and ground burrow by foxes in Experiment 2. The results are in minutes per daily 24 hours. Dominances are marked here also.

	MALE-DO	MALE-SD	FEMALE-DO	FEMALE-SD
Inside nest box (no:1, 2, 3)	0	0	0	0
On roof of nest box no:1	0	90	8	72
On roof of nest box no:2	97	222	28	44
On roof of nest box no:3	57	23	178	76
Inside ground burrow	1	0	0	143

Experiment 3

The use of nest boxes and their roofs was very slight in blue fox pack housed in the largest enclosure (table 7). Only FEMALE-SD was interested in the nest boxes; it stayed inside box no:2 for about 2.5 hours and inside box no:4 for slightly less than half an hour. MALE-DO was observed most often on the roofs, particularly on that of nest box no:3. Also FEMALE-DO was the second common user of a roof, and here again mainly on roof of nest box no:3.

The spatial use of the enclosure area for the pack of six blue foxes is given in table 8. Part D (see also fig. 3) was favored the most. In particular, the animals preferred to sleep and lie in this part of the enclosure. The second most utilized area was A, whereas the other parts were only slightly favored. Marked individual differences were observed here again. No marked sexual differences can be stated, and also the correlation between the area used and the social status of the animal was non-significant.

Table 7. The use of nest boxes and their roofs in Experiment 3 (during mid-winter). Here again the data are presented in minutes per daily 24 hours. Dominances for the foxes of both males (M) and females (F) are as follows: DO=dominant, SD=subdominant, SO=subordinate. Fig. 3 is available for the further understanding of the arrangements.

	M-DO	M-SD	M-SO	F-DO	F-SD	F-SO
Inside nest box no:1	4	0	0	0	1	0
Inside nest box no:2	0	0	0	0	146	0
Inside nest box no:3	1	0	0	0	1	0
Inside nest box no:4	0	0	0	0	23	1
On roof of nest box no:1	3	0	0	1	0	1
On roof of nest box no:2	0	0	1	3	3	5
On roof of nest box no:3	326	5	0	80	1	9
On roof of nest box no:4	0	0	1	8	0	0

Table 8. A detailed table of the use of enclosure area in Experiment 3. The most common behaviours for each subarea are given in minutes per daily 24 hours. For the dominances see table 7.

USED AREA	F-SO	F-SD	F-DO	M-SO	M-DO	M-SD	Mean
A: Sitting	104	27	17	42	24	41	43
Standing	50	31	16	49	54	50	50
Walking	102	92	62	116	145	127	107
Sleeping	97	-	-	39	14	-	45
Lying awake	108	2	3	24	10	11	26
B: Sitting	19	-	1	5	11	3	27
Standing	43	3	4	14	7	12	14
Walking	72	10	17	49	27	22	33
Sleeping	-	-	-	1	-	-	<1
Lying awake	5	-	-	-	-	3	1
C: Sitting	12	-	8	3	3	4	5
Standing	26	-	19	24	6	8	14
Walking	34	15	39	26	29	41	31
Sleeping	-	-	-	-	14	-	2
Lying awake	10	-	-	-	21	-	5
D: Sitting	20	63	45	33	13	27	34
Standing	15	121	104	48	30	78	84
Walking	27	152	150	122	37	112	100
Sleeping	467	732	799	708	569	736	682
Lying awake	40	178	143	124	116	146	125

The fact that the animals were especially partial to the use of part D for sleeping and lying awake was also confirmed by the fixed sleeping holes inside the enclosure. Their sites are shown in fig. 3; altogether 12 holes were found where the animals quite regularly slept. Each animal seemed to have its own hole or holes which it preferred. We also measured the sizes of the sleeping holes (table 9). The mean diameter of such a hole was 45 cm and the depth averaged 10 cm. Our consecutive 24-h observations also confirm the fact that the foxes regularly used these sleeping holes for both sleeping and resting.

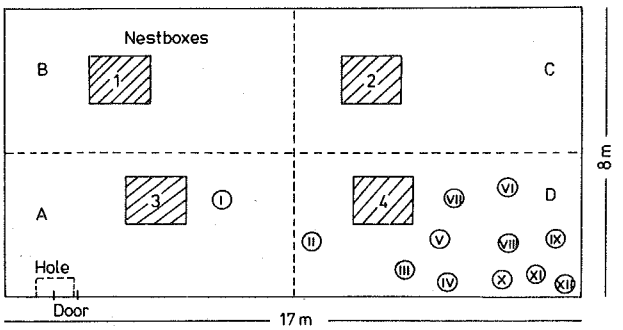


Fig. 3. Schematic illustration of the arrangements in Experiment 3. Circles with Roman numerals show the sites of the sleeping holes. The enclosure was occupied by six blue foxes (3 males, 3 females).

Table 9. The sizes of the sleeping holes in Experiment 3. The Roman numerals indicate the sites of sleeping holes which are given in fig. 3. The studied enclosure was occupied by 6 blue foxes. The data include the winter period.

Sleeping hole	Diameter (cm)	Depth (cm)
I	45	10
II	43	12
III	50	14
IV	50	10
V	40	10
VI	40	8
VII	40	14
VIII	45	8
IX	45	8
X	50	8
XI	47	10
XII	40	6

Discussion

Farmed fur animals have been raised in conventional cage conditions which have evolved through tradition and long-term experience. However, individuals concerned about the welfare of furbearing animals oppose not only such use of animals in general, but the conditions in which the animals have been housed in particular. Especially the demands for large cages and enclosures are well-known. As there have not been enough data available concerning the raising of farmbred fur animals employing various housing constructions and specifically concerning animal farming in larger cages, the discussion on animal welfare has become difficult and emotional. Studies such as the present work are therefore needed to provide a more scientific perspective for ethological and ethical discussions of this subject.

A detailed mapping on the use of wooden and net shelves by farmed blue foxes under shadehouse conditions is available (*Harri et al., 1988*). It revealed that almost all of the animals used shelves more or less, however, only one of the 18 animals studied used a shelf as a sleeping place. The other foxes preferred to sleep on the net floor of the cages. The use of the shelves was only occasional and mostly concentrated in bursts of short visits. The data gathered mainly by automatic samplings both during the summer and winter periods provide similar conclusions (*Harri et al., 1990*). Blue and silver foxes spent on average 6.8 and 1.7 % of their daily time on the shelf. A major portion of its use comprised visits of short duration. In the present study, the male fox utilized the shelves mostly for sitting, which amounted to about 233 minutes daily. The total time budgets for sleeping and lying awake correspondingly were 85 and 94 minutes. Our female fox, on the other hand, exhibited a different trend; she was observed to sit on the shelves for 122 minutes daily, but the time spent on sleeping and lying awake was 134 and 150 minutes, respectively. Both sexes, furthermore, were found to spend more of their daily sleeping budget away from the shelves, i.e. they preferred to sleep on the ground. Our results from the larger cages with the groups of 4 and 6 animals also showed that the animals most often sleep and lie on the ground. All of these data support the conclusion that the animals did not need the shelves for sleeping or resting sites at all, but their functions, if such could be stated, are to provide the animals with higher vantage points from which they may observe the environment. In Denmark, on the other hand, it has been noticed that under certain conditions during the winter period foxes use shelves significantly more. In her preliminary report Hoffmeyer (1986) mentioned that their blue and silver foxes used wooden shelves 94 and 83 %, respectively. In terms of the total time budget, the results of Hoffmeyer (1986) are in contrast with those observed in Finland. However, in terms of the number of animals employing shelves occasionally, all the results can be fitted into a similar framework. Ambient air temperatures, wind conditions, shelf construction, research methods etc., can naturally also produce differences, as more closely speculated by Harri et al. (1988).

Studies concerning the use of shelves in conventional shadehouses showed that wooden shelves were used markedly more than shelves made of net (*Harri et al., 1988; 1991*). In the situation where the animals were offered net shelves first and, then three weeks later transferred into cages with wooden shelves, the wooden ones were used slightly more. On the other hand, the present results showed that both wooden and wire-mesh (or net) shelves were preferred equally by the animals. However, the number of animals in the present study was low, i.e. two foxes, and thus no significant conclusions can be drawn. It has been presented (*Harri et al., 1988; 1990*) that wooden shelves do not necessarily provide any marked protection against cold and draught. A study performed with farmed raccoon dogs supports the same conclusion (*Korhonen, 1987*). This is due to the fact that wooden shelves easily get wet and freeze during the winter, which significantly increases the heat loss of the animals. Thus, the pressure to select wooden or net shelves does not seem to be necessarily based on the thermoregulatory basis, but can be the result of some other factors or coincidence. Further studies are needed to clarify this question in detail.

In each of the present experiments our foxes spent minimal time inside the nest boxes. Although our observations were also made during the coldest part of the winter, the animals did not prefer the nests or their roofs to a large extent. They seemed to rest willingly on the snow instead. Thus, it is tempting to conclude that due to their thick furcoat they manage very well without any extra protection against the winter weather. It is known that the thermal insulation of arctic fox's

furcoat is one of the best in the world. The lower critical temperature of such a coat has been approximated to be close to -40°C (*Scholander et al., 1950*), which means that the arctic fox is not required to increase its basal metabolic rate before that temperature. From this point of view, it can be understood why the arctic blue fox does not prefer nest boxes or other extra equipment within the cage even during the winter. In conventional farm cages the conclusion was similar; the use of shelves was not dependent on ambient air temperatures (*Harri et al., 1988*). Furthermore, Harri et al. (1990) reported that the platforms were used more either at or above freezing temperatures than during the very cold weather. Wind alone did not increase the use of their platforms, but high winds combined with high temperatures promoted it instead. Finally they concluded that the platforms do not function as shelters, but were rather used by the foxes because they were available.

It is known that blue foxes in the wild prefer to sit on a high place. On farms, on the other hand, the most typical situation when animals were on the shelves was at the beginning of the working day (*Harri et al., 1988*). The animals then knew that food was coming and wanted to be sure that they did not miss it. It is difficult to say to what extent, if at all, the social status of the animals affects their behavioural patterns, especially use of shelves, nest boxes and their roofs. The present results partly confirm the hypothesis that dominant animals may more eagerly prefer higher places. The data from table 7 shows such a tendency but, on the other hand, table 6 markedly does not. Because the number of animals studied was too small for any definite conclusions, further data is needed in order to clarify the situation more precisely.

All of our three experiments with various-sized enclosures showed that their surface areas were not evenly used, but that some sites were preferred by the animals. In addition, the amounts of different activities at various sites differed. There may be various explanations for the uneven use observed. The two largest of our enclosures were side by side (parts A and D in the largest enclosure next to parts A and B of the next largest cage) and the animal groups could have influenced each other. Additionally, certain sites might have had something which interested the animals more, although we could not observe such. The nest boxes in experiment 3 were evenly distributed and could not affect the results. In experiment 2, on the other hand, the boxes were either in part B or C. In experiment 1 the shelves were placed only on part D, and there was just one nest box. Whether or not these produced some of the differences observed in the activity patterns is difficult to approximate. Coincidence might also be one explanation for the differences found.

The behavioural patterns and circadian activity profiles of the animals studied was rather similar to those observed for animals housed in conventional shadehouse conditions (*Korhonen, 1988*). Under both conditions, sleeping and resting seemed to be the most common activities. However, the number of animals studied was very limited and therefore, more data are required in order to form any definite conclusions.

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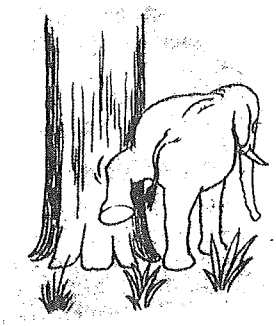

Original Report

Features of social behaviour in an arctic fox group housed in a large enclosure

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Summary

The work aims to document features of social behaviour of the arctic blue fox (*Alopex lagopus L*) in captivity. During late summer a group of four juvenile individuals (2 males, 2 females) originating from the same litter was placed in a large ground-floor enclosure. Within 1 to 4 days from the start of the experiments the social relationships and hierarchies between the animals could already be seen. The males were normally dominant to females. In males, the smaller animal was the leader but in females, on the other hand, the bigger one was dominant. Normally, social rank and feeding order seemed to be the same among all individuals of the group. From the start of the experiments, the animals displayed frequent urinations and defecations throughout the enclosure. Responses to familiar and unfamiliar odors were similar, i.e. the animals marked the odor samples studied typically each time and most often by urination but, to a lesser extent, by defecation. Activity patterns and locomotory behaviour of the animals were normal, resembling that previously observed in foxes housed in conventional cages. The surface area of the enclosure was not very effectively and evenly used as animals preferred certain sites within the area. It was concluded that although in the wild the arctic blue fox is rather solitary, it also can form clear social organization when housed in a large enclosure.

Introduction

The arctic fox (*Alopex lagopus L*) is a medium-sized predator (family *Canidae*) which originally has lived under the severe conditions of circumpolar tundra regions. Its ability to survive under such extreme circumstances is mainly based on its excellent fur coat insulation, seasonally altering energy requirements and behavioural strategies (*Macpherson, 1969; Underwood, 1971; Eberhardt, 1977; Kennedy, 1980; Eberhardt et al., 1983; Korhonen et al., 1985; Wakely & Mallory, 1988*). Since the arctic fox, and especially its colour mutation, the blue fox, have become important as farmed fur animals, they are more commonly found in the subarctic regions of Scandinavia, too. Additionally, this in turn has generated considerable scientific interest concerning the behaviour, adaptability and survival strategies of the arctic fox (*c.f. Korhonen et al., 1985; Korhonen & Harri, 1986; Harri et al., 1988; Korhonen, 1988a*).

Although the development of communication and its role in the social organization of canids have been studied rather intensively (*c.f. Kleiman,*

1966; Macpherson, 1969; Fox & Cohen, 1977; Henry, 1977; Jorgenson et al., 1978; MacDonald, 1980), data concerning such aspects as territorial behaviour, social organization, intraspecific interactions and scent-marking are still rather scarce concerning the arctic fox (*c.f. Chesemore, 1986; Eberhardt & Hanson, 1978; Korhonen, 1988a*). Such data, however, are needed not only for an understanding of the biology of this species, but also due to the increasing needs of commercial fur production. The wild arctic fox is considered to be relatively solitary, with little social contact occuring between individuals, except during the breeding season (*Kleiman, 1967; Fox, 1969; Banfield, 1977*). Observations in captivity, however, support the conclusion that this is not necessarily entirely the case under farm conditions (*c.f. Korhonen, 1988a; Wakely & Mallory, 1988*).

The main objectives of the present study were (i) to describe marking behaviour of arctic blue foxes in captivity, (ii) to test their reactions to urine and faeces originating from both familiar and unfamiliar mammal species, (iii) to clarify social interactions and hierarchies of arctic blue foxes in relation to their visual status signals (iv) to provide data on their daily behavioural activities, (v) to establish whether feeding hierarchies occur in this species in captivity, and (vi) to document comparative behavioural data for conventional farming practices.

Material and methods

Animals and general procedure
The experiments were carried out at the Muddusjärvi Research Farm of the University of Helsinki, in Finnish Lapland. The subjects were juvenile arctic blue foxes (2 males, 2 females) originally farmborn (June 10th, 1990) and all derived from the same litter. Before the experiments (lasted from Sept. to Dec.) they were housed according to conventional farming procedures. At the beginning of September they were transferred to a large ground-floor enclosure measuring 11 m long x 8 m wide x 2 m high. The enclosure contained three wooden nest boxes measuring 70 cm long x 40 cm wide x 40 cm high. The animals were fed basal ready-mixed fresh feed prepared by the research farm's kitchen (*c.f. Korhonen & Harri, 1986*).

Estimation of feeding hierarchies
The animals were monitored during several days for 15 minutes before feeding, at feeding time, and for 15 minutes after feeding. The feed was presented to each animal on a wooden tray measuring 30 cm long x 25 cm wide x 2 cm thick. Each tray was placed at least 2 m away from the others. The order in which individuals ate, as well as the number and outcome of challenges made by other foxes, was recorded. The behaviour of both the challenger and the defender was noted. Feeding dominance was determined on the basis of aggressive encounters and visual status signals over feed items.

Sampling and testing of selected odors
Samples of urine and faeces were collected from the experimental animals raised on the Muddusjärvi research farm. Animals were simply picked up by hand, after which they normally urinated. The samples were then promptly gathered into the plastic bottles, labeled, and frozen until required. Faeces were collected from the cages of the same animals. Samples from lambs were received from animals housed in the local sheep barn. Local tap water represented the control sample.

To initiate a trial, a sample was placed inside the enclosure on a wooden plate (30 cm long x 25 cm wide x 2 cm thick). A trial lasted for 5 min from the time the first visit occurred. A visit was recorded when a fox's nose came within about 5 cm of the plate. A marking response was recorded when the subject urinated or defecated within 30 cm of the stimulus plate after a visit. The order of testing was randomized.

Monitoring of behavioural patterns
Behavioural patterns and activity of the animals were recorded by visual observations lasting 24 consecutive hours. Each behaviour was recorded on paper by certain codes and analyzed later.

To make it possible to obtain more accurate observation data, the cage surface area was divided into five equal parts marked here A, B, C, D and E representing left-forward corner, left-rear corner, right-rear corner, right-forward corner and the middle part of the enclosure, respectively (see fig. 1).

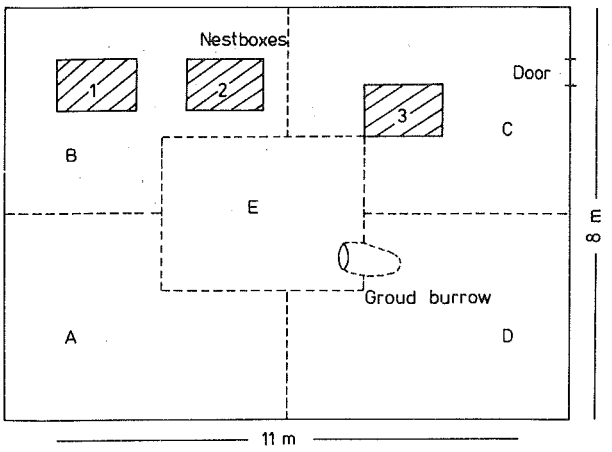

Fig. 1. Schematic presentation of the enclosure studied. The cage area was divided into 5 different subareas marked here by letters A-E.

Results

Social status and dominance

Hierarchies developed within 1 to 4 days after the foxes were placed in the enclosure. Based on our observations, we concluded that normally males dominated females. Unfortunately, we did not weigh the animals at the beginning of the experiments. So, we cannot say any real facts of relationships between dominances and body weights at that time. However, at the end of the experiments we measured their weights; MALE-DO, MALE-SD, FEMALE-DO and FEMALE-SD weighed 8.6, 9.2, 7.2 and 6.9 kg, respectively. Thus, in males, the smaller individual was the leader but, in females, the situation was reversed. Furthermore, especially in females, dominance was not always quite clear; so, also the subdominant individual (FEMALE-SD) in some cases showed dominance over the s.c. dominant female (FEMALE-DO). Obviously, due to their juvenile character, the dominances were every now and then more playful than strictly serious. Thus, the animals studied are marked here as dominant (DO) or subdominant (SD), but the term "subordinate" has been avoided.

Visual status signals were employed by the animals to maintain their hierarchical positions. The subdominant animal could approach the dominant one from the rear with its head and tail lowered and its ears back. The subdominant animal also showed passive appeasement characterized by lying flat with its head down, ears back and tail pressed to the ground. The dominant individual in this situation normally held its head high with the ears and tail up. Agonistic displays occurred when the dominant individual chased the subdominant one. The former then normally held its head, ears and tail high, quickly approaching the subdominant animal with high leaps, a steady stare, and open mouth. The subdominant individual retreated in a crouched position with its head and tail low, and its ears back. Growls could accompany the discribed agonistic display, mainly delivered by the dominant individual.

Altogether 39 social rank contacts were recorded between the males and 30 contacts between the females during 24 consecutive hours. Very seldom did the animals, however, display pure physical contacts, but most of the interactions could be classified as visual ones. Social contacts of the dominant and subdominant males with females were 11 and 13, respectively. The dominant female had 7 social contacts with the dominant male and 8 contacts with the subdominant male and, correspondingly, the subdominant female was observed to have contact with dominant and subdominant male 6 and 7 times, respectively.

Aggressive or subaggressive interactions were noticed before and at feeding times, ranging from low growls to physical contacts or fights. When the animals noticed that feed was coming, they became restless, running here and there all over the enclosure, meanwhile stopping to listen and staring towards the farmer while displaying visual status signals or social contacts. The feed was provided on four wooden trays each directed to one individual. The most common feeding patterns was the following: MALE-DO very quickly ate the feed ration on its own tray (or almost all of it), then ran to the feed tray of MALE-SD pushing him away, and then consuming that feed, too (table 1; pattern A). As a consequence of this, MALE-SD pushed FEMALE-DO away from its tray and, accordingly, FEMALE-DO warded off FEMALE-SD which was now left without feed. Patterns B and C (table 1) show the second most common feeding patterns observed; now both the males warded off the females from the feeding trays and ate their feed, too. Pattern D, i.e. when all the individuals ate only their own feed, was least common. Rough aggressive encounters or pure fights occurred very seldom because the animals seemed to be aware of their position within the group. Thus feeding hierarchies were normally solved by visual status signals, and social rank and feed rank orders seemed to be same among the group.

Table 1. Summary of the most common feeding patterns and hierarchies in the group of four arctic blue foxes. DO=dominant, SD=subdominant. Feeding orders are described as follows: FA=feeding tray of MALE-DO, FB=feeding tray of MALE-SD, FC=feeding tray of FEMALE-DO, FD=feeding tray of FEMALE-SD (see also fig. 2). Feeding orders are described here in two stages: 1st stage=at the start of feeding, 2nd stage=since the feeding order was changed during feeding time studied. - indicates that the individual was not close to feeding tray at all. Pattern A was the most common and pattern D the least common.

		MALE-DO	MALE-SD	FEMALE-DO	FEMALE-SD
Pattern A:	stage 1	FA	FB	FC	FD
	stage 2	FB	FC	FD	-
Pattern B:	stage 1	FA	FB	FC	FD
	stage 2	FC	FD	-	-
Pattern C:	stage 1	FA	FB	FC	FD
	stage 2	FD	FC	-	-
Pattern D:	stage 1	FA	FB	FC	FD
	stage 2	FA	FB	FC	FD

Scent-marking

The locations of faeces were monitored as carefully as possible during the first 5 days after the animals were put into the enclosure. Our hypothesis was that the foxes would probably mark their new living area, and this seemed to hold true. The first day after the start of the housing experiment faeces were found from each part of the enclosure (fig. 2), and at the end of the first 5 days, the entire ground surface of the enclosure was covered with smaller or larger pieces of faeces. Because the ground was not yet covered with snow, we cannot say anything with certainty about the distribution of urine marks within the enclosure. However, it can be assumed that the situation probably was about the same as concerns the faeces.

We also recorded numbers of urinations and defecations by the foxes during daily 24 hours (table 2). Any marked differences between the individuals were not found. The subdominant male and female urinated most, i.e. 10 times each during the consecutive 24 hours period. Circadian numbers of defecations varied from 6 to 8. Further, we located the sites of urine and faeces of each individual as carefully as possible. The most favorite sites were parts A and D, whereas the least used was the middle part of the enclosure (part E). Often, both urination and defecation occurred in the same part of the enclosure.

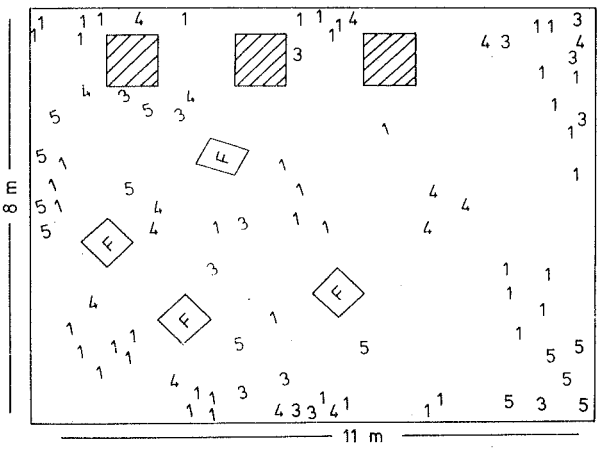

Fig. 2. Marking of enclosure area by arctic blue foxes studied. Only the sites of faeces are given. The data include 5 consecutive days (numbers indicate the days) from the start of the experiment in early September. Shaded quadrants are nest boxes and F shows the site of each feeding tray.

Table 2. Locations and numbers of faeces and urinations (in parenthesis) within the enclosure. The data was gathered during mid-October by careful observations lasting 24 consecutive hours. For further description of the cage area see fig. 1. DO=dominant, SD=subdominant.

CAGE AREA	MALE-DO	MALE-SD	FEMALE-DO	FEMALE-SD	TOTAL
A	5 (4)	4 (1)	1 (2)	1 (1)	11 (8)
B	0 (2)	3 (2)	1 (1)	2 (0)	5 (5)
C	0 (0)	0 (0)	2 (0)	2 (2)	4 (0)
D	3 (1)	3 (4)	3 (4)	4 (3)	13 (12)
E	0 (0)	0 (1)	0 (0)	1 (0)	1 (1)
TOTAL	8 (7)	10 (8)	7 (7)	10 ()	35 (26)

Table 3. Marking responses of arctic blue foxes to selected urine samples during the first 5 minutes (1-5 are the minutes). + indicates sniffing or any other positive interest. - means no marked attention. U=urination, D=defecation. DO=dominant, SD=subdominant. BF=blue fox, SF=silver fox, RD=raccoon dog, LA=lamb, MI=mink, HU=human being. M=male, F=female. A=adult, J=juvenile. Markings were tested during October.

	MALE-DO					MALE-SD					FEMALE-DO					FEMALE-SD				
SAMPLE	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Control	+	+	-	-	+	+	+	+	+	-	+	-	+	+	-	-	-	+	+	-
BF, M/A	+	-	+	+	+	+	-	-	-	+	+	-	-	U	-	-	-	-	+	U
BF, F/A	+	-	-	-	-	+	-	-	-	-	+	-	-	-	-	+	+	D	U	+
BF, M/J	-	+	-	-	-	+	+	-	-	-	+	-	-	-	-	-	+	+	-	U
BF, F/J	+	-	-	-	-	+	-	-	-	-	+	U	+	-	+	-	+	-	-	-
SF, M/A	+	-	+	+	-	+	-	+	-	-	+	-	U	-	-	+	U	-	-	-
SF, F/A	+	+	-	-	-	+	D	-	-	U	+	-	-	-	-	+	-	-	U	-
RD, F/A	-	-	-	-	-	+	-	-	-	-	+	D	-	-	+	+	-	-	U	-
LA, F/A	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	+	U	-	-	+
MI, M/A	+	-	D	-	-	+	-	-	D	-	+	U	-	-	-	+	-	-	-	-
MI, F/A	+	-	-	-	-	-	-	U	-	-	+	-	-	-	-	+	-	-	+	U
HU, M/A	+	+	+	-	-	+	+	-	-	+	+	+	-	-	+	+	+	-	-	-

Responses to odor samples

Typical reactions of foxes to the tested samples were the following; during the first minute after setting the sample into the enclosure the foxes came to sniff the test plate or showed other positive interest in it. Then they all scattered away from the plate, butsoon after one of the individuals approached and marked it by defecating or urinating on it or close to it. Most often the marking occurred 3-5 minutes after the testing was started. None of the trials elicited a zero approach to a tested sample (tables 3 and 4), but human and control samples did not bring out any scent-marking response.

The dominant male was observed to mark the samples less, i.e., only once (sampling containing urine of adult male mink), and it was by defecating. The subdominant female was the most common marker (altogether 14 markings of the total 25 samples), although the dominant female reached almost the same amount (12 markings). The subdominant male was observed to mark 7 times. In many cases more than one individual marked the same sample. It also happened that the same individual could mark the same sample up to three times during the 5 consecutive minutes. The faeces of lambs were not marked, but the animals ate them during the 4 first minutes.

After the first 5 minutes of the start of the trial, the animals typically lost their interest in the samples.

Table 4. Marking responses of arctic blue foxes to selected samples of faeces during the first 5 minutes (numbers from 1 to 5 represent minutes). + indicates sniffing or any other positive interest. - means no marked attention. For the abbreviations see tabel 3. Marking tests were made during October.

	MALE-DO					MALE-SD					FEMALE-DO					FEMALE-SD				
SAMPLE	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Control	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	+	-	-	-	-
BF, M/A	+	-	-	-	-	+	U	-	-	-	+	-	-	-	-	-	-	-	-	-
BF, F/A	+	-	-	-	-	+	-	-	-	-	+	U	-	-	-	+	-	-	+	-
BF, M/J	+	+	-	-	-	+	+	-	-	-	+	U	U	U	-	+	-	-	-	-
BF, F/J	+	-	-	-	-	-	U	-	-	-	+	-	-	-	-	+	-	-	-	-
SF, M/A	+	+	-	-	-	-	+	-	-	-	+	-	-	+	-	+	+	U	-	+
SF, F/A	+	-	-	+	-	+	-	-	-	-	+	U	-	-	+	+	+	D	-	-
SF, M/J	+	+	-	-	+	-	-	-	-	+	U	-	+	-	+	+	+	+	-	
SF, F/J	+	-	+	+	-	+	-	+	+	-	-	-	-	-	-	+	-	+	-	U
RD, F/A	+	+	-	-	-	+	-	-	+	-	+	-	-	-	-	+	-	+	U	-
LA, F/A	+	+	+	+	-	+	+	+	+	-	+	-	-	+	-	+	+	+	+	-
MI, M/A	-	-	-	-	-	+	-	-	-	-	+	-	U	-	-	+	-	-	-	+
MI, F/A	-	-	-	-	-	+	+	U	-	-	+	-	-	-	-	+	-	-	U	-

Behavioural activities

Typically the daily activities of the arctic blue foxes studied consisted of a system of shorter or longer bursts of locomotor activity alternated with rest periods. Rest or inactivity, however, was the most common of the observed circadian behavioural patterns; the foxes used from 11 to 13 hours daily for sleeping, from 5 to 5.5 hours for lying awake, and from 1 to 2 hours for standing and sitting (table 5). Their circadian locomotor activity varied from about 2 to 3 hours. The time used for drinking, eating, defecating or urination was rather minimal, i.e. normally less than 10 minutes per 24 hours.

The term "others" includes activities such as vocalizations, digging, listening, stretching, rolling, ground sniffing and yawning. The duration of such activities was often short, and therefore, the time given in table 5 has been more or less approximated, and their duration has not been presented in detail.

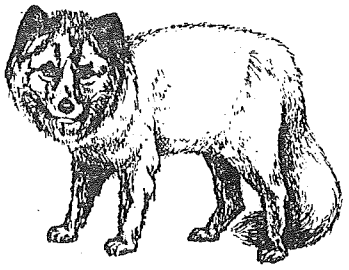

Table 5. An example of circadian behavioural activities (in minutes) of arctic blue foxes housed in the enclosure studied. The data are based on observations of 24 consecutive hours made in October. Only the most common patterns are listed here. DO=dominant, SD=subdominant.

VARIABLE MEASURED	MALE-DO	MALE-SD	FEMALE-DO	FEMALE-SD
Locomotor activity	142	157	119	117
Sleeping	702	667	785	158
Lying awake	279	333	328	253
Sitting	191	188	138	154
Standing	42	40	22	46
Self-grooming	46	23	25	63
Eating	10	9	8	8
Drinking	5	6	6	6
Defecation	4	3	3	4
Urination	3	5	3	5
Others	16	9	3	26

Spatial use of housing surface area

The total cage surface area was not very effectively or evenly used, but the animals preferred certain sites within the enclosure (table 6). Part A was most commonly used by each of the foxes, i.e. they occupied that area from 7.2 to 14.8 hours daily. Use of the other sites varied significantly among the individuals. If we look at table 6 more closely, it tempts us to conclude that each fox had its own living area within the enclosure which was the second most used after part A. Thus parts E, B, D-E and C were preferred by MALE-DO, MALE-SD, FEMALE-DO and FEMALE-SD, respectively.

Table 6. Spatial utilization of housing enclosure by arctic blue foxes. The data are expressed as percentages of the total 24 hours. For the description of marking the cage area, see fig. 1. DO=dominant, SD=subdominant. The results here are based on the same observations as those presented in table 5.

CAGE AREA	MALE-DO	MALE-SD	FEMALE-DO	FEMALE-DO
A	46.9	61.7	56.9	29.9
B	8.9	23.3	1.7	10.3
C	2.9	2.9	4.2	26.3
D	5.2	4.8	16.7	20.1
E	36.1	7.3	20.5	13.4

Discussion

The social organization of canids varies from solitary (*Kleiman, 1972; Burrows, 1968*) and permanent pair (*Fox, 1975; Ikeda, 1982*) to pack or social group (*Mech, 1970; van Lawick, 1978*). According to Kleiman & Eisenberg (1973), however, the permanent or seasonal pair bond seems to be the basic social grouping. During the course of evolution factors such as adaptation to a cursorial life, the tendency towards omnivorous food habits, and large litter size has promoted the development of tolerance between the sexes, permitting the formation of pair bonds. Canids have also developed sophisticated pack-hunting techniques as an adaptation to hunting large prey based on long-term pair bonding (*c.f. Kleiman, 1967; Kleiman & Eisenberg, 1973; Fox, 1975*).

Although the arctic fox is considered to be rather solitary in the wild (*Fox, 1969; Banfield, 1977*) in captivity is seems to form relatively quickly a fixed social group organization. As the results showed, social hierarchies and dominances were already observed after 1-4 days from the start of the housing experiment, and were mainly established by visual signals or threats but less by hard attacks. Probably because of farmborn origin the formation of the social group was rather gentle, in contrast to that described in wild arctic foxes (*c.f. Wakely & Mallory, 1988*). It is also interesting to note that although the studied foxes were descendants of animals raised in farms through many generations, they still exhibited an internal ability to form social groups and organization with ease.

Males were observed to dominate females, but the dominant individuals were not necessarily the heaviest as often noted in many terrestrial species (*Schein & Fohrman, 1955; Wilson, 1975*). Normally juvenile hierarchies of wild arctic foxes have been considered to be nonlinear, where dominant individuals are associated with neither a particular sex nor body size. When the animals have reached their adult size, i.e. after the fall equinox, the hierarchies become linear, and the dominant individuals are the heaviest males (*Wakely & Mallory, 1988*). The fact that hierarchies in the present work developed so quickly, and that the males became the leaders, is probably due to the fact that the animals were put in the enclosure not before autumn, i.e. after almost reaching their adult size. Rather low numbers of social contacts and scent-marking, on the other hand, led us to suppose that social hierarchy had not yet reached its full competency.

Although social rank and feeding order are not necessarily the same in some canids (*c.f. Jeselnik & Brisbin, 1990*), it often held true in the present study; males normally dominated females at feeding, and the dominant male ruled over the subdominant male. Feeding hierarchies probably are of the greatest significance for the wild arctic fox that is used to living under severe circumpolar conditions, where the abundance of food resources is variable and unpredictable. Under such circumstances dominant individuals can best control food resources thus surviving at the expense of their cohorts (*Mallory & Wakely, 1988*).

Scent-marking is acknowledged to be important territorial organizing behaviour in canids, but may also variously function to label depleted food caches, aid in long-distance sex recognition, express social status and/or reproductive condition, promote reproductive synchrony, and direct dispersing individuals into unoccupied areas (*c.f. Fox & Cohen, 1977; Henry, 1977; Blizard & Perry, 1979; MacDonald, 1980*). Typically scent-marking is defined as urination, defecation and/-or rubbing of the body towards a specific object, elicited by familiar conspicuous landmarks and novel objects or odors, and repeated frequently in response to the same stimulus (*c.f. Kleiman, 1966*).

Although many canids display frequent urinations and defecations throughout their environment, the predominant marking mode in foxes is normally urination (*c.f. Henry, 1977; Blizard & Perry, 1979*). In the present work the arctic blue foxes also showed intensive urination frequency all over the enclosure. Furthermore, we succeeded in following how the foxes marked their new living area from the first day on; it was clearly seen that defecation also had significant functions in the marking system as figure 1 shows. Already during the first 5 days the animals totally marked by defecation their living area, i.e., the entire surface area of the enclosure. The marking system of the arctic foxes, however, is totally different from that observed in the other farmed canid, the raccoon dog (*Yamamoto & Hidaka, 1982; Korhonen 1988b; Korhonen et al., 1990*); raccoon dogs deposit their faeces on particular sites which leads to the formation of large dung piles within a cage. Normally there exists only one main dung pile (or latrine) which all raccoon dogs in the same cage use communally. They also urinate onto the dung pile.

Both familiar and unfamiliar scent marks were investigated by the experimental animals, but no significant differences emerged between the odor types; usually the animals marked all the samples studied either by urination or defecation. However, the samples gathered for the present study all originated from the same farm, and thus, it is difficult to precisely conclude to which extent they were either totally familiar of unfamiliar. Blizard & Perry (1979) carried out odor test comparions for the red fox, and noted that unfamiliar odors generally attracted a higher frequency of visiting and marking than familiar odors. Their unfamiliar samples, however, originated from different places distanced up to 240 km from the test site. Marking by urination was elicited most often in their experiment, i.e. altogether 105 times but the defecation only 16 times

of all test samples. Our arctic foxes also marked more often by urination than by defecation, i.e. 28 and 6 times, respectively. The reactions of captive arctic foxes to some familiar and unfamiliar odors have also been tested previously under laboratory conditions (*Fox & Cohen, 1977*). In that work, any response by the foxes to their own urine or faeces was not found, but strange conspecific urine and faeces caused marking by urination, and faeces of rat induced marking by defecation. Fox & Cohen (1977) tested the reactions of arctic foxes to propionic acid (a major component of anal gland secretion in the red fox) and skatole, too. The former led to marking by urination but the latter evoked no response. Comparative tests were made with other canids like the wolf, grey fox and red fox. These authors concluded that arctic foxes differed from the other canids studied in their overall use of urination and, to a lesser extent, defecation as a marking method. However, in our work we found more markings by defecation, too. One reason for this could be the fact that we tested a wider scale of different samples than in the work of Fox & Cohen (1977). The reproductive condition of animals and the season as well as the age of animals and group size could also affect the marking behaviour, and thus explain the differences observed.

The finding that females marked significantly more than males, and that less marking was elicited from the dominant males, and that less marking was elicited from the dominant male than the subdominant one is surprising. At least in some carnivores the dominant males are the most common markers (*c.f. Liberg, 1981*). In the work of Fox & Cohen (1977) the reactions of one male and one female arctic fox to different odors were tested as described above, but no marked differences between the sexes were found. It has also been assumed that aggressive behaviour would be elicited in male foxes if they had been treated with female or male odors (*c.f. Preston, 1975; Blizard & Perry, 1979*). Our dominant male, however, was outside these frames. One reason for the higher marking frequency of our females could be the fact that in nature female foxes often have smaller living areas than males, and therefore females can more easily experience conspecific odors as a threat than their male partner does (*c.f. Henry, 1977; MacDonald, 1980*). Another, more reasonable explanation, could be the fact that the data were gathered outside the breeding season when marking frequency normally is less pronounced (*Korhonen & Alasuutari, unpublished data*).

The most common behavioural activities of farmed blue foxes kept in conventionally-sized cages have been documented previously in Finland (*Korhonen, 1988b*). Locomotor activity of those animals during September-October varied from 124 to 42 minutes, respectively, which fits well within the framework of the present data. The other recorded activity parameters are close to the values observed in the present study. It is thus tempting to conclude that the behaviour and activity pattern of the arctic blue fox probably is about the same order of magnitude irrespective of cage size. In the farmed raccoon dog, on the other hand, significantly increased locomotor activity in large enclosures in comparison to that observed in normal-sized cages has been noted (*c.f. Korhonen et al., 1990*). Its higher activity level in a large enclosure resembles that recorded in the wild state (*Ikeda, 1982*). Additionally, the raccoon dog seems to be significantly more active than the arctic blue fox (*Korhonen, 1988*). The wild raccoon dog expresses a wide spectrum of food items, and is known to be a food collector requiring large amounts of active time for searching and treatment of its small food items. The arctic blue fox, on the other hand, depends on a greater proportion of meat which could explain its smaller locomotor activity in comparison to that of the raccoon dog (*c.f. Gittleman & Harvey, 1982*).

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Original Report

Latrine utilization in raccoon dogs housed in different-sized cages and enclosures

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Summary

This paper describes latrine utilization patterns in farmed raccoon dogs housed in different sized cages and enclosures. Normally, all individuals living in the same cage or enclosure utilized one communal latrine. Latrine sizes varied, depending on the number of animals, season and time interval studied. It is obvious that latrines serve as a site of informational exchange among individuals, and thus have a significant social importance for the raccoon dog. Observations that even four individuals of same litter could defecate at the same time, was quite new among this species. The results do not confirm the fact that movement of a dung pile could be used to prevent animals from defecating on sleeping plates or nest boxes.

Introduction

Many carnivorous species deposit their faeces at definite sites called latrines (*c.f. MacDonald, 1980*). It seems obvious that such defecation sites would have some social significance, as has been suggested in some species (*c.f. Kruuk, 1978; Bearder & Randall, 1978*). In the Japanese raccoon dog (*N.p. viverrinus* Temmick), both in the wild state and in captivity, the communal utilization and olfactory recognition of latrines has also been documented (*Ikeda et al., 1979; Ikeda, 1982, 1984; Yamamoto & Hidaka, 1982; Yamamoto, 1984*).

The main impetus for the present experimental series was the fact that we observed that such a social utilization of latrines occurred also in Finnisl raccoon dogs (*N.p. Gray 1834*) under fur farm conditions (*c.f. Korhonen, 1988*). Thus, we decided to monitor the situation more closely, and gathered data from animals of different types of housing management both in farm cages and in ground floor enclosures. Our experiments were carried out mainly with Finnish raccoon dogs but, as we had obtained some Japanese raccoon dogs, we documented their defecation patterns as well. The final purpose of the present work was to clarify to which extent understanding of defecation patterns and latrine behaviour can provide

farmers with practical knowledge of how to prevent farmed canids from defecating inside their nest boxes.

Materials and methods

The experiments were carried out between 1989-91 at the Research Fur Farm of the University of Kuopio at Juankoski, and at the Muddusjärvi Experimental Farm in Finnish Lapland.

They were performed both in farm cages under shadehouse conditions (Exps. A-E) and in large ground floor enclosures in an open field (Exps. F-J). For the details see tables and figs 1-2. Behavioural data was gathered by visual observations, some of which lasted 24 consecutive hours and others for only 10-30 minutes daily. Interest was focused on the most common behavioural patterns, including defecation and urination. The formation of smaller dung piles into common latrines was monitored. Each latrine was mapped and its size measured.

Most of the animals studied were weighed regularly by a bow balance (accuracy of ±50 g). At the same time as the animals were weighed, also their character (tameness) was subjectively estimated. Estimation was performed in a blind manner by the same person each time. The reaction of the animal towards the visitor was scored on the following scale: 1=very tame, 2=tame, 3=normal, 4=defensive, 5=very defensive.

Table 1. Summary of the experimental arrangements in farm cages. N=number of animals per cage. TI=time interval studied.

EXPERIMENT	CAGE SIZE (cm) Length X Width X Height			N	TI
A	60	60	60	1	15.7.-11.9.
B	120	60	60	3	15.7.-11.9.
C	240	105	60	4	15.7.-11.9.
D	240	220	60	3	15.7.-11.9.
E	240	105	60	4	10.1.-10.3.

Table 2. Summary of the experimental arrangements in large ground floor enclosures. N=number of animals per cage, TI=time interval studied.

EXPERIMENT	CAGE SIZE (cm) Length X Width X Height			N	TI
F	6	4	2	2	21.3.-05.4.
G	6	5	2	3	21.3.-05.4.
H	6	4	2	7*	09.8.-31.8.
I	6	5	2	6*	09.8.-31.8.
J	17	8	2	7**	01.6.-06.9.

* mother and kits
** mother, father and kits

Results

Experiments in farm cages

The basic data for latrines, body weights and characters of the animals housed in farm cages are presented in table 3. The size of latrines varied, of course, because of the different numbers of animals per cages and the different time intervals measured. Thus, any accurate figures on the speed of latrine formation or on the development of

their shape cannot be given here. However, it can be concluded (see table 3, fig. 1) that the animal groups studied produced rather similar latrines as concerns their size and shape.

The animals in Exps. A-D were all growing juveniles and thus their final body weights (in November) presented in table 3 are comparable. Despite the different cage sizes and animal numbers per cage, the mean body weights did not differ from each other significantly. Their tameness values in Exps. A-C were also similar. In Exp. D, on the other hand, the animals were more tame. Body weight values for the animals in Exp. E (*Japanese raccoon dogs*) were measured during winter, and thus these values are not comparable to those of the previous experiments (A-D). These animals were the wildest as concerns the character of our farm cage animals.

Table 3. Size of latrines, body weights and tameness score of the animals in farm cages. In Exp. C there were two latrines per cage; the size of smaller latrine is given in parenthesis.

VARIABLE MEASURED	A	B	C	D	E
Size of latrine, cm					
length	28	68	45 (37)	46	50
width	25	56	43 (40)	40	25
height	9	7	13 (3)	19	9
Mean body weight, kg	9.2	8.8	9.1	9.1	6.0
Tameness	3.3	3.3	3.3	2.3	4.0

Figure 1 provides a schematic illustration of the latrines according to the various sizes of the experimental cages (A-E). The general conclusion is that the animals normally defecated at definite sites which led to the formation of dung piles and latrines.

As concerns the smaller cages, the latrines normally seemed to be located in the middle section of the cages. In the larger cages, on the other hand, latrines were typically concentrated only at certain sites. In Exp. C we observed under some cages two latrines instead of one.

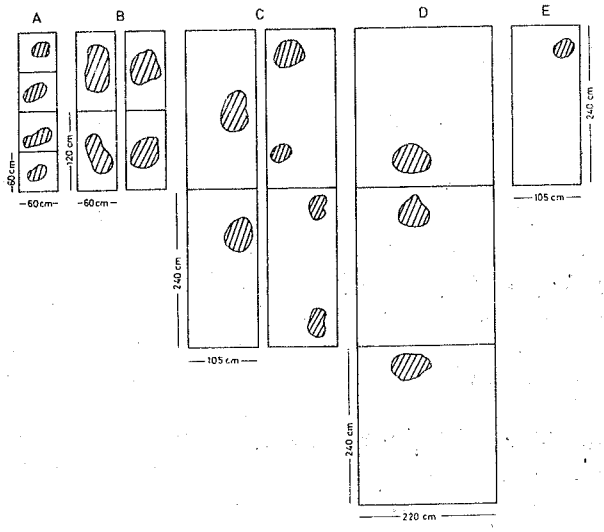

Fig. 1. Locations of latrines (shaded areas) in farm cage experiments. For the further description of the cages see table 1.

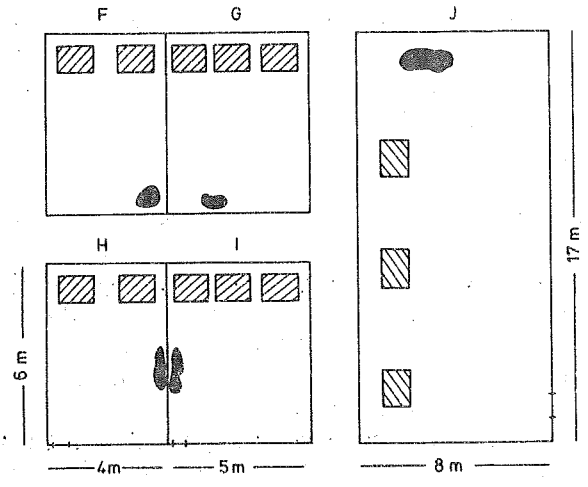

Fig. 2. Schematic presentation of the experimental arrangements in Exp. D. the cage area was divided into 6 different subareas (A-F).

In Exp. D, we additionally removed all latrines on October 28th. The original site was carefully cleaned and limed. Instead, however, the animals again began to defecate on the original site. In Exp. E (group of Japanese raccoon dogs) we repeated Exp. D by removal of all latrines and cleaning the sites. Disinfection was also done very carefully. The conclusion here was again the same; the animals preferred to defecate on their old, permanent latrine site.

Experiments in ground floor enclosures

In all of the present experiments, we did not measure the sizes of the latrines very accurately. Thus, some of these values have been approxi mated (Table 4). Here again, the problem was the differences in measured time intervals, which makes it difficult to draw any definite conclusions concerning the speed of latrine formation. In experiments I and J, we had an opportunity to observe defecation patterns of an entire family by accurate 24-h period observations. It was found that especially the length of the latrine in such cases was increased. The height of the latrine, on the other hand, was of the same order of magnitude in all of the experimental groups studied.

Body weights of the animals were not measured simultaneously. Therefore, the values presented in table 4 are not for accurate comparison but are mainly documentative examples.

Table 4. Size of latrines and mean body weights of animals in large ground floor enclosures.

VARIABLE MEASURED	F	G	H	I	J
Size of latrine, cm					
length	35*	30*	130	120	120
width	30*	40*	60	55	50
height	10*	10*	12	11	12
Mean body weight, kg	6.2	5.8	6.8**	7.8**	-

* approximation
** weight of the kits

Schematic pictures of the enclosures with latrines are given in Fig. 4. Here again, the latrines were concentrated on certain sites of the enclosure area, and only one latrine per each enclosure was observed. In Exps. H and I the latrines were sited on the common border of these two enclosures. In each enclosure (F-J), the latrines were not located very close to the nest boxes.

In Exp. J, we carefully transferred the latrine to another site (close to nest box number 2), and carefully cleaned the original site. Additionally, we covered the original site with a small layer of sand. However, it appeared that the animals avoided the new site, and first sniffed very eagerly the old, original site, and finally (after a few hours of removal) started defecation there again. They also urinated on the latrine. Thereafter, we again cleaned the enclosure, and did not leave any latrines at all. For a while, however, the animals began defecating on the original latrine again. In this experiment, we had 7 raccoon dogs (mother, father and 5 kits) within the enclosure.

We additionally observed communal defecation patterns, i.e. it happened that 2-4 animals would defecate at the same time.

Discussion

It is an established fact that raccoon dogs in the Japanese islands deposit their faeces at definite sites called latrines (*Ikeda et al., 1979; Yamamoto, 1984*). The sites and total number of latrines additionally seem to be fairly stable throughout the year, but the utilization rate of the latrines and the number of faeces deposited change seasonally. According to Ikeda (1982), the utilization rate of latrines is highest during late autumn, i.e. in October and, accordingly, lowest in late winter during March. These changes probably reflect modifications in the feeding and living habits of this species; during autumn raccoon dogs prepare for scarce winter conditions by excessive fattening and intensive eating behaviour. The coldest part of the winter, on the other hand, is spent in a superficial hibernation with significantly less

eating and locomotion. The present observation showed that under farm conditions, the sites and total number of latrines also remain surprisingly fixed for a long run.

The communal utilization of latrines is typical in wild raccoon dogs. Often, individual home ranges overlap widely and the communal utilization of latrines and feeding sites of such animals is pronounced (*Ikeda, 1982, 1984*). Our results showed that the communal utilization of latrines is normal for farm-raised raccoon dogs as well, and is independent of the number of animals per cage or cage size. These all support the idea that latrines have a marked importance to the raccoon dogs.

According to Ikeda (1982) latrines may operate as functions of land marks and for orientation to individuals in the wild. Furthermore, the fact that several raccoon dogs can utilize the same latrine in a communal manner suggests that raccoon dogs utilize latrines as information sites. This implies cohesion rather than avoidance among conspecific individuals. Thus, the olfactory memorization of latrines regulates their social behaviour when they actually encounter each other. Yamamoto (1984) stated that raccoon dogs can in fact olfactorily recognize and memorize both their own faeces and those of strance conspecifics individually. Thus an accumulated dung pile at the latrine would represent accumulated information which can have considerable importance in the long run.

Yamamoto & Hidaka (1982) have studied the utilization of latrines in captive raccoon dogs in Japan. Here again, they noticed that all of the raccoon dogs living in the same cage had one latrine which was utilized communaly. When the dung pile at the latrine in a cage was experimentally transferred to another site, and the original site cleaned, defecation and urination now occurred at the new site which became the new latrine. Yamamoto & Hidaka (1982) concluded that the presence of a dung pile, and not the location of latrine itself, is important to the raccoon dog. Yamamoto (1984) additionally conducted another experiment in which the latrine was totally removed from the cage. Now, the first urination occurred 35 min after removal, but defecation not earlier than 48 hours later. Yamamoto (1984) thus concluded that it is difficult for raccoon dogs to defecate without a latrine as well as to establish a new one. Thus, defecation will be supressed when no dung pile is present nearby.

Our observations are, to some extent, in contrast with the observations of Yamamoto (1984). Firstly, we noticed that it is very difficult to force raccoon dogs to change their defecation site if they do not want to independently. However, we have also made some observations of raccoon dogs who have willingly changed their latrine (*Korhonen et al., 1991*), and this normally occured during the winter when lots of snow was present. Secondly, we noticed no supression of defecation whatsoever in the absence of a dung pile. It is difficult to pinpoint why our results are different. One explanation might be that we studied farm-born animals which are used to the removal of both cage and site by farmers.

Interesting was the observation that even four individuals could defecate at the same time into the same latrine. Such a collective behavioural pattern is evidently a good example of their well-developed social life and co-operation. While all the individuals belonged to same family, it shows that family linkings are important for this species particularly and could be maintained by various common habits such as social defecation.

In recent years, people concerned about the welfare of animals have made complaints against the use of animals in general and especially against the conditions in which animals have been kept. It has been claimed, for example, that farmed canids (foxes, raccoon dogs) should have nests and resting platforms, where they are protected against cold and draught. An experiment in which we studied the use of sleeping plates in farmed raccoon dogs, however, revealed that most of the individuals used their sleeping plates only as a place to defecate or urinate (*Korhonen, 1987*). This same problem was observed in the nest boxes (*Korhonen & Nurminen, 1986*); we observed that there were several raccoon dogs which very willingly defecate inside their nests. The haircoat of such animals was always dirty or very dirty. Furthermore, ammonia levels in such nest boxes normally were rather high. Hoffmeyer (1986) also noticed in foxes that approximately 68% and 83% defecated onto their rest-shelves and nest boxes, respectively. Thus, both fox and raccoon dog farmers seem to face these same problems at present. Those Japanese studies (*Yamamoto & Hidaka, 1982; Yamamoto, 1984*), in which they succeeded to change the defecation site by changing the site of latrines, are interesting. Thus, one could suppose that movement of a dung pile might be used

to prevent animals from defecating on restshelves or nest boxes, too. The only problem is, that our present results do not confirm the fact that the animals' defecation site could be affected by changing the site of the latrines.

Acknowledgements

Financial support for this investigation was provided by the Finnish Research Council for Natural Sciences and by the Ella and Georg Ehrnrooth Foundation. The authors would like to thank Mr. Matti Tengvall and Mr. Pentti Tuominen for assistance in the field.

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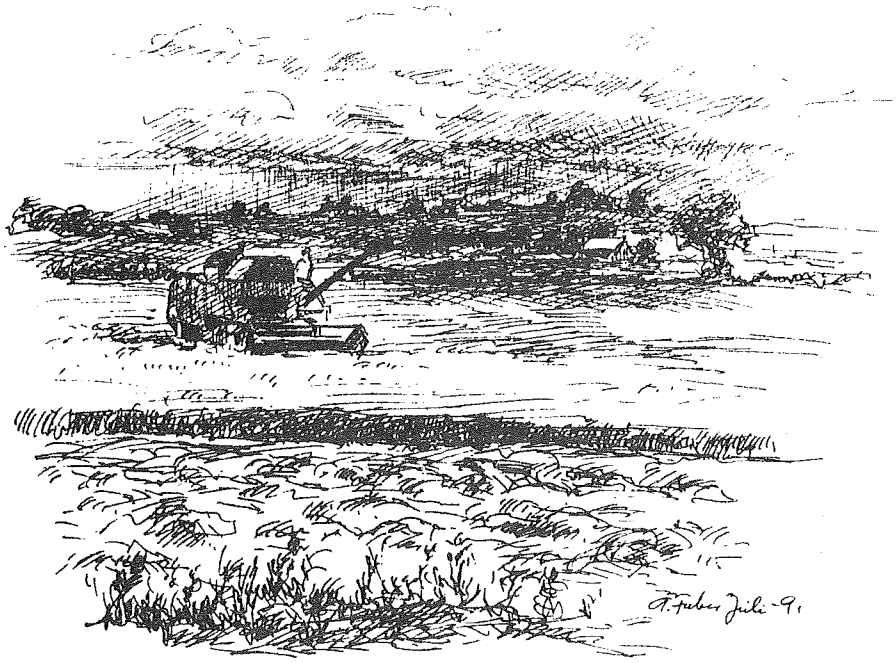
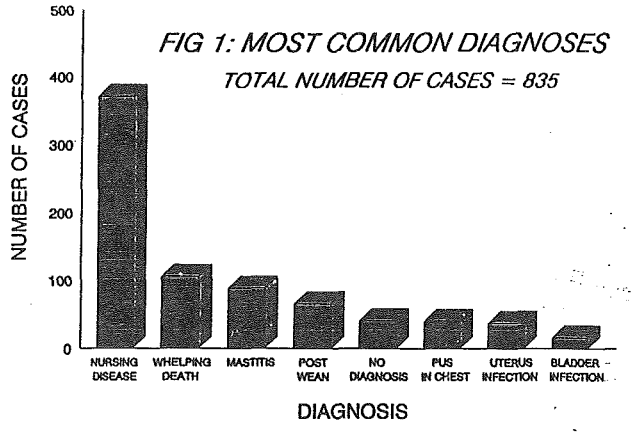


Nursing disease: Preliminary results and recommendations.

Bruce Hunter, Richard Schneider.

The disease associated with the lactation period in mink, nursing disease was found to be the most significant problem by a large margin.
A number of key points regarding nursing disease have emerged in the analysis of the data so far.
A surprising and very consistent finding was the time of onset of this disease. Over all ranches, the affected animals became ill over a very restricted period of time, averaging 42 days after whelping.
A number of factors were examined to see if there was any relationship between them and nursing disease.
Alternatively, it may be that much of the difference between ranches was due to genetic differences in the stock.
Litter size had a significant effect, with affected females raising litters 1/2 kit larger on average than unaffected females.
From the analysis to this point, we have drawn a number of tentative conclusions. Nursing disease is not an infectious disease, nor is it caused by any specific external factor such as feed or temperature.
High temperatures or a deficient water supply at the critical period, however, can result in major losses. Females raising large litters are at greater risk than females raising smaller litters.
A final summary of the findings from the mink study will be made available at the end of the year.



Canada Mink Breeders Association. Educational Bulletin, No. 98, April 1991, 5 pp, 3 figs. Sentences from report chosen by Gunnar Jørgensen.

Reorganisation of adaptive seasonal functions under domestication.

L.A. Praslova.

Selection of foxes for tameness was associated with earlier onset of the breeding season and the seasonal moult. In some tame vixens, reproductive activity took place outside the normal breeding season. Moulting commenced very early in 62% of vixens whose dams and paternal granddams exhibited extra-seasonal breeding. These changes were considered to be due to an altered sensitivity of the hypothalamic-pituitary axis to light.

Referativnyi Zhurnal, 4.58.183, 1990. Only abstract received. In RUSS. CAB-abstract.

Growth and furring of mink (*Mustela vison*) given diets containing the ß-adrenergic agonist, cimaterol.

O. Slayden, J.E. Oldfield, F. Stormshak.

An experiment was conducted to evaluate the effect of dietary cimaterol, a ß-adrenergic agonist, on growth, carcass characteristics and pelt quality of kit mink. The 40 standard dark and 40 sapphire mink kits were assigned to a control or to one of three treatment groups (five males and five females of each colour phase per group). Treatment consisted of the inclusion of 0.5, 2 and 5 mg cimaterol per kg (dry) of a standard ranch mink diet (control). All animals were weighed at the initiation of the experiment (24 July) and at 28-day intervals until 16 October. At slaughter (12 December) body weights were recorded and pelts measured for length and evaluated for fur colour and quality by experienced fur graders. Samples of fur from similar sites on each animal were removed for measurement of guard hair and underfur diameter. Frozen carcasses were analysed for protein and fat content. Mink final weight decreased with increasing concentrations of dietary cimaterol ($P<0.05$). Pelt length, which was found to be highly correlated with body size, was also reduced by cimaterol treatment. Feeding 2 and 5 mg cimaterol per kg diet to male kits, and 5 mg/kg to female kits caused a significant reduction in the proportion of carcass fat and increased the proportion of carcass protein ($P<0.05$). Fur fibre diameter for both guard hair and underfur was not significantly affected by dietary cimaterol. There was also no significant effect of

cimaterol treatment on fur quality. Cimaterol treatment did not result in diversion of nutrients from body proteins to the synthesis of fur and pelt proteins. Results of this research indicate that oral administration of cimaterol to mink will be of little practical value in fur production.

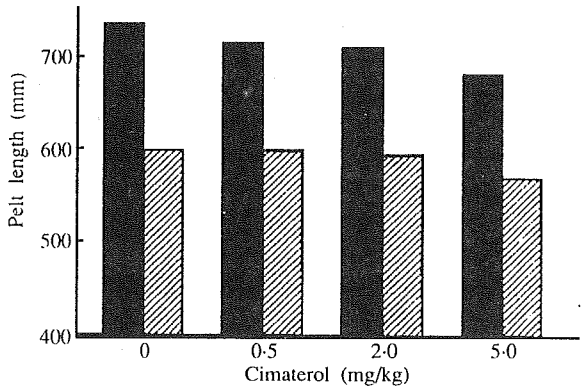


Fig. 2. Pelt length of male ■ and female ▨ mink given 0 to 5 mg cimaterol per kg dry diet. Treatment with 5 mg cimaterol per kg resulted in a significant reduction in pelt length compared with controls ($P < 0{\cdot}05$). Common estimate of s.e. = 12·5.

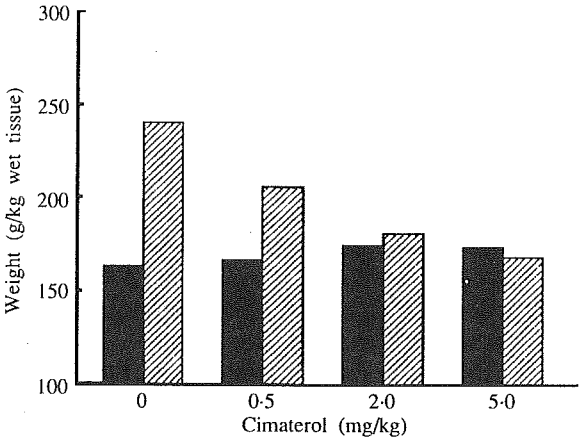


Fig. 3. Body fat ▨ and protein ■ expressed in g/kg wet tissue in mink given 0 to 5 mg cimaterol per kg dry diet. Treatment with cimaterol resulted in a significant reduction in body fat ($P < 0{\cdot}05$) and an increase in body protein ($P < 0{\cdot}05$). Common estimates of s.e. for fat and protein were 1·2 and 2·8, respectively.

Anim. Prod. 1991, 52; 377-381. 3 tables, 3 figs., 2 references. Authors' abstract.

Reversal of ketamine-xylazine anesthesia in the chinchilla by yohimbine.

C.E. Hargett, Jr., J.W. Record, M. Carrier, Jr., K.C. Bordwell, J.H. Patterson, Jr.

A group of 10 chinchillas was anesthetized with 40 mg/kg of ketamine and 2 mg/kg of xylazine intramuscularly. After reaching stage III anesthesia, five of the animals were administered 2.1 mg/kg of yohimbine intraperitoneally with the other five animals serving as controls. Fourteen days later the groups were reversed and the experiment repeated.

The duration of surgical anesthesia and the total time to standing unaided were calculated for each group. The mean duration of surgical anesthesia was 62.2 minutes and the mean total time to standing unaided was 107.7 minutes for the yohimbine group. The mean duration of surgical anesthesia was 131.3 minutes and the mean total time to standing unaided was 202.6 minutes for the control group.

Yohimbine is an effective antagonist of xylazine and can be used for that purpose in the chinchilla.

Lab Animal (USA); 1989; v. 18 (7) p. 41-43. 1 table, 8 references. Authors' summary.

Mapping of silver fox genes. III Chromosomal localization of the genes for GOT2, AK1, ALDOC, ACP1, ITPA, PGP and BLVR.

T.B. Nesterova, I.V. Nikitina, S.M. Zakian, N.B. Rubstov, V.G. Matveeva, S.I. Radjabli.

Evidence is presented for the chromosome localization of seven silver fox genes obtained with the help of panel of fox X Chinese hamster somatic cell hybrids. The AK1, GOT2 and ALDOC are assigned to chromosome VFU2, PGP to chromosome VFU3, BLVR to chromosome VFU5, ACP1 to chromosome VFU8 and ITPA to chromosome VFU14. The genetic map of 29 fox genes is compared with that reported for man and other animals. The results obtained support and extend our previous suggestion that formation of the Canidae branch of the Carnivora phylogenetic tree was associated with a great increase in the rate of reorganization of the ancestral karyotype.

Genetika, 26, No. 11, 2028-2030, 1990. 1 fig., 3 tables, 20 references. In RUSS. Su. ENGL. Authors' summary.

The possibility of using a major gene in investigating the concentration of 11-oxycorticosteroids in the blood in silver-black foxes.

L.L. Os'kina, I.L. Chepkasov, L.V. Samorodova.

The inheritance of the blood concentration of 11-oxycorticosteroids was investigated in 201 wild and domesticated silver-black foxes. It was concluded that inheritance of the trait is best described by a single-locus, diallelic model.

Referativnyi Zhurnal, 1990 1.58.463. Only summary received. In RUSS. CAB-abstract.

EcoRI and BamHI families of repeated sequences in mustelids.

T.P. Lushnikova, A.S. Graphodatsky, S.V. Ivanov, D.V. Ternovsky, Yu.G. Ternovskaya, A.G. Romaschenko, S.I. Radjabli.

The restriction enzymes EcoRI and BamHI digest the genomic DNAs from six mustelids species *Mustela lutreola, M. vison, M. erminea, M. sibirica, Vormela peregusna*, producing repeated fragments varying in length. Some fragments were hybridized to chromosomes and restriction digests of DNAs from some mustelids and other mammals. The 0.7 kb EcoRI repeats from DNA of *M. erminea* are dispersed over chromosomes of carnivores. The 1.35, 1.9 and 2.7 kb BamHI repeats from DNA of polecat *M. putorius furo* are specific for mustelids. These repeats demonstrate interspecific variation in length and the number of copies. All BamHI repeats have no strict tandem organization. The 1.9 kb BamHI repeats are concentrated in the heterochromatic pericentromeric regions and additional chromosome arms. The 1.35 kb BamHI repeats are located only in the centromeric regions of chromosomes of five species and are absent in *Vormela peregusna.*

24 references. Only abstract received. In RUSS, Su. ENGL. Authors' summary.

Chromosomal localization and the evolution age of satellite DNAs of mustelidae.

T.P. Lushnikova, A.S. Graphodatsky, A.G. Romashchenko, S.I. Radjabli.

DNA reassociation kinetics were studied in the European mink (*Mustela lutreola*), the American mink (*M. vison*), and the marbled polecat (*Vormela peregusna*). Variation in DNA quantity and heterochromatin amount occurs in connection with changes in size of all kinetic fractions. Moderately repetitive genome component is the most viable in these three species.

Cryptic CsCl satellite of the stoat (*M. erminea*), and $Ag+/Cs_2SO_4$ satellites of *M. vison, V. peregusna* were used for in situ homo- and heterologous hybridization. Satellite DNAs revealed may be classified for the evolution age and chromosomal location type. More ancient satellite DNAs were dispersed in carnivores or mammalian genomes. Mustelids' specific satellites are concentrated in heterochromatic chromosome regions.
The evolutionary implications of these findings are discussed.

25 references. Only abstract received. In RUSS, Su. ENGL. Authors' summary.

Gonad endocrine function in female silver fox selected for domesticative behavior.

L.V. Osadchuk, L.N. Trut.

Selection for domesticative behavior in female silver fox is accompanied by a number of changes in endocrine function of ovaries. Significant changes in peripheral blood estradiol and progesterone levels and their production by gonads during anestrous may be an endocrine basis for extraseasonal activation of the reproductive system and an earlier beginning of seasonal reproduction in domesticated females. The increase in hormone level during the preimplantation period of pregnancy and before parturition in tame foxes may influence their productivity.

5 tables, 20 references. In RUSS, Su. ENGL. Authors' summary.

Crossbreeding for heterosis in arctic foxes.

T.S. Kalinina, N.N. Dygalo.

In silver-black foxes and rats that had been selected over a long period for absence of defensive response to humans, the level of tyrosine hydroxylase, a key enzyme in the biosynthesis of catecholamines in the brain, was lower than in non-selected animals. When glucocorticoids were injected into pregnant rats from an aggressive strain, tyrosine hydroxylase was activated in 20-day fetuses, and the ensuing animals displayed less aggression than their parents.

Referativnyi Zhurnal, 1990, 1.58.478. Only Abstract received. In RUSS. CAB-abstract.

Crossing for heterosis in arctic foxes.

S.N. Kashtanov.

Analysis of arctic fox populations for serum protein polymorphism demonstrated that the simple assortative mating for some pelt traits had led to inbreeding; this, in turn, led to low fertility and smaller size. The monitoring of genotypes for marker genes is advocated as a means of avoiding inbreeding.

Referativnyi Zhurnal, 1990, 1.58.471. Only abstract received. In RUSS. CAB-abstract.

A genetic improvement program for nutria (*Myocastor coypus*).

C.A. Mezzadra.

Nutria (*Myocastor coypus*), a native species from South-America, is one of the most important species in relation to fur production and exportation of fine furs in Argentina. In addition to that, nutria meat can be processed and marketed in packing plants using installed capacity for processing hares. For these reasons, and because nutria is able to be breed in captivity, a program for genetic improvement is proposed, following an open nucleus breeding scheme in cooperation with private breeders. It will use a selection index for improving not only fur traits, but also growth traits. The selection criteria would be scores for color, hue, brightness, density and silkiness for pelt traits, and average daily gain from birth to slaughter, weight at slaughter and/or body length at a constant age or weight.

Rev. Arg. Prod. Anim. Vol. 8, No. 5: 441-446, 1988. 2 tables, 1 fig., 12 references. In SPAN, Su. ENGL. Authors' summary.

Original Report

Preliminary studies on the morphology and biochemistry of semen in male nutria

Stanislaw Jarosz, Olga Szeleszczuk
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Abstract

Semen from a total of 24 male nutria was collected by electroejaculation (EE) method and as a result of previous premedication it did not undergo gelatinization. It was subject to macroscopic, microscopic and biochemical tests. The volume of liquid semen was ave. 1.8 cm^3 (0.1-7.0 cm^3), pH 6.4 (6.0-7.0), motility 60% (10-100%), concentration 4.033 thous./mm^3. Crude protein level in semen plasma was ave. 203.7 mg%, that of fructose 62.5 mg%, GPC 75.8 mg%. The levels of microelements were as follows: Na-2.82, Cu-3.30, Zn-1.50, Ca-3.28 and Mg-3.20 mg/mm^3.

Introduction

Semen from male nutria is easiest collected by the electroejaculation (EE) method. According to Barta et al. (1984) and Halleman et al. (1987) the semen obtained from male nutria under full halothene anaesthesia, underwent gelatinization already a few seconds after sampling, which made its estimation and preservation difficult.

The method of nutria semen sampling, worked out by Authors (after previous premedication with a tranquillizer) allowed us to obtain semen, which even after 48 h did not undergo gelatinization. This method provided the basis for an objective evaluation of full semen and its conservation. Based on the quality of the collected semen it was possible to predict the reproductive performance of males.

The basic aim of this study was a morphological and biochemical estimate of fresh nutria semen.

Material and methods

Semen was collected by the electroejaculation method from a total of 24 one-year and two-year old male nutria after premedication with tranquillizers. Immediately after semen collection, macro-and mikroscopic examinations were made of the following parameters: volume, color, pH, motility and concentration of spermatozoa.

For a preliminary morphological examination of spermatozoa, semen smears were performed, which were stained and tested according to Blom (1981). Semen plasma was subjected to biochemical tests, viz. the following levels were determined: of crude protein, fructose, glicerophosphocholine (GPC) and selected trace elements

(Na, Ca, Mg, Cu, Zn). Protein level was determined by biuret method after Ostrowski (1974), fructose level by Kulka, modified by Peter (1956), GPC according to Hunter, modified by Mann (1954), (cited after Bielanski, 1986). The levels of trace elements were determined by the method of absorption spectophotometry while aminotransferase activity by the method of Reitman (1957). The results obtained were calculated statistically (mean standard deviations).

Results and discussion

The volume of the ejaculates obtained was ave. 1.8 cm^3 (from 0.1 to 7 cm^3) (table 1). A similar volume of semen obtained from male nutria is reported by Halleman (1987), without considering gellatinized fraction, whereas Barta et al. (1984), using halothene anaesthesia, obtained from male nutria ejaculates of lesser volume, on an average 1.18 cm^3.

Table 1. Volume, pH, concentration and motility of nutria semen.

Specification	$\bar{x}$	Standard error	Standard deviation
Volumen of semen (ml)	1.8051	0.1166	0.7277
pH of semen	6.4346	0.0764	0.3898
Motility of semen (%)	59.1667	5.2446	25.693
Concentration (thous.(mm^3)	4.033		3951.58

Mean nitrogen ion concentration (pH) in the ejaculates obtained was 6.4 (from 6.0 to 7.0) (table 1). This result was slightly different from that of Jakubicka (1989) viz. 6.8. Maybe this difference results from estimating semen undergoing gellatinization. According to Mann (1958) pH of semen may be a specific or individual trait. Mention should be made that nitrogen ion concentration in semen, irrespective of species, is one of the factors affecting the motility and viability of spermatozoa.

Mean number of motile spermatozoa (with progressive movement) in nutria semen was in our studies 59.1% (10-100%). It is lower than the value obtained by Barta et al. (1986), who found ave. 76.95% of motile spermatozoa. While Halleman (1987) reports a still higher number-ave. 83% (55-95%).

It can be supposed that differences are due to estimating spermatozoa motility entirely based on the liquified fraction after having separated gel. However, in our studies (thanks to the fact that semen did not undergo gellatinization) spermatozoa motility was estimated in total semen, from all ejaculates obtained, both of good and worse quality. Also, in such semen it was possible to calculate spermatozoa concentration in a full ejaculate. It was estimated to ave. 4.033 thous./mm^3 (table 1). For this reason, nutria semen is considered as dense, which is confirmed by quality assessment, according to which as much as 68% of ejaculates obtained are classified as dense (D) and 5% as very dense (DD). In experiments of Barta et al. (1986) as much as 21% of ejaculates were assessed as DD and 30% as D. However mention should be made that only a liquid fraction of semen, after gel separation, was estimated. Mean content of normal spermatozoa (N) in nutria semen was 71.4% (table 2). In smears under study no primary changes were found.

The available literature lacks studies on the biochemical composition of nutria semen and according to Morson et al. (1988) a function of every sexual organ can be determined based on biochemical indices.

For the prostate gland such an index is fructose (*Mann, 1988*). An index for the function of epididymides is glicerophosphocholine (GPC) (*Barej et al., 1976*) while protein is secreted by all accessory glands, however, at very diversified levels (*Kosiniak, 1976*).

Table 2. Morphology of nutria semen.

Normal sperma-tozoa	Secondary changes 2a	2b	3a	3b	3c	4a	4b	5a	6a
53	-	-	-	3	16	2	-	-	-
65	-	2	-	17	9	5	2	-	-
80	-	-	-	1	10	2	7	-	-
51	-	11	-	8	24	6	-	-	-
83	-	-	-	-	4	8	5	-	-
79	-	-	-	8	12	1	-	-	-
79	-	-	-	4	-	19	7	-	-
78	8	-	-	1	9	-	2	-	-
63	21	-	-	3	2	-	1	-	-

Explanation of secondary changes:
2a - spermatozoa with a drop of protoplasm in distal postition
2b - spermatozoa with a drop of protoplasm in proximal postion
3a, 3b - spermatozoa with folded single or double loops
4a - injured spermatozoa, loose heads
4b - " " broken tail
5a - spermatozoa with changes in acrosome, double contour
5b - spermatozoa with changes in acrosome, without front cap.

Biochemical composition of male nutria semen is presented in table 3. The protein level in semen plasma reached ave. 203.7 mg/100 cm^3, fructose 62.3 mg/100 mm^3, GPC 75.8 mg/100 mm^3. Mean levels of trace elements are listed in table 4. The activity of aspargine and alanine aminotransferases was ave. 0.894 and 0.874 mol/cm^3, respectively. The presence of these enzymes determines all metabolic processes occuring in semen. They are localized in the spermatozoa midpiece and on cytoplasmatic membranes. Destabilization of cell membranes during collecting and preservation of semen leads to the releasing of enzymes and mineral components (*Strzezek et al., 1987*). Torska et al. has shown a strict correlation between the presence of AspAT's in bull semen plasma and its concentration and quality. Similarly Kocwin-Podsiadio (1978) has proved a highly significant correlation between activity of AspAT and ALAT in boar semen plasma and some indices of its quantitative and qualitative estimation.

Based on the hitherto carried out investigations it is suggested that measuring the activity of aminotransferases can be utilized as a test for a degree of spermatozoa injury during the process of male nutria semen collection and preservation.

Table 3. Protein, fructose and glicerophosphocholine (GPC) mean level in nutria semen.

$\bar{x}$	Protein level mg/100 ml	Fructose level mg/100 ml	GPC level mg/100 ml
	203.7 ± 53.4	62.4 ± 9.13	75.8 ± 14.18

Table 4. Mean levels of trace elements (mg/mm^3).

$\bar{x}$	Na	Cu	Zn	Ca	Mg
	2.82 ± 1.5	3.30 ± 3.05	1.50 ± 1.37	3.28 ± 2.5	3.20 ± 2.75

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Effects of prolactin on mammalian reproduction.

Bruce D. Murphy.

Prolactin is a protein hormone produced by the mammalian pituitary gland under the influence of the neurotransmitter dopamine, which exerts a negative control on its synthesis and secretion of prolactin. Prolactin interacts with a protein membrane receptor in a variety of target tissues, including the mammary gland, ovary and liver. The cellular mechanism by which it exerts its effects remains obscure. Among the biological effects of prolactin are inhibition of the occurrence of reproductive cycles in humans, rodents and some ruminants. This interference occurs postpartum when prolactin levels are high as a result of lactation.

Prolactin has positive effects on reproductive processes; it induces progesterone synthesis in the corpus luteum of carnivores, including the dog, ferret and mink, as well as in the pig. It does so through multiple means, one of these being the potentiation of the uptake of extracellular cholesterol. In the mink, prolactin induces the activation of the corpus luteum, an event which brings about the termination of the embryonic diapause. In some rodents, prolactin prevents the luteal degradation of progesterone to its less active metabolite , 20α-OH-progesterone.

Dopamine agonists, which reduce prolactin secretion, and dopamine antagonists which increase it, can be used to manipulate reproductive events in mammals. Reduction of prolactin levels allows reproductive cycles to resume in lactating animals. Elevation of prolactin secretion will induce precocious embryo implantation in mink.

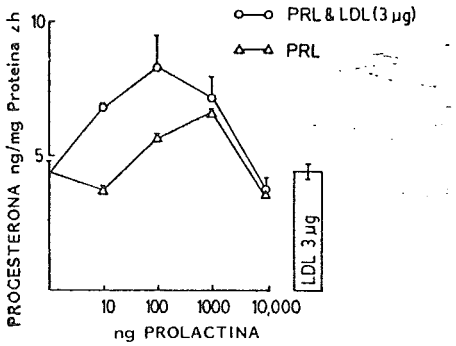


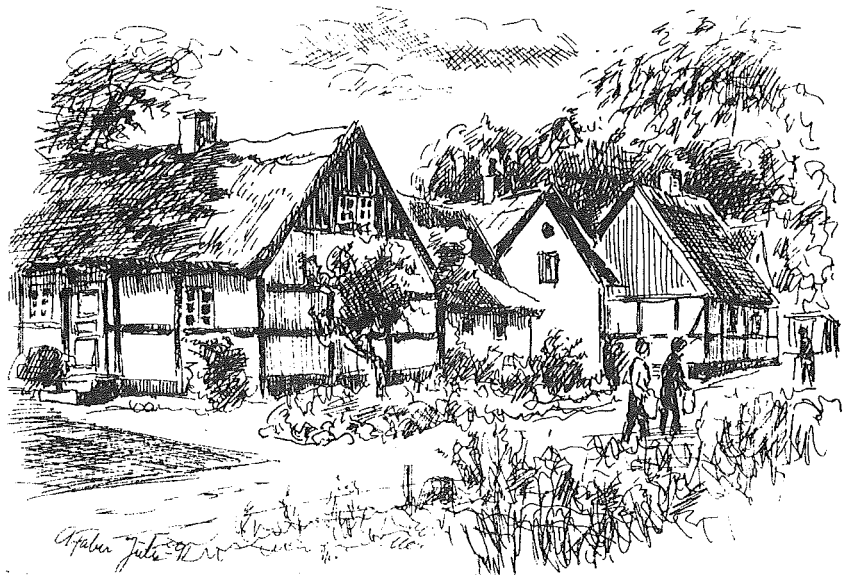
FIGURA 1. Efecto de la prolactina sobre la secreción de progesterona, en células luteales de visón. El tejido luteal fue reunido de animales en el período de post-implantación y disociado con colegenasa. Las células así obtenidas fueron incubadas con prolactina (0-100 µg) en ausencia o en presencia de lipoproteína de baja densidad (LDL) canina. La producción de progesterona en el medio de incubación fue medida por radioinmunoanálisis.

Academia Nacional de Agronomia y Veterinaria, Tomo XLIV, No. 2, 15 pp. Buenos Aires, Republica Argentina. 6 figs. 39 references. In SPAN. Author's summary.

The effect of adrenocorticotropin on the progesterone plasma level and progesterone production in female silver fox adrenal glands in vitro.

L.V. Osadchuk.

Plasma progesterone increased following a single injection of ACTH (3 ME/kg). The progesterone production was also increased by ACTH after



incubation of adrenals in vitro. The data suggest that the adrenal glands of female silver foxes are capable not only of secreting progesterone, but also of responding to ACTH with a further increase in the progesterone secretion.

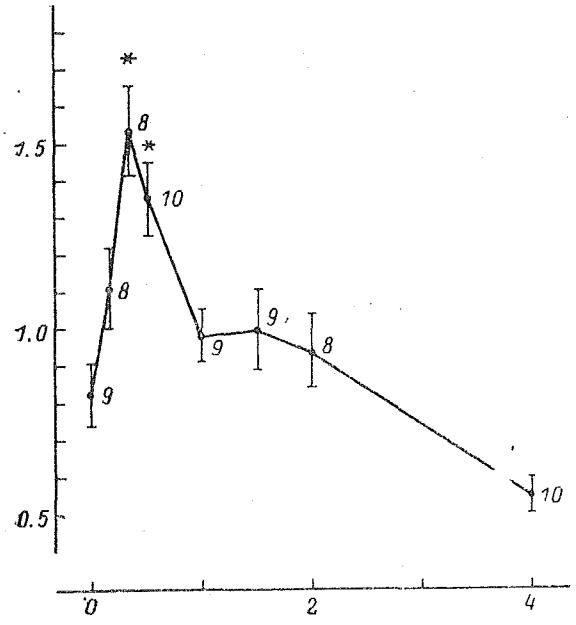


Рис. 1. Влияние АКТГ на уровень прогестерона в плазме периферической крови у самок серебристо-черных лисиц.

По оси абсцисс — время после инъекции АКТГ, ч; *по оси ординат* — содержание прогестерона в плазме, нг/мл. * — $p < 0.05$ по сравнению с исходным; в скобках дано количество животных.

Sechenov Physiological Journal of the USSR, LXXIV, No. 7, 1988, pp 1015-1019. 2 figs., 17 references. In RUSS, Su. ENGl. Author's summary.

Progesterone and oestradiol in vitro production by adrenal and ovaries in silver fox oestrous cycle.

L.V. Osadchuk.

The purpose of the experiment was to study the contribution of adrenals and ovaries to peripheral of progesterone and oestradiol in silver foxes, which have a seasonal pattern of breeding. The in vitro production of oestradiol and progesterone was examined at different stages of the ovarian cycle after adrenal or gonadal incubation. During the anoestrous season, when the reproductive system is totally inactive, the adrenals were the main source of progesterone. In proestrous prior to ovulation, adrenals and ovaries produced equal quantities of progesterone, and in oestrous after ovulation, the ovaries secreted the largest amounts of progesterone exceeding the adrenal production by 4-5 times. The adrenal production of oestradiol was very small in comparison with ovaries during the whole oestrous cycle.

Izvestiya Sibirskogo otdeleniya AN SSSR. Seriya biologicheskikh nauk (USSR); 1989; No. 3, p. 64-68. 1 table. In RUSS, Su. ENGL. Author's summary.

Photoperiodic regulation of the endocrine function of ovaries in silver-black foxes and its change under domestication.

L.V. Osadchuk.

On the silver-black foxes has been shown, that under domestication, influence of photoperiod on the synchronization of the reproductive cycle is decreased and the stimulative effect on the hormonal activity of ovary gonads is increased.

1 table, 6 references. In RUSS, Su. ENGL. Author's summary.

Photoperiodic shortening of sexual maturation in mink.

D.V. Klochkov, R.G. Gulevich.

Earlier sexual maturity and pelt maturation in females were induced by a light regime that mimicked the early onset of autumn.

Referativnyi Zhurnal , 1990, 4.58.186. Only abstract received. In RUSS. CAB-abstract.

Artificial insemination in fox breeding.

J.A. Fougner.

Details are given of semen collection, dilution and freezing, artificial insemination, and detection of oestrus in silver foxes and arctic foxes in Norway.

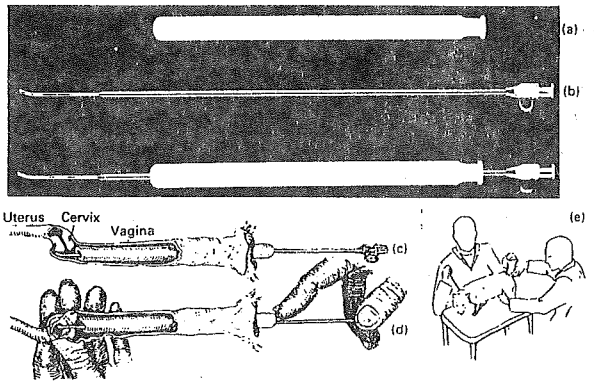


Fig. 1. The insemination equipment and technigues required for artificial insemination of foxes:
(a) plastic speculum;
(b) metal catheter;
(c) sagittal section of the genitalia slowing the placement of the speculum and catheter against the portio;
(d) sagittal section of the genitalia showing the caudal bending of the cervix while inserting the catheter through the short cervical canal into the corpus uteri;
(e) external view of the procedure described in (d). (See Fougner et al., 1973).

Journal of Reproduction and Fertility, Suppl. No. 39: 317-323, 1989. 1 table, 1 fig., 16 references. CAB-abstract.

The effect of photoperiod on folliculogenesis and the level of sex hormones in the blood in standard and sapphire mink during the prepubertal and pubertal periods.

R.G. Gulevich, D.V. Klochkov, A.A. Kim.

Experimental females were maintained under continuous light from 22 June to 21 July, and controls were maintained under natural light. Some females (7-10 per group) were slaughtered in Nov. and some in March. The standard controls averaged more primordial, growing, maturing (except Graafian) and atretic follicles in March, and a higher serum concentration of oestrogens in Nov. and in March than the sapphire controls. The number of primordial follicles in standard controls averaged 1331 and the number of Graafian follicles 0.8 vs 2591 and 2.3 resp. in the experimental standards. Experimental sapphire females averaged more Graafian follicles than experimental standards. The concentration of oestrogens was lower and that of progesterone was higher in experimental than in control standards, similar differences for the sapphires being small. A significantly higher number of atretic follicles was observed in the experimental sapphires than in other groups. The concentration of progesterone in the experimental sapphires was similar to that in the controls, but the concentration of oestrogens was higher in the experimental than in the control females.

Referativnyi Zhurnal, 1990, 1.58.309. Only abstract received. In RUSS. CAB-abstract.

Original Report

Protein digestion in fistulated polar foxes

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Abstract

The protein digestion in polar foxes was studied using animals with fistulas inserted into the pylorus region of the small intestine. The protein levels used were 45, 30, 15 and 0 percent of metabolizable energy from protein. Chromic oxide was used as an indigestible marker.

Increasing dietary protein levels caused lower dry matter content and higher protein content in digesta. Endogenous dilution affected the amino acid composition of digesta and feces, especially when the "protein-free" diet was used. The total amount of endogenous protein might be rather limited, and appears to have a minor effect on apparent digestibilities of polar foxes fed normal diets. It is indicated that further studies with fistulated foxes should aim at determining ileal digestibilities.

Introduction

Protein digestion and absorption have been investigated only a little in polar foxes (Alopex lagopus), with the exception of a series of Polish studies (*Bieguszewski & Lewicki, 1969; Podkówka et al., 1974; Bieguszewski, 1975; Bieguszewski & Szymeczko, 1979*). Other studies have shown that there may be considerable difference between the digestive processes of polar foxes and mink (*Skrede et al., 1980; Enggaard Hansen, 1987*). Recent developments in experimental technique may allow more detailed studies of protein digestion in foxes. The present study was carried out to investigate aspects of protein digestion using fistulated foxes and different levels of dietary protein.

Material and Methods

The animals used in this experiment were obtained from a private fur farm in Bydgoszcz, Poland. The animals were housed in metabolic cages equipped for quantitative feeding and collections of feces. Two adult male polar foxes, weighing ca. 6 kg, were fitted with simple small intestine cannulas according to the method developed by Szymeczko R. (not published). The cannulas were inserted into the pylorus region, 56,5 cm from the start of the small intestine. This corresponds to ca. 27,2% of the total length of the small intestine. After a recovery period of 10 days the animals were fed in succession four experimental diets: High protein diet (HP); Medium protein diet (MP); Low protein diet (LP); and Protein free diet (PF). The protein levels corresponded to ca. 45, 30, 15 and 0 percent of metabolizable energy from protein. Diet ingredients and contents of dry matter and nitrogen are shown in Table 1. Due to the methionine content in the vitamin/mineral mixture and possible other minor N sources, the PF diet were not as N-free as planned.

Table 1. Composition of experimental diets (%).

Diet code	HP	MP	LP	PF
Ingredients				
Slaughter offal	31.50	24.70	15.30	-
Fish meal	11.50	9.00	5.50	-
Meat-and-bone meal	8.60	6.70	4.20	-
Cooked maize starch	7.60	11.40	17.10	22.40
Soybean oil	-	4.30	9.40	14.70
Cellulose powder	0.90	1.00	1.20	1.40
Vitamin/mineral mix[a]	0.09	0.10	0.12	0.14
Water	39.81	42.89	47.18	61.36
Contents				
Dry matter (DM%)	32.59	31.04	28.41	26.24
Nitrogen (% of DM)	7.30	5.60	3.70	0.50

[a] Containing per 1000 g: Vit. A, 3.500.000 I.U.; Vit. D_3, 500.000 I.U; Vit. E, 28 g; Vit. K, 0.2 g; Vit. B_1, 1.5 g; Vit. B_2, 2.8 g; Vit. B_6, 2.8 g; Vit. B_{12}, 0.02 g; calcium d-pantothenate, 7.0 g; nicotinic acid, 10.0 g; folic acid, 0.2 g; choline chloride, 50.0 g; cobalt, 1.0 g; manganese, 1.0 g; iron, 17 g; zinc, 2.0 g; copper 1.0 g; iodine, 0.1 g; selenium, 0.6 g; methionine, 200 g.

The amino acid composition of the experimental diets is shown in Table 2.

Table 2. Amino acid composition of experimental diets (g/16g N).

Diet code	HP	MP	LP	PF
Arginine	6.00	6.62	6.92	1.44
Phenylalanine	3.93	4.18	4.45	1.44
Histidine	2.27	2.51	2.67	0.86
Isoleucine	3.78	4.13	4.40	1.12
Leucine	6.71	7.30	7.77	3.14
Lysine	6.55	7.19	7.66	0.93
Methionine	2.55	2.79	3.22	4.80
Threonine	3.78	4.19	4.52	1.06
Valine	4.63	5.08	5.38	1.73
Alanine	5.27	5.86	6.34	1.89
Aspartic acid	7.86	8.73	9.40	1.95
Cystine	0.94	1.02	1.12	0.74
Glutamic acid	11.92	12.74	13.66	4.61
Glycine	6.34	7.18	7.58	1.18
Proline	4.92	5.63	5.73	2.40
Serine	3.96	4.32	4.82	1.63
Tyrosine	3.21	3.37	3.61	1.25

All diets were added 0,3% chromic oxide as an indigestible marker, in order to allow determinations of nitrogen and amino acid digestibility. Each diet was given to the foxes for 12 days in one meal of 0.5 kg daily, at 10.00 a.m. exactly. Water was supplied ad libitum.

After 5 days of preliminary feeding, feces were collected each day at 9.00 during 7 days and kept frozen at -18°C until the end of the experiment. Digesta samples were collected three times daily, between 10.16 - 10.45; 12.16 - 12.45 and 14.16 - 14.45, during the last three days of each feeding

period. Samples of digesta were collected into a special type of rubber balloon attached to the cannulas and kept in an ice-water bath. Digesta samples taken during the collection periods were pooled and stored in the refrigerator at -18°C.

Dry matter in the experimental diets, digesta and feces was estimated in the laboratory of the Physiology Department, Academy of Agriculture and Technology, Bydgoszcz, Poland. After freeze drying, the samples of the experimental diets, digesta and feces were analyzed for Kjeldahl-N and chromic oxide in the laboratory of the Department of Animal Science, Agricultural University of Norway. Amino acid determinations were performed at the Biomedical Center, University of Uppsala, Sweden.

The results are presented as averages for three collection periods of digesta and pooled feces of two polar foxes.

Results and Discussion

The three protein-containing diets were well accepted by the animals, and the entire daily ration was rapidly consumed. The "protein-free" diet was poorly accepted and the consumption varied from about 25 to 50% of the daily ration. The amount of methionine in the "protein-free" diet was relatively high, due to the inclusion in the mineral/vitamin mixture. Table 3 shows the content of dry matter and nitrogen in digesta and feces.

Table 3. Average content of dry matter and nitrogen in samples of digesta and feces (%).

	Dry matter		Nitrogen	
Diet	Digesta	Feces	Digesta	Feces
HP	15.0	44.3	7.0	4.5
MP	14.3	44.4	6.0	3.8
LP	18.1	53.0	4.8	3.5
NP	23.4	53.3	0.9	2.4

In pigs and chickens, it has been shown that the amount of dry matter in digesta after a protein-free diet is greater than with diets containing protein (*Zebrowska, 1971; Zebrowska & Buraczewska, 1972 a; Zebrowska et al., 1975; Rymarz, 1976*). In the opinion of the latter authors this phenomenon results from the fast passage of digesta to duodenum with protein-free diets as compared with the protein-containing diets. In experiments with piglets, Asche et al. (1989) found a faster passage of digesta dry matter in animals fed a corn-soybean meal diet as compared with a protein-free diet.

As shown in Table 3 there was a clearcut relationship between dietary levels of nitrogen and the amount of total nitrogen in digesta from the proximal segment of the fox intestine. Taking into account that endogenous protein is slowly digested in rats and pigs (*Ochoa-Solano & Gitler, 1968; Zebrowska, 1971; Zebrowska & Buraczewska, 1972b*), it can be assumed that very little endogenous nitrogen was absorbed before the fistula in the polar foxes. With the exception of the high-protein diet, the digesta contained more nitrogen than the corresponding diet.

Table 4 shows the average amino acid composition of digesta and feces from the experimental foxes. It is evident that the amino acid levels of digesta from the "protein-free" diet differed greatly from those of the protein-containing diets, while fecal amino acids were less influenced. The low level of methionine in digesta from the "protein-free" diet, shows the great preponderance of endogenous protein with this diet. The fecal amino acid compositon after the "protein-free diet" was comparable with data obtained by Skrede et al. (1980), but the contents of histidine and threonine were lower in the present study.

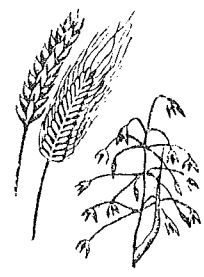

Table 4. Average content of amino acids in digesta and in feces of polar foxes fed different levels of protein (g/16 g N).

Amino	Digesta after				Feces after			
acids	HP	MP	LP	PF	HP	MP	LP	PF
ARG	4.77	4.74	4.68	1.70	3.83	4.51	3.92	4.07
PHE	3.38	3.35	3.38	1.68	3.21	3.67	3.51	3.51
HIS	2.07	2.10	2.08	1.06	1.54	1.76	1.74	1.80
ISO	3.49	3.48	3.46	1.55	2.95	3.55	3.46	3.41
LEU	5.92	5.87	5.90	3.27	4.76	5.67	5.52	5.84
LYS	5.92	5.96	6.05	1.97	4.22	4.86	4.85	4.86
MET	2.12	2.18	2.36	1.00	1.76	2.05	2.07	2.01
THR	3.80	3.77	3.77	2.34	2.94	3.51	3.58	4.36
VAL	4.28	4.30	4.26	2.28	3.70	4.36	4.22	4.46
ALA	4.64	4.68	4.64	2.03	4.04	4.17	4.23	4.05
ASP	8.46	8.44	8.25	3.47	7.08	7.77	7.50	7.23
CYS	1.11	1.16	1.15	1.55	1.74	2.04	2.58	3.44
GLU	11.10	11.13	10.97	5.40	8.56	9.10	9.26	9.46
GLY	5.99	6.32	5.85	1.88	5.53	4.76	4.39	3.66
PRO	4.59	4.95	4.63	2.83	4.24	4.00	3.84	4.13
SER	4.03	4.02	3.90	2.60	3.45	3.98	4.15	4.57
TYR	2.92	2.87	2.89	1.56	2.60	3.09	2.89	3.03

The results of the determination of apparent digestibility of nitrogen and amino acids, using the chromic oxide marker method, are shown in Table 5.

Table 5. Average apparent digestibility of nitrogen and individual amino acids in digesta and feces (%).

	Digesta after				Feces after			
	HP	MP	LP	PF	HP	MP	LP	PF
N	12.1	3.3	-13.5	-70.2	85.4	85.0	83.8	-2.6
ARG	30.4	30.9	25.4	-116.8	90.7	89.7	91.0	-166.7
PHE	24.3	23.3	14.4	-108.3	88.0	86.7	87.4	-125.0
HIS	19.7	20.1	14.7	-79.0	90.2	89.5	89.6	-59.9
ISO	18.4	19.3	13.6	-172.7	88.6	87.1	87.3	-206.8
LEU	22.2	22.6	14.4	-70.7	89.7	88.3	88.6	-17.2
LYS	20.1	20.3	10.8	-240.9	90.6	88.3	89.8	-326.1
MET	27.5	25.3	16.9	63.3	90.5	89.2	89.6	63.6
THR	11.2	14.0	5.4	-317.6	88.6	87.4	87.1	-280.7
VAL	18.4	18.9	12.5	-133.3	88.3	87.1	87.4	-126.7
ALA	22.0	23.2	17.5	-86.8	88.9	89.3	89.3	-88.2
ASP	4.7	7.4	0.8	-216.3	86.9	86.6	87.1	-229.4
CYS	-9.3	-6.5	-14.4	-313.8	73.5	69.7	63.0	-356.9
GLU	17.6	15.9	-4.2	-106.1	89.5	89.2	89.1	-79.3
GLY	15.9	14.8	12.5	-139.6	87.2	89.0	90.8	-137.5
PRO	17.0	15.6	7.8	-121.3	87.4	89.2	89.2	-65.0
SER	10.4	9.1	8.4	-168.3	87.4	85.4	86.1	-133.3
TYR	19.8	18.7	9.42	-95.8	88.2	86.1	87.0	-95.8

The decreasing values of apparent digestibility with decreasing dietary protein level are probably related to the dilution effect of endogenous protein. This also explains the negative values of the "protein-free" diet.

As yet, a reliable method for measurement of the amount of endogenous protein secreted into the alimentary tract has not been worked out. The results of experiments with other animals presented in the literature are therefore very often controversial. Some authors indicate that the amount of endogenous nitrogen exceeds several times the dietary level (*Nasset & Ju, 1961; Nasset, 1965; Ochoa-Solano & Gitler, 1968; Rymarz, 1976*).

The results of the present study as well as data presented by other authors (*Zebrowska & Buraczewska, 1972 b; Horszczaruk et al., 1974; Buraczewska et al., 1975; Zebrowska et al. 1978; Leibholz, 1982; Szymeczko & Skrede, 1990*) do not confirm so great an endogenous dilution. The results of the present study with polar foxes would tend to support the thesis that the amount of endogenous protein is rather limited. Thus the effect of protein level on the apparent digestibilities was in general rather slight, if the "protein-free" diet was excluded. Nevertheless, studies aiming at comparison of different protein sources should be carried out with isonitrogenous diets.

The digesta samples of the protein-containing diets revealed a positive apparent digestibility of amino acids, with the exception of cystine. Thus, a certain part of the amino acids was already absorbed in the segment of alimentary tract before the fistula. In an experiment with mink fed diets with protein from different sources, Szymeczko & Skrede (1990) found a gradual lowering of the lysine, arginine and methionine levels in digesta from different segments of the digestive tract, while the amounts of threonine, cystine and aspartic acid increased with increasing distance from the stomach. The data in Table 5 show that in digesta from fistulas placed in a proximal segment of the small intestine of foxes, the apparent digestibility was highest for arginine, methionine, fenylalanine, leucine and alanine, and lowest for cystine, aspartic acid and threonine. The amounts of threonine and cystine were much higher in the digesta of foxes fed a "protein-free" diet compared with the levels of these amino acids in feed. The low apparent digestibility of cystine, threonine and aspartic acid (Table 5) was probably the result of the high share of these amino acids in the endogenous protein in foxes, as shown earlier in other species (*Zebrowska & Buraczewska, 1972; Holmes et al., 1974; Bielorai, 1977; Zebrowska et al., 1978; Low, 1979; Buraczewska, 1979; Skrede & Krogdahl, 1985; Szymeczko & Skrede, 1990*).

The importance of increased knowledge of the digestive capacity of foxes is well recognized. Proper feed evaluation is dependent on precise digestibility coefficients. It may be speculated that ileal digestibilities could be preferable to fecal in foxes, if they can be established with reasonable safety. This will be studied in further experiments with fistulated foxes. We consider this technique as promising as regards wide aspects of digestion in foxes.

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Original Report

Feed consumption of a balanced ration in coypus during growth pregnancy and lactation

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Summary

Feed intake was estimated in coypus fed balanced rations, during growth, pregnancy and lactation, from November 1989 to Juni 1990, to estimate a tentative requirement of dry feed. Growing animals were housed in wired cages of 1x1 m, and pregnant and lactating females in corrals and in wired cages. All animals were fed ad libitum a dry balanced ration of 18% of crude protein, in special feeders. Five groups of seven growing males of an initial weight 0.67, 1.27, 2.71, 3.09 and 3.92 kg were fed until pelting at 5 kg. Four breeder families, of 6 females and one male each, placed in corrals; and one lactating female with 6 offspring, one female in the last two weeks of pregnancy and two females after weaning, were individually housed, and fed during different lengths of time. Feed intake in growing animals was described by the equation $y = 0.55\ x^{0.83}$, where (y) is intake in g/d and (x) is body weight in kg. During pregnancy, the animals housed in corrals consumed 160 g/d/head or 1100 g/d/family, and the female housed in a cage 145 g/d. During the 30 days of lactation the feed intake increased from 250 g/d the first week, to 350 in the middle of lactation to reach 500 g/d at the end. From these figures, a feed requirement per female was estimated (including the proportional intake of the male) of 27 kg during pregnancy and 10.5 kg during the 30 days of lactation. The amount of feed required to reach 5 kg of weight in growing animals, was estimated to 24 kg/head, for a feeding period of 6 months and 28 kg for 8 months of feeding.

Shortening the lactation and the growing period, by weaning earlier and using a well-balanced ration during growth, should allow for saving important amounts of feed.

Introduction

The production of furs from coypus raised in captivity in well developed farms, is demanding an important amount of dry balanced rations in some areas of Argentina.

Feeding balanced rations with or without greens is already an adopted practice in highly specialized farms. However, it is well known that the cost of feeding balanced rations is high, representing the main component of the total cost of production. It is therefore very important to establish

The agreement between the observed and estimated parameters indicated that equations 1 and 2 worked quite well for practical purposes, so they were used to calculate the requirement of dry feed for different lengths of the growing period, which is summarized in figure 2.

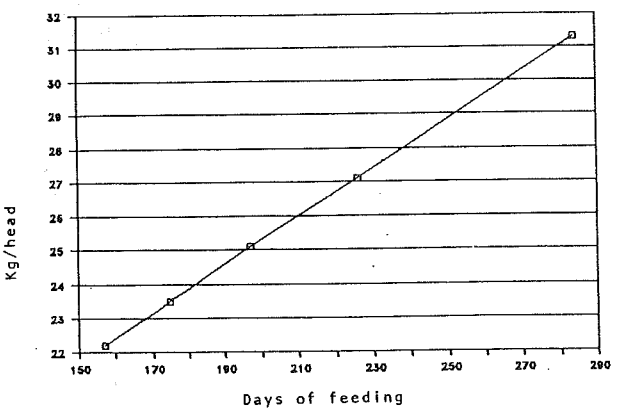

Figure 2. Demand of dry feed from weaning to pelting in coypus in relation to the length of the growing period.

As shown in fig. 2 the total demand of feed increases with the length of the feeding period. For example, for a length of 6 months the feed requirement is approximately 24 kg and for 8 months 28 kg.

Pregnancy and lactation

During pregnancy the consumption by a family of 6 young females and a male was 1.1 kg/d, which is equivalent to 157 g/head or 180 g/female including the cost of the male. With this level of intake, the females gained 26 g/d and the male 23 g/d, which indicates that when the animals have been fed ad libitum eat more than they need for maintenance. The female housed in a cage had an intake of 145 g/d and maintained its body weight. It seems that a consumption of 150 g/d per female and 200 g/d for the male should be adequate, which is equivalent to 180 g/female including the extra cost of the male. Therefore, in 145 days of pregnancy the requirement of a female is approximately 26 to 27 kg.

During lactation, the feed consumption increased with the progress of the lactation, being 252 g/d the first week, 368 g/d the third and 500 g/d the fourth week of lactation, representing an average intake of 350 g/d or 10 kg during 30 days of lactation.

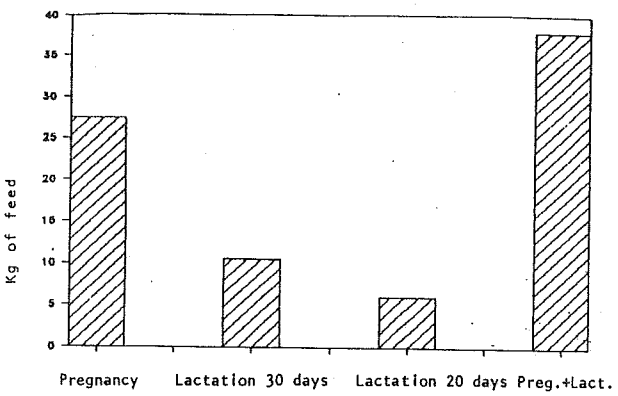

Figure 3. Demand of dry feed in coypus dams during pregnancy and lactation.

It was observed that females gaining too much weight during pregnancy, tended to consume higher amount of feed in lactation or to lose weight, therefore the feed requirements during pregnancy and lactation should be considered together. Based on an intake of 180 and 350 g/d during pregnancy and lactation, respectively, the daily requirement of dry feed for breeder families was estimated according to the number of lactating females as shown in fig. 4. For example, for 3 lactating dams an allowance of 1.7 kg/d should meet the requirements of the family and for 5 lactating dams it should be increased to 2.3 kg/d.

After weaning the intake of the dam decreased to the level of pregnancy (table 2).

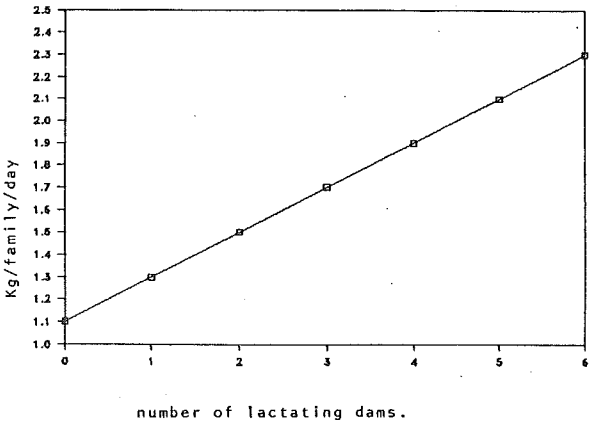

Figure 4. Demand of dry feed, during pregnancy and lactation in coypu families of 6 dams, in relation to the number of lactating dams.

The total requirement of feed to obtain a coypu fur will be the result of the feed required during pregnancy (P) and lactation (L) divided by the number of weaned kits (N) plus the feed required to raise the kit from weaning to pelting (G).

$R = G + (P + L) / N$ ..... equation 3

For example, if the number of weaned kits per family is 5 per dam and the growing period is 200 days, the requirement of feed will be: P = 27; L = 10; G = 25 (fig. 2).

$R = (37/5) + 25 = 32.5$ kg

Table 2. Feed intake in two female coypus after a lactation of 30 days.

Parameters	Animal 1	Animal 2
Dam body weight at weaning (kg)	5.4	5.1
Number of weaned kits	6	7
Kit weaning weight (g)	551	550
Dam weight after 31 days	5.8	5.4
Weight gained g/d	13.0	13.6
Feed intake g/d	154	149

This amount of feed could be reduced by restricting the animals more during pregnancy, weaning the kit earlier and shortening the growing period by allowing a higher intake of a well balanced feed.

How much pregnant females could be restricted without affecting their reproductive performance is unknown. Nonetheless, a kit could be weaned at 20 days if its body weight is over 500 g, and the growing period could be reduced to 6 months or even less with balanced feeds.

Another very important fact is that a female, for pregnancy and lactation, will require 37 kg of dry feed, regardless of the number of kits. As the number of weaned kits decreases the requirement per kit goes up. For example, weaning 3 kits per dam, the demand of feed per weaned kit is approximately 12 kg (37/3), however with 5 kits per dam the feed per kit goes down to 7.5 kg. In conclusion, the requirement of dry feed to produce a fur in coypus will depend mainly on the number of weaned kits and the length of the growing period, providing other variables are under control. With 5 kits weaned per dam, the requirement is 7.5 kg/kit, and to grow from weaning to pelting, in a 6 month period of feeding, will demand another 24 kg, which in total accounts for 31.5 kg per fur.

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Effect of diet on the skin fatty acid profile in mink.

E. Ulmanen, S. Turunen, L. Blomstedt.

Mlae mink fed from weaning on a standard diet or one containing partly rancid marine oils (herring offal) and fatty acids were monitored from skin neutral- and phospholipids from summer to early autumn. The proportion oflinoleic acid was smaller in both lipid fractions in mink receiving the marine oil diet. Skin phospholipids contained a relatively high titer of arachidonic acid regardless of the dietary regime. The proportion of neutral lipid palmitoleic acid increased markedly toward autumn in both groups of animals. Few differences beside reduced linoleate were observed in skin fatty acids between control and marine oil receiving animals, suggesting that reduced linleate availability, complemented with possible lipid oxidation products, contributed to poor underfur growth observed in minks receiving the marine oil diet.

Acta Agric. Scand. 41: 171-178, 1991. 7 tables, 12 references. Authors' summary.

Efficacy of hydrated sodium calcium aluminosilicate and activated charcoal in reducing the toxicity of dietary aflatoxin to mink.

R.J. Bonna, R.J. Aulerich, S.J. Bursian, R.H. Poppenga, W.E. Braselton, G.L. Watson.

Mink were fed diets that contained 0, 34, or 102 ppb (µg/kg) aflatoxins with or without 0.5% hydrated sodium calcium aluminosilicate (HSCAS) and/or 1.0% activated charcoal (AC) for 77 days. Consumption of the diet that contained 34 ppb aflatoxins was lethal to 20% of the mink, while 102 ppb dietary aflotoxins resulted in 100% mortality within 53 days. The addition of AC to the diet containing 102 ppb aflatoxins reduced mortality and increased survival time of the mink while the addition of HSCAS, alone or in combination with AC, prevented mortality. Histologic examination of livers and kidneys from the mink demonstrated liver lesions ranging from extremely severe in mink fed 102 ppb aflatoxin to mild to moderate in those that received 34 ppb aflatoxins. The addition of HSCAS and/or AC to the diets that contained 102 ppb aflatoxins reduced or essentially eliminated histopathologic lesions in the livers. No histopathologic alterations associated with the dietary treatments were observed in the kidneys.

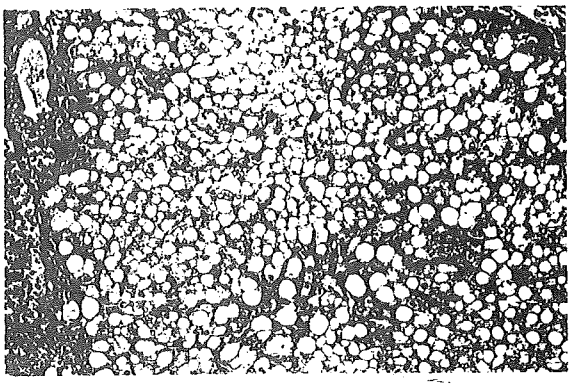


Fig. 2. Photomicrograph showing hepatocellular degeneration and macrovesiculation of hepatocytes (arrow) in the mink fed the diet that contained 102 ppb aflatoxins (40x enlarged 5.6 times).

Arch. Environ. Contam.Toxicol. 20, 441-447, 1991. 5 tables, 3 figs., 32 references. Authors' abstract.

Evaluation of the growth rate and fur and meat utility of sapphire and standard coypu at different systems of feeding.

J. Kuzniewicz.

The whole cycle of research on sapphire and standard coypu was carried out between 1979-1986. Varied feeding systems were applied, with granulated mixtures (in experimental groups) and traditional feeding (in control groups). Granulated mixtures contained alfalfa meal, dried grass and maize meal. The first part of the experiment (A) was carried out in the years 1979-1980 on 3 groups of animals: group I (experimental) was fed granulated mixture containing 25% dried alfalfa, group II (experimental) was fed granulated mixture containing 50% dried alfalfa and group III (control) was fed traditional feeds.

The second part of the experiment (B) was carried out between 1982-1983 on 3 groups: group I (experimental) was fed granulated mixture containing 25% dried grass and group Ii (experimental) 50% dried grass. Group III (control) was fed traditional feeds.

The third part of the experiment (C) was carried

out between 1985-1986 on 3 groups of animals, too. Group I (experimental) was fed granulated mixture containing 25% - and group II (experimental) 50% maize fodder. Group III (control) was given traditional feeds. Each studied group consisted of 240 sapphire and standard coypu, at the sex ratio of 1:1.2160 animals were studied in the whole research cycle (3 experiments). Each experiment in the cycle lasted 22 weeks, from separation (4th week) till 26th week of life. In the period of time the growth rate was evaluated and after slaughter the following evaluations were conducted: 1) evaluation of skins and of hair cover, 2) evaluation of meat and physiochemical analyses of meat and fat, 3) economical efficiency of coypu production.

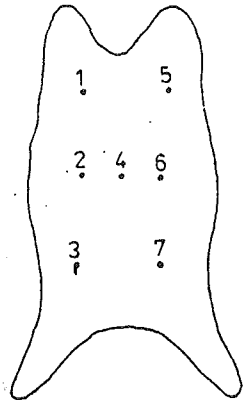


Fig. 1. Sampling areas: 1,2,3 - ventral part; 4 - lateral part; 5,6,7 - dorsal part.

On the basis of obtained results it was found out, that:

- feeding coypu granulated mixtures containing dried alfalfa, grasses and maize proved advantageous as compared to traditional feeding;
- obtained results of laboratory examinations of skins from coypu slaughtered in 26th week of life æroved their full usefulness for fur purposes;
- studied features of hair cover, such as: thickness, density and length in 26 week old coypu did not differ from those in older animals (one year old);
- in all experiments high slaughter yield was obtained. The highest index was found for experiment A (61-63%);
- the lowest feed consumption was observed in experimental groups which were fed granulated mixtures;
- the mean cost of rearing one animal within 3 experiments was the lowest in group II;
- as far as obtained economical results are concerned, feeding granulated mixtures containing 50% dried alfalfa (experiment A, group II) proved most advantageous.

Zeszyty Naukowe Akademii Rolniczej we Wroclawiu, Rozprawy; No. 78; 82 pp, 1989. 15 tables, 1 fig., 85 references. In POLH, Su. ENGL. Author's summary.

The influence of Tylosin on feed utilization, water balance and passage time in mink.

Karen Marie Tybjerg.

This paper comprises a study of literature as well as own investigations of the effects of Tylosin on feed utilization, water balance, and passage time in adult male mink.

Tylosin (30 ppm) was added to two qualities of wet feed, fresh feed and thermally treated feed (24 hours at 25°C).

Feed and faeces were analysed for content of protein, fat, glucose, and starch as well as of the minerals Na, Cl and K.

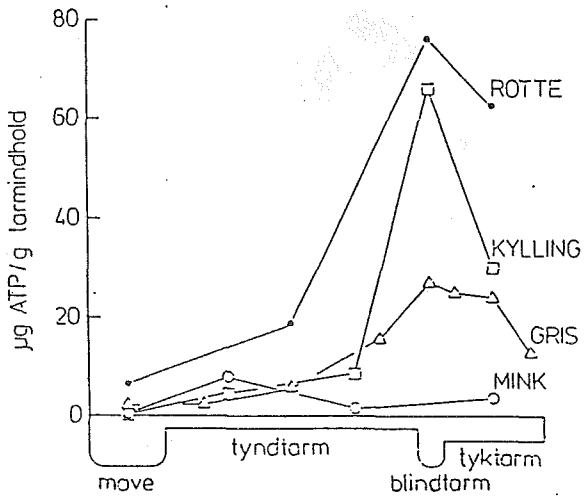


Fig. 7. µg ATP/g tarmindhold (Jensen, 1990)

Feed samples of all 4 feed mixtures were sent for analysis to the Laboratory of Analysis of the Danish Fur Breeders Association.

Tylosin added to fresh feed had no effect on the utilization of protein, fat, glucose or starch of adult mink. No effect was found on water balance or passage time, either.

Tylosin added to thermally treated feed gave a longer passage time.

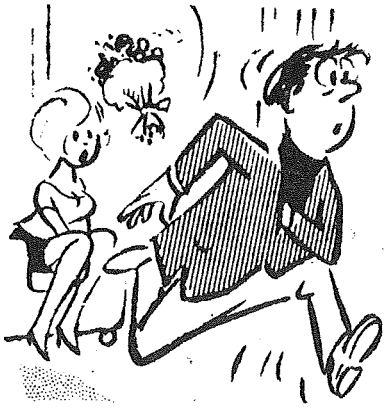
When compared to the control group, Tylosin added to thermally treated feed resulted in a lower digestibility of glucose but a higher digestibility of starch.

The digestibility of Na fell in mink given thermally treated feed with added Tylosin as compared to mink given thermally treated feed.

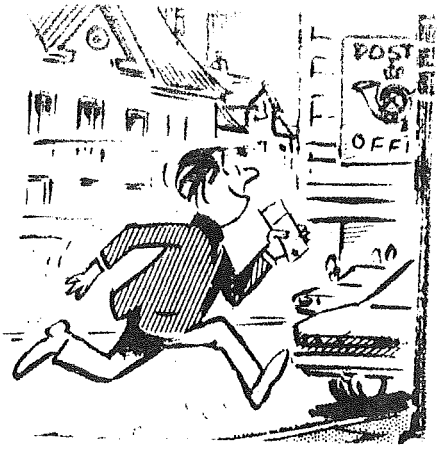
As a result of the thermal treatment, there was a significant increase in the total number of bacteria. Tylosin in thermally treated feed reduces the growth of bacteria to the advantage of blastomycetes.

M.Sc. Thesis, The Agricultural and Veterinary University, Dept. of Fur Animal Production, Copenhagen . 58 pp, 23 tables, 16 figures. In DANH. Author's summary, translated by Hanne Artved.

MY GOODNESS!!!



I'VE FORGOTTEN TO PAY



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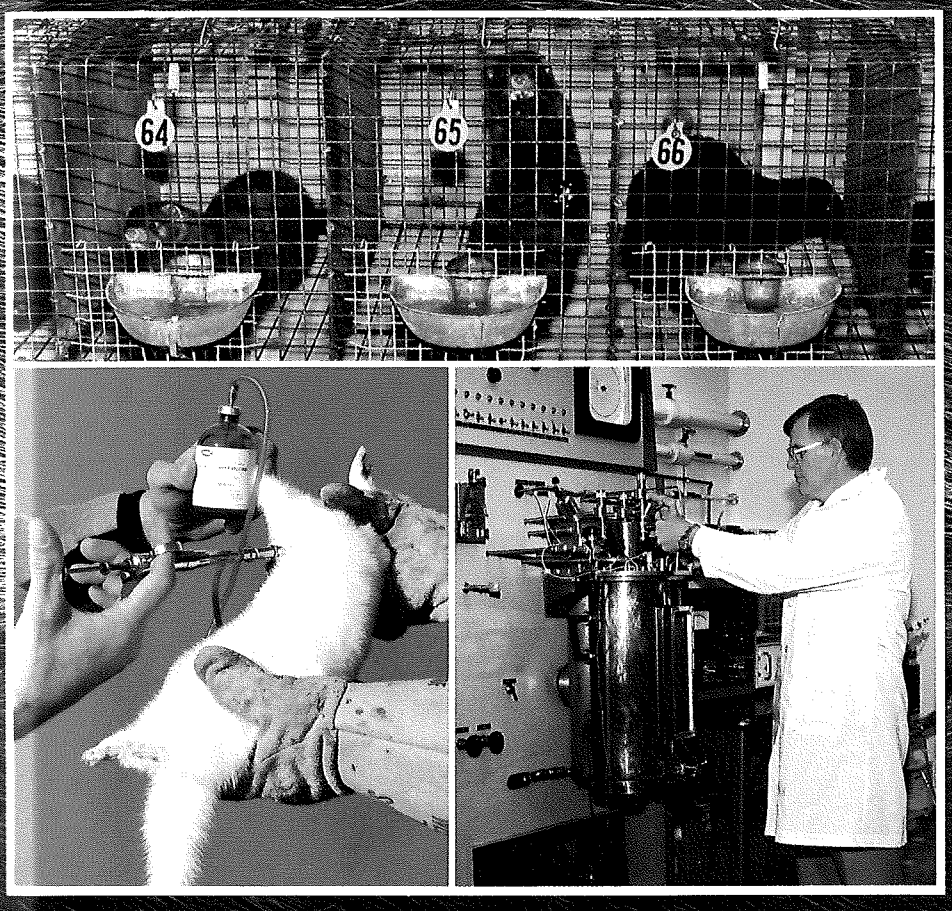

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Original Report

Mink Carcass and Organs as Sources of Scientific Materials. Observations on Kidneys in Nursing Sickness.

Otto Hansen[1], Tove N. Clausen[2], Søren Wamberg[3]

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Summary

The enzyme responsible for salt preservation of the organism and for the urinary concentration mechanism of the kidney, the renal Na,K-ATPase, was isolated from healthy mink and from dams suffering from nursing sickness. The α-peptide of renal Na,K-ATPase was characterized as the carnivore α_1-subtype in immunoblots. The ouabain binding affinity to purified renal Na,K-ATPase was nevertheless extremely high (app. K_{dis} 1.0 nM). The ouabain binding capacity per mg protein was less than half of the expected value suggesting the presence of inactive protein, e.g. the existence of a diprotomer containing one active and one inactive α-subunit. The number of enzyme units in crude renal membrane fractions from mink with nursing sickness was 18% higher than in those from healthy mink. This is consistent with an increased rate of synthesis due to salt depletion, dehydration and chronic exposure to aldosterone.

Introduction

Several countries of the northern hemisphere have mink farming and around 1/3 of the world production of mink fur takes place in Denmark. 12-15 million kits are reared and pelted per year in Denmark. Carcass and organs from this carnivore are thus easily available and may replace those from dogs or cats for scientific purposes.

Carnivores are usually able to concentrate their urine considerably. This feature is dependent on the structure of the medullary zone of the kidney and its ability to create interstitial hyperosmolarity implying sufficient sodium pump capacity of this zone. Since the maximum value of urinary osmolality in mink is about 3000 mosm/kg (*Eriksson et al., 1984*), mink kidney constitutes a potential source for purification of the sodium pump equivalent, the $(Na^+ + K^+)$-activated ATPase or abbreviated Na,K-ATPase. The membrane-embedded enzyme is responsible for active transport of Na^+ K^+ and contains two different proteins, α and ß, both of which span the membrane bilayer. The catalytic α-subunit is the receptor for cardiac glycosides, e.g. ouabain, which specifically block the pump activity (*Hansen, 1984*). Establishing the maximum ouabain binding capacity per mg protein of pure enzyme is essential for determination of the mode of action of Na,K-ATPase as an αß-protomer or an $\alpha_2\beta_2$-diprotomer.

In our study of a common metabolic disorder in nursing mink (nursing sickness) we observed the following characteristics: severe electrolyte disturbances, extracellular dehydration with low plasma sodium and extremely low urine sodium concentrations, hyperaldosteronism, hyperglycemia, and hyperosmolarity of plasma. In spite of these facts, inability to concentrate urine was a prominent feature of the disease (*Clausen and Hansen, 1989; Clausen et al., 1990*). For these reasons we found it worthwile characterizing the kidney Na,K-ATPase of healthy and sick mink.

Materials and methods

The kidneys were removed from healthy mink and from mink with nursing sickness immediately after sacrifice (overdose of sodium pentobarbital) and pelting. They were placed in ice-cold imidazole-sucrose-EDTA as prescribed by Jørgensen (1974 and 1988). After removal of the capsule, the kidneys were cut in longitudinal sections. The slices were placed for one hour in the isotonic buffer to make the red outer medulla more easily visible after which the zone was dissected out. Enzyme preparation by homogenization, preparation of crude membranes by differential centrifugation, SDS-activation in the presence of ATP and isopycnic zonal centrifugation were carried out as described (*Jørgensen, 1974, 1988*).

For comparison of sodium pump capacity in healthy and sick animals part of the crude membrane fraction obtained by differential centrifugation was used. The SDS concentration necessary for optimum Na,K-ATPase activity was determined and the activated preparation used in ouabain binding experiments. [^{3}H] ouabain was obtained from Amersham International. The isotope was purified by chromatography on Na,K-ATPase and ouabain binding was determined at equilibrium of binding as described elsewhere (*Hansen, 1976*). The hydrolytic activity of the enzyme with ATP in the presence of Na^++K^+ or with pNPP in the presence of K^+ was measured with conventional spectrophotometric methods (*Jørgensen, 1988*).

SDS-polyacrylamide gel electrophoresis was performed with a mini gel equipment and a 4-16% polyacrylamide gel. The gels were stained with Coomassie Brilliant Blue R-250 or transferred to Immobilon PVDF membranes in a semidry electroblotter. The blots were incubated with diluted culture supernatant of anti-α subunit antibody secreting hybridoma clones. (Splenocytes were harvested from rats or mice immunized with pig or chicken kidney Na,K-ATPase, respectively). Bound antibodies were detected with a horse radish peroxidase-conjugated anti-mouse or anti-rat IgG (Dakopatts or Zymed) and 3-amino-9-ethylcarbazole (Aldrich-Chemie) and H_2O_2 in acetate-buffer.

Isozyme specific antibodies raised against rat α_1, α_2 and α_3 isoforms of Na,K-ATPase were obtained from Upstate Biotechnology Inc., New York, and used for isoform typing of mink kidney enzyme in sandwich ELISA.

Results and discussion

The purification procedure involves separation of the crude membrane fraction from the homogenate by differential centrifugation, treatment of this fraction by detergent, and finally isopycnic zonal centrifugation of the product.

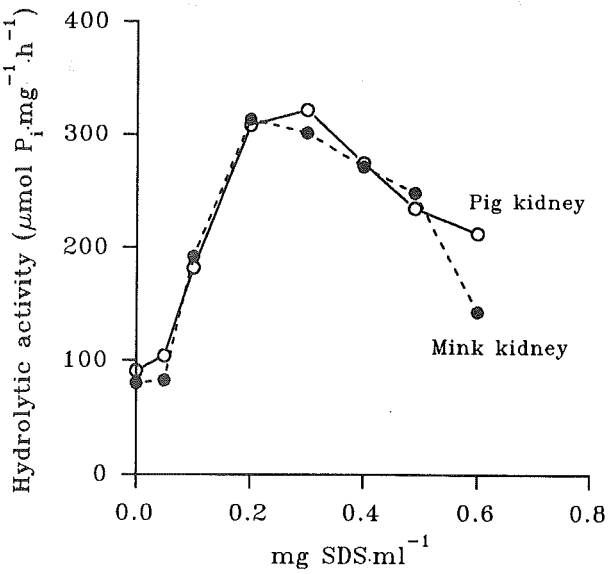

Fig. 1. Activation of Na,K-ATPase activity of crude membrane fractions from mink and pig kidney at different SDS-concentrations. After differential centrifugation of the homogenate the crude membrane fraction (1.5 mg·ml^{-1}) was incubated with SDS at the indicated concentrations for 30 min. at20 °C in the presence of imidazole (pH 7.5, 20°C), EDTA and Na_2ATP (*Jørgensen, 1988*).

During the delicate step of detergent treatment extraneous protein is released from the membranes and latent Na,K-ATPase activity is demasked, probably due to opening of vesicles. From fig. 1 it is seen that demasking of latent Na,K-ATPase activity in crude membranes from pig kidney and mink kidney takes place at identical SDS-concentrations. A 3-4 fold increase in specific activity is noticed in both cases at optimum concentration of SDS. Before zonal centrifugation activation by an SDS-concentration of 0.3 mg·ml^{-1} was selected at the indicated protein concentration.

The most active fractions of the mink kidney enzyme purified by zonal centrifugation were characterized as to ouabain binding affinity and capacity. An example is given in fig. 2, which is a Scatchard-type plot of binding isotherms at equilibrium of binding.

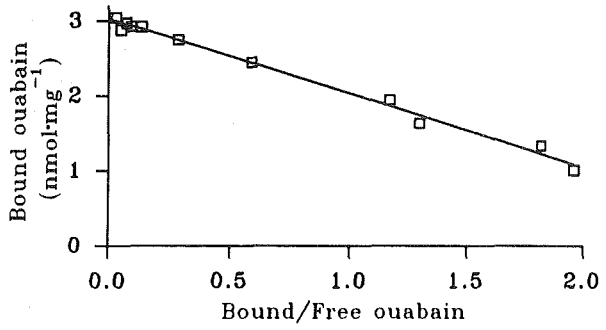

Fig. 2. Scatchard plot of ouabain binding isotherms with purified enzyme isolated from healthy mink kidney. Binding took place with 0.015 mg protein·ml^{-1} in the presence of 3 mM Mg^{2+}, 3 mM Pi and 40 mM Tris-HCl (pH 7.25). Binding isotherms were determined at equilibrium as described (*Hansen, 1976*).

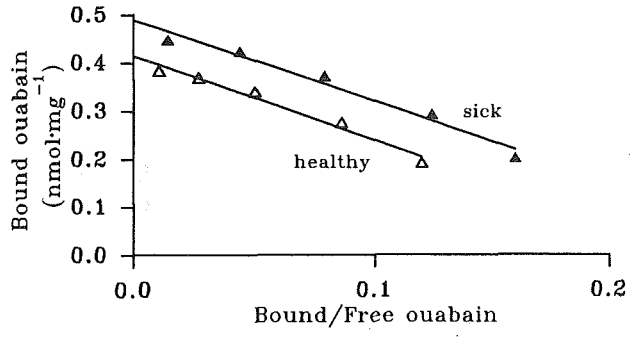

Fig. 3. Scatchard plots of ouabain binding isotherms with membrane fractions isolated from kidney of healthy mink and of dams suffering from nursing sickness. Binding took place with 0.1 mg·ml^{-1} (healthy mink) or 0.097 mg·ml^{-1} (sick mink) in the presence of 3 mM Mg^{2+}, 3 mM Pi and 40 mM Tris-HCl (pH 7.25). Binding isotherms were determined at equilibrium as described (*Hansen, 1976*).

Data are compatible with a straight line and thus only one ouabain binding component is seen. From the ordinate intercept and the slope of the straight line, respectively, it is noticed that the binding capacity is 3.0 nmol·(mg protein)$^{-1}$ and the apparent dissociation constant is 1.0 nM (*Hansen, 1984*). The affinity for cardiac glycosides is thus very high, even though kidney enzymes usually are of the α_1-isozyme type, vide infra.

The SDS-activated crude membrane fraction without further purification was used for solving the question, whether an adaptation took place in mink with nursing sickness, since the fraction at this step according to Jørgensen (1984) contains the major part of Na,K-ATPase in the homogenate. Fig. 3 is a plot of ouabain binding isotherms to the activated crude membrane fraction isolated from kidney outer medulla of healthy mink and dams with nursing sickness (20 versus 7 animals).

It is seen that the apparent ouabain affinity is somewhat lower (K_{dis} 1.7 nM) than in purified enzyme and the ouabain binding capacity per mg protein is 18% lower in healthy mink than in sick females. Sick dams thus seem to have a higher enzyme capacity for reabsorption of Na^+, an observation which is consistent with the very high concentration of aldosterone measured in dams with nursing sickness (*Clausen et al., 1990*) and subsequent enzyme adaptation.

A number of observations on purified mink kidney enzyme is gathered in table 1. The hydrolytic activity is high immediately after preparation of the enzyme but some 20% decrease in activity is seen after freezing. Still, since a careful activation procedure is used and since the enzyme judging from SDS-gel electrophoresis (fig. 4) is pure, the ouabain binding capacity seems remarkably low. Based upon the molecular weight of the α-subunit (M_r 112000) plus the protein component of the ß-subunit (M_r 34000) a ouabain binding capacity of 6.8 nmols per mg protein would be expected in the absence of impurities and denatured protein. The observation suggests the presence of inactive protein, e.g. the existence of a diprotomer, $\alpha_2ß_2$, containing one active and one inactive α-subunit.

Table 1. Hydrolytic activity and ouabain binding capacity of the most active fractions from two productions of purified Na,K-ATPase from mink kidney by sucrose gradient contrifugation.

Na,K-ATPase	K-pNPPase	Ouabain binding capacity
µmol·mg^{-1}·min^{-1}		nmol·mg^{-1}
43.2	6.48	3.2
38.2	6.00	3.2
35.9	5.09	3.0

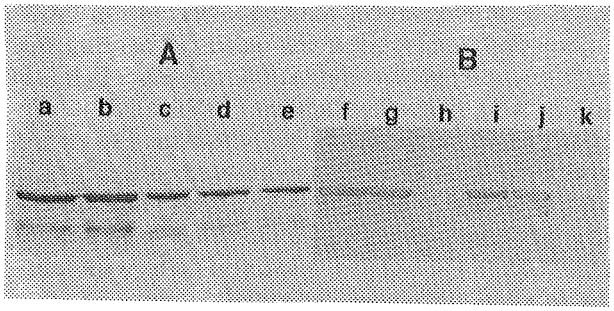

Fig. 4. SDS-polyacrylamide gel electrophoresis (A) and immunoblotting (B) of purified Na,K-ATPase from pig kidney and mink kidney. Lanes a, b, f and g: 2.6 µg (mink), lanes c, h and k: 1.6 µg (pig) and lanes d, e, i and j: 1.6 µg (mink). Electrophoretic blots on Immobilon membranes (B) were incubated with a 1:100 diluted solution of the culture supernatant from hybridoma clone 2F (immunogen chicken renal Na,K-ATPase).

In addition to the SDS-gel fig. 4 also contains immunoblots of mink kidney and for comparison pig kidney Na,K-ATPase. It is seen that the mobility of the ß-peptide from mink kidney is slower than that of pig kidney Na,K-ATPase. Immunostaining reveals that mink α-peptide is recognized by 2F-antibody from mice, which does not recognize pig kidney α-peptide. Canine renal Na,K-ATPase also reacts with 2F-antibody and mink enzyme thus seems to be related to other carnivore α_1-types of the enzyme (personal communication by Dr. D.M. Fambrough, who kindly supplied us with the mice hybridoma). The preference of α_1 was confirmed with an ELISA technique in microplates coated with mink kidney Na,K-ATPase and isoform specific antibodies. A weak reaction with α_2 and α_3 antibodies was also seen, however, which may be explained by species cross reactivity (rat versus mink antigen).

Conclusions

Mink kidney represents a source rich in Na,K-ATPase that may be purified to high specific activity from this species. As expected the kidney enzyme belongs to the carnivore α_1-isozyme subtype. Numerous western laboratories are using dog kidneys as a source of Na,K-ATPase (and probably many other kidney constituents) and mink kidney may thus replace them in this respect.

More specifically, the kidneys from animals suffering from nursing sickness have adapted to the ailment by increasing the concentration of Na,K-ATPase compared to healthy individuals. This observation seems consistent with the low plasma sodium, the extremely low urine sodium concentration and the hyperaldosteronism seen in nursing sickness and may together point to salt depletion as essential in this disorder.

Acknowledgements

We would like to thank Mr. Gert Almind, Ms. Inga Edney, Ms. Lis Hygom and Mr. Toke Nørby for technical assistance. This work was supported by the Danish Biomembrane Research Centre and by the Danish Agricultural and Veterinary Research Council grant 13-4338.

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Original Report

Age related prevalence of coccidia in Danish farmed foxes

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Abstract

A coccidia infection was detected in Danish farmed foxes in 1983-1986. The highest incidence (88%) and intensity of the infection was found in the youngest cubs (2 months old) whereas no infection was detected in foxes aged 6½ months or more.

Introduction

As part of a new field course in terrestrial parasitology at the University of Copenhagen, coccidial infections were registered in foxes reared on a Danish fur farm.

The investigation was repeated yearly until 1987 when the farm stopped keeping foxes. The results from four consecutive years are presented.

Material and methods

From 1983 to 1986 a total of 113 foxes were examined on Gre-Ca Farm, at Grøfte near the city of Sorø in the middle of the island of Zealand. Mostly mink were reared on the farm but until 1986 a substantial number of foxes were also present.

From 1983 to 1985 the cubs were bred on Gre-Ca Farm whereas in the last year, 1986, they were imported from a farm in Jutland. Faecal samples were taken every year on a day in the autumn. The age of the foxes was known from the farm breeding scheme except in 1986 where only a rough age estimate was given. The foxes to be studied were selected in order to obtain an adequate representation of different ages of adults and cubs. Most noted were blue foxes (*Alopex lagopus*).

The foxes were kept in pairs on wire floors.

Fresh faecal samples were obtained from the top of the faecal piles below the cages.

One gram of faeces was dispensed in a mortar in 14 ml saturated NaCl and flotating oocysts were counted in a 0.15 ml subsample in a Macmaster counting chamber.

One count was performed for each fox and therefore 100 oocysts/gram faces was the lowest positive concentration that could be registered.

Results

All oocysts had the same appearance with one end tapering. No more than two sporocysts were seen in the oocysts but further identification was not done.

Faeces of adult foxes were coccidia negative whereas coccidia positive cubs were found in all years (table 1).

When ranked according to the sampling date in table 1 the per cent coccidia positive cubs decreased with the sampling date of the year.

When the compiled data from all years were arranged according to the age of the cubs (table 2) it appeared that a maximum of 88% infected cubs was found in the 2 month old foxes which was the youngest group examined. This was followed by an age dependent decrease in infection frequency until no infection was recorded in subadults aged 195 days.

The amount of oocysts excreted was highest in the youngest cubs (figure 1) where 4 out of 14 (29%) of the cubs between 49 and 67 days old excreted more than 10.000 oocysts per gram of faeces.

No other parasites were found.

Table 1. Frequency of coccidia positive foxes on Gre-Ca Farm.

Year	Sample date	Age class	Number examined	Age in days	Per cent positive
1983	Sept. 1.	Cub	13	59-125	31 %
		Adult	16	464-845	0 %
1984	Aug. 28.	Cub	25	77-128	40 %
		Adult	10	463-839	0 %
1985	Aug. 21.	Cub	24	49-115	54 %
		Adult	5	473-1194	0 %
1986	Oct. 28.	Cub	13	120*	15 %
		Subadult	7	195*	0 %

* The information on the fox age was about 4 and 6½ months respectively.

Table 2. Age group frequency of coccidia positive fox cubs and subadults on Gre-Ca Farm, compiled data from 1983 - 1986.

Number	Age in days	Age in months	% oocyst positive
8	49-60	2	88 %
25	61-90	3	40 %
37	91-120	4	30 %
5	121-150	5	20 %
7	195	6.5	0 %

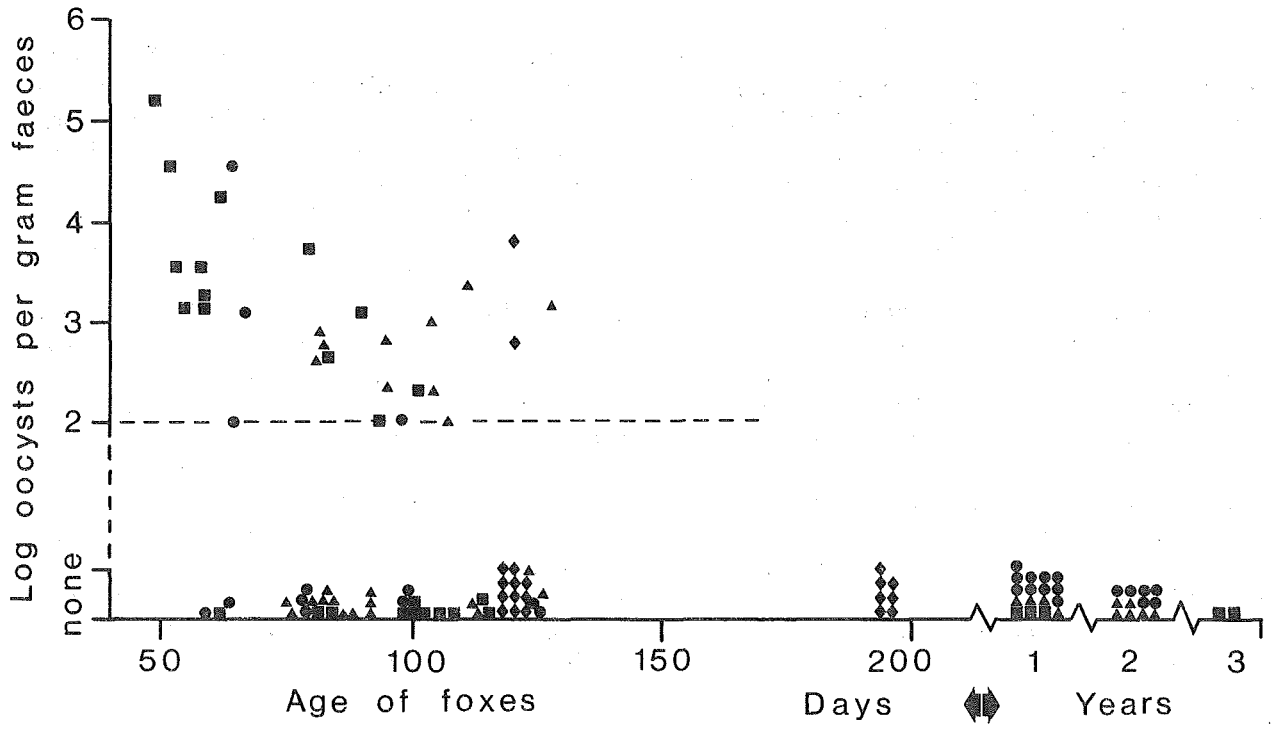

Figure 1. Oocyst output from foxes farmed on Gre-Ca Farm. Samples were obtained in (●) 1983, (▲) 1984, (■) 1985 and (◆) 1986. (- -) indicate method limit of detection.

Discussion

In the present investigation high rates of a coccidia infection were detected in farmed fox cubs but no infections were found in foxes 6½ months old or more.

The results from every year in four consecutive years fitted into the same pattern of incidence and intensity of infection.

No in vitro sporulation of the oocysts was carried out but according to Levine and Ivens, 1981, complete sporulation of Isospora species from farmed foxes takes about 2 days at 25 degrees Celcius. Therefore, the present sampling procedure and the warm season makes it likely that some of the oocysts had sufficient time to sporulate. No more than two sporocysts were seen which suggests the parasite to be an Isospora sp.

According to Rose (1987), immunity to Isospora has not been the subject of much investigation but the results suggest that immune responses to Isospora and Eimeria do not differ significantly. Isospora canis in the dog has been investigated by Lepp and Todd, 1974. This is a host-parasite system related to the present study and the results showed that 1½ and 2½ months old pups given 100.000 oocysts were completely immune to challenge infection when 3½ months old. Thus, it is possible that the age-dependent resistance observed in the present material is a specific acquired immunity. In that case, as all adult foxes show complete resistance, the conclusion would be that all foxes are infected as cubs. This is supported by the present finding of 88% infection in the 2 month old cubs and a coccidia positive period up to 5 months of age which makes it likely that the remaining 12% cubs also become infected.

Henriksen & Andersen (1986) found the highest frequency of coccidial infection to be 64% in July dropping to 43% in August. This is comparable to the present 40% and 54% per cent infection rates recorded from cubs in August in two consecutive years. It might therefore be possible that in July

higher infection rates could have been found among the cubs on Gre-Ca Farm.

In January and April respectively, Henriksen & Andersen (1986) recorded 40% and 43% infected foxes. According to the present results, only adult foxes should be present in these months and therefore no oocyst should be expected. Further investigation is needed to clarify this point.

Twenty-nine per cent of the youngest group of cubs examined (49 to 67 days old) excreted more than 10.000 oocysts per gram faeces. According to Henriksen & Andersen (1986) infections of this size are regarded as clinically significant, causing diarrhea in mammals. Gre-Ca Farm had no experience of gastrointestinal disease problems in the foxes. This is supported by Rose (1987), stating a lack of pathogenicity and econonomic significance of Isospora compared to Eimeria, but the present results suggest the possibility of clinical isosporidiosis in young fox cubs.

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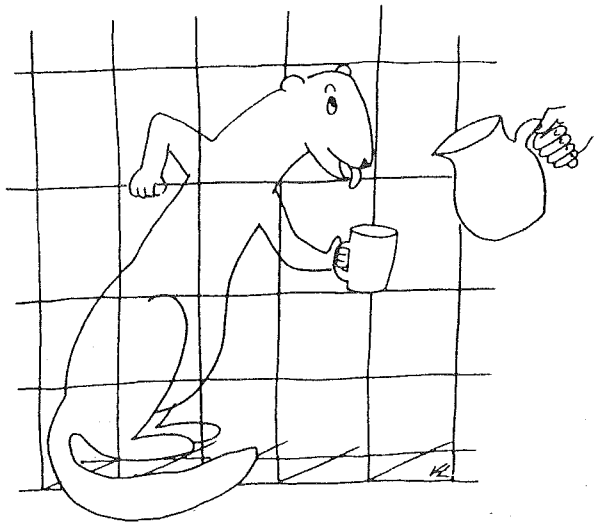


Prevalence of *Campylobacter jejuni* in ranch mink at pelting: Cultural, serological, and histological evidence of infection.

Judith A. Bell, Dean D. Manning.

This survey of 500 mink on three Wisconsin ranches at pelting gives an estimate of the prevalence of *Campylobacter jejuni* in the feces of clinically normal animals. On ranches 1 and 2, which used wet feed, *C. jejuni* was isolated by colon content culture from 7% and 32% of mink one year, and 43% and 13% the next year; the 200 bile samples tested were culture-negative. On ranch 3, which fed a pelleted ration, the organism was never isolated. Among culture-positive mink tested, 22 of 55 had bacterial agglutination serum titers to homologous and/or heterologous *Campylobacter* isolates from the ranch of origin. Four of 23 culture-negative animals tested had titers. No histological evidence of inflammatory changes in the lower ileum and/or colon was found, although *Campylobacter*-like organisms were rarely seen in silver-stained sections from both culture-negative and culture-positive animals. We conclude that the presence of *C. jejuni* in the mink gut does not necessarily indicate a role in gastrointestinal disease.

Can Vet J; 31;5: 367-371, 1990. 3 tables, 29 references. Authors' summary.

Rodenciosis in otters (*Myocastor coypus*) from a commercial breeding unit: First findings in Argentina.

A.L. Cipolla, P.E. Martino, J.A. Villar, M. Catena.

This work describes the first findings of rodenciosis in otters (*Myocastor coypus*) from a commercial breeding unit of Argentina. From a total of 60 animals, 4 were affected in two consecutive years. *Yersinia pseudotuberculosis* was isolated from nodular lesions found in liver, spleen, lung and mesenteric lymph nodes. The histopathology showed necrotic foci surrounded by inflammatory cells, but no giant cells were observed. The role played by rodents in the epidemiology of the disease is discussed. Prophlactic measures and the risk of its transmission to man are mentioned.

Rev. Arg. Prod. Anim. Vol. 7, No. 5: 481-486, 1987. 3 figs., 35 references. In SPAN, Su. ENGL. Authors' summary.

***Trichinella* infection in the ferret: A model for the hyperresponsive syndrome in occult lymphatic filariasis.**

J. Thompson, R. Haberkorn, R. Crandall, C. Crandall.

Ferrets infected with *Trichinella* and injected with *Brugia malayi* microfilariae (mf) were used as a model to evaluate the pathology induced by drug treatment in filariasis and by immune sera reactive with mf. Ferrets orally infected with 500-700 *Trichinella* larvae 1 month before iv injection of 10^6 mf developed within 4 days liver and lung histopathology characteristic of the hyperresponsive syndrome. Passive transfer of sera containing a high titer IgG antibody to the mf sheath cleared circulating mf and reduced the inflammatory respones to mf. Ferrets injected with mf were injected with Ivermectin (0.5 mg/kg). Microfilaremia was reduced within 24 hours after treatment in both *Trichinella*-infected and control-infected ferrets following iv injection of mf exhibiting the histopathology of a hyperresponsive syndrome within 4 days, and drug treatment did not appear to alter this response.

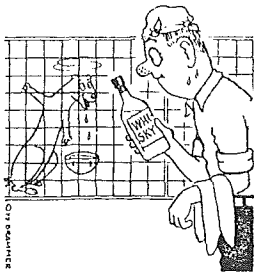
Trichinellosis Proceedings of the Seventh International Conference on Trichinellosis, Alicante, Spain, 2-6 October 1988 (edited by C.E. Tanner, A.R. Martinez-Fernandez and F. Bolas-Fernandez) 287-292, 1989. 1 table, 2 figs., 7 references. Authors' summary.

Muscular dystrophies.

N.J.H. Sharp, J.N. Kornegay, S.B. Lane.

Topics covered in this review are Golden Retriever muscular dystrophy, Irish Terrier myopathy, dystrophy-like myopathy in cats and muscular dystrophies in other species, laboratory animals, mink and chickens.

Seminars in Veterinary Medicine and Surgery (small animal); 4; 2: 133-140, 1989. 6 figs., 38 references. CAB-abstract.



Pathological findings indicative of distemper in European seals.

A. Bergman, B. Järplid, B.-M. Svensson.

The first recorded cases of the recent epizootic were harbour seals observed at the Danish island Anholt, 12 April 1988. The disease then spread throughout the sea waters of north-western Europe. The total mortality in Europe up to November 1988, was estimated to be at least 17000 seals. The mortality rate in Danish-Swedish waters was about 60%.

Autopsies including sampling for histology of most organs were performed on 37 harbour seals and 12 grey seals, collected mainly at the Swedish west coast and in the southern Baltic. In most of the harbour seals and in three of the grey seals we found histological changes in the upper and lower respiratory tracts, in the lower urinary tract and in the lymphatic system consistent with those diagnostic of distemper viral infection in the canine. These diagnostic criteria were: presence of intracytoplasmic eosinophilic inclusion bodies of epithelial cells of the trachea and the urinary bladder, interstitial pneumonia, and atrophy of lymphatic organs due to depletion of lymphocytes. Our findings in pathology of a canine distemper-like disease in the seals were presented in late August 1988 together with the Dutch findings in virology by Dr. Osterhaus and collaborators.

Veterinary Microbiology, 23: 331-341, 1990. 9 figs., 18 references. Authors' summary.

Original vaccine against dermatomycoses of animals.

A.M. Litvinov.

The contagious skin disease, caused by certain parasitic fungi, has a world-wide distribution. "Ringworm" (dermatomycosis) in cattle has been reported by FAO in 113 countries. The disease may cause economic loss in calf-rearing colonies, rabbit and fur-animal ranches and may effect horse, sheep and goat and pet animals, respectively. Traditional treatment was found to be temporarily effective. Research institutes in the Soviet Union developed specific vaccines: LFT-130, SzP-1 and Mentavak. Large amounts of vaccines are produced and exported. The author presents a detailed report on experiences connected with the use of these vaccines during the last 20 years. The most important information - on administration, dose, reaction to vaccination and immunity duration to be expected - are given for each of the above vaccines. Prophylactic and treatment effects are estimated at 99.8 per cent. Establishing immunised stocks is of public health importance, immunised affected animals being no danger of infection to people.

Phylaxia Allatorvosi Kozlemenyek (Hungary) v. 25 (1), p. 13-17, 75, 1989. Journal article; Review article. In HUNG. CAB-abstract.

Epidemiological Information Systems
OIE Scientific and Technical Review,
Vol. 19 (1), March 1991, 232 pp.

The present issue contains 9 papers written by leading epidemiologists from America, Asia/Oceania and Europe. It presents work conducted to improve the efficiency of existing systems or to outline new approaches which offer a better study of the complex phenomena encountered in the field.

The first group of three papers deals with principles on which modern information systems should be based if they are to benefit those who use them. One paper describes objectives which should form the basis for developing an integrated national animal health information system.

Another paper describes steps in the implementation of a micro-computer approach to the management of animal disease information. One paper discusses the OIE worldwide information system.

Two papers describe applications of animal health information management to nomadic and transhumant livestock populations in Africa. A discription of a system of investigations introduced into Senegal in 1983 is performed.

Four papers deal with specific techniques which are finding a wider use of applications in veterinary epidemiology. These are application of the techniques of ecopathology to the investigation of health problems on farms, geographic information systems and remote sensing imagery, as a technique for obtaining disease-related data. The implementation of epidemiological and ecological methods in the control of tuberculosis in badgers is described.

The issue closes with a presentation of the newly emerging discipline of quantitative risk assessment which has wide application in the field of public health and animal health.

All papers are written in English with summaries in French and Spanish. Two papers are written in both English and French in their full length. Each paper contains a comprehensive list of references.

Reviewed by Birthe M. Damgaard, DVM, Natl. Inst. of Animal Science, Denmark.

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Dear Sir:

As a longtime reader and occasional contributor to Scientifur, I like to express my disappointment about the decision not to publish original articles any longer. It is true that these articles can be published in a variety of other scientific journals but since they address a field of relatively narrow specialty they are only of peripheral interest to many readers of these journals.

I thought with the introduction of peer reviewed articles into Scientifur, the publication gained considerably in reputation at Scientific Institutions and their subscribing libraries. I quite liked the idea to have fur animal related articles concentrated in one specialty publication. I was also to suggest a publication fee to authors as is done in most other journals. This may have helped to defer some of the publication costs. At any rate this is just one man's opinion.

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Dip.Vet.Path.

DKO/ew

Mr. Gunnar Jørgensen
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Miguel de Mariscal
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Bilbao, 11th March, 1991.

Dear Sirs,

I am a Spanish recently graduated veterinarian interested in the Mink. I studied the fourth year of the Veterinary Medicine course at Glasgow University Veterinary School and during my last year I worked at times in a mink farm in Mutriku (Guipuzcoa, Spain).

Since there is not much to do in this field in my country I would like to know whether somebody like me could go somewhere in Denmark or any other of the Scandinavian countries to work preferably, but also to study in the field.

I suspect through Scientifur that you are quite a busy person and would not want at all to disturb you much but in any case, I shall thank you in advance for your attention.

Yours sincerely,

Miguel de Mariscal.

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